Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Environmental Impact Statement

Chapter 6 Nature conservation

November 2013

Table of contents

Table index

Figure index

6. Nature conservation

6.1 Purpose of chapter

The purpose of this chapter is to assess the potential impacts of the NGBR Project on terrestrial and aquatic ecology. It includes an overview of the existing environment, consideration of potential construction and operation impacts, and the identification of proposed mitigation and management measures. A detailed existing environment report for nature conservation, including sensitive environmental areas, terrestrial flora, terrestrial fauna and aquatic biology and ecology was prepared and is provided in Volume 2 Appendix F Nature conservation. This chapter summarises the key findings of the existing environment report and identifies the potential impacts of the proposed mitigation and management practices to be employed during the NGBR Project.

The terrestrial and aquatic ecological values that are considered in this chapter include:

- Broad vegetation communities and habitats for terrestrial fauna
- Regional Ecosystems (REs) and regulated regrowth protected under the Vegetation Management Act 1999 (VM Act)
- Flora species 'confirmed present' or considered 'likely to occur', including those listed as threatened under the Nature Conservation Act 1992 (NC Act), Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and species listed as least concern under the NC Act
- Terrestrial fauna species 'confirmed present' or considered 'likely to occur', including those listed as threatened under the NC Act, EPBC Act and species listed as least concern under the NC Act
- Wetlands, watercourses and other aquatic habitats
- Aquatic fauna and flora species confirmed present or considered 'likely to occur', including those listed as threatened under the NC Act, EPBC Act and species listed as least concern under the NC Act.

Terrestrial and aquatic ecological values that are Matters of National Environmental Significance (MNES), protected under the EPBC Act, are identified in this chapter; however, they are discussed in detail within Volume 1 Chapter 7 MNES.

This nature conservation chapter was prepared in accordance with the Terms of Reference (TOR) for the NGBR Project. A table that cross-references the contents of this chapter and the TOR is included as Volume 2 Appendix A TOR cross-reference table.

All mitigation and management measures identified within this chapter are included within Volume 2 Appendix P Environmental management framework.

6.2 Methodology

6.2.1 Study area

This chapter considers vegetation communities, terrestrial and aquatic fauna habitats and flora and fauna species that are present or are likely to be present in the preliminary investigation corridor (nominally 1,000 m in width). In order to understand large-scale vegetation communities, landscape-induced patterns, sub-catchment scale processes and the broader distribution of species and habitat (and the role areas within the preliminary investigation corridor plays in these), the study area included areas beyond the preliminary investigation corridor where appropriate. Therefore, the study area encompasses the preliminary investigation corridor (approximately 300 km in length), as well as the broader landscape in which this corridor is located. This includes surface watercourses and their watersheds, floodplains and wetlands.

Where the NGBR Project connects with supporting infrastructure (rail loop/s and port infrastructure) at the Port of Abbot Point, full identification and description of ecological values has not been undertaken. Values associated with the balloon loop and broader Adani Terminal 0 development, including the coal dumping station for unloading coal trains and its associated surrounding landscape, are being assessed as part of the Terminal 0 project.

The final NGBR Project footprint (consisting of a nominal 100 m wide final rail corridor and ancillary infrastructure) was used for calculating vegetation clearing impacts.

6.2.2 Desktop assessment

A desktop assessment was conducted so that a targeted and informed field investigation could be undertaken. Historical records from the area were also used to supplement findings from the field investigation. The desktop assessment involved searching a variety of literature and publicly available database sources for information on the terrestrial and aquatic ecological values of the study area. These sources included:

- The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) Protected Matters Search Tool and Directory of Important Wetlands
- The former Queensland Department of Environment and Resource Management (DERM) Essential Habitat mapping (Version 3), Burdekin Natural Resource Management Region Back on Track Actions for Biodiversity report, Biodiversity Planning Assessment expert panel report and mapping, RE and regrowth mapping (Version 6.1), HERBRECS Specimen Database
- Queensland Museum database search
- Birds Australia Bird Atlas data
- Publicly available Environmental Impact Statement documents for projects in the region
- Abbot Point cumulative impact assessment report (Eco Logical Australia (ELA) and Open Lines 2013)
- Department of Environment and Heritage Protection (DEHP) Wetland mapping

- DEHP Wildlife Online Database
- Protected Matters Search Tool and Environmental Reporting Tool
- Aquatic Conservation Assessments, using AquaBAMM, for the Riverine and Non-Riverine Wetlands of the Great Barrier Reef Catchment, Inglis and Howell 2009
- Freshwater Fishes of North-Eastern Australia, Pusey *et al.* 2004
- Freshwater Fish of Burdekin Dry Tropics Natural Resource Management Region, Carter and Tait 2008.

Many of these desktop sources collate historical records from across all seasons, ranging from 1870 through to 2012. However, in many instances the record date was not specified.

6.2.3 Field surveys

Overview

Targeted field surveys were undertaken during May and June 2013 to provide current, site-specific information on key terrestrial and aquatic habitats within the preliminary investigation corridor and wider study area. These surveys identified the characteristics and attributes of representative habitats and the diversity and abundance of terrestrial and aquatic flora and fauna species. This field data supplemented and verified information gathered during the desktop assessment outlined in Section 6.2.2. Based on the desktop assessment, RE mapping and aerial photography were used to provide a broad indication of the diversity and distribution of habitats across the landscape within the preliminary investigation corridor and to inform the selection of survey sites. Representative data collected for communities and habitats was then extrapolated to those areas not directly accessible during the survey.

Average weather conditions during the survey periods are summarised below:

- 7 to 11 May: average temperature range: 16.1 °C – 25.6 °C; rainfall: 12.2 mm (data sourced from Moranbah (Station ID 34035))
- 12 to 15 May: average temperature range: 16.3 °C – 27.5 °C; rainfall: 0.6 mm (data sourced from Collinsville (Station ID 33013))
- 16 to 17 May: average temperature range: 18.2 °C – 25.2 °C; rainfall: 26.4 mm (data sourced from Bowen (Station ID 033257))
- 13 to 14 June: average temperature range: 11.1 °C – 25.8 °C; rainfall: 0.2 mm (data sourced from Moranbah (Station ID 34035)).

Weather conditions both preceding and during field surveys were suitable for detecting the presence of targeted flora and fauna species during field surveys.

The field survey included random traverses of the preliminary investigation corridor and survey of selected sites.

Indigenous involvement by representative traditional owner groups has been sought separately as part of the cultural heritage clearances for the NGBR Project in accordance with CHMPs being developed in parallel to the EIS. Significant findings regarding flora or fauna with indigenous values will be incorporated into the Environmental Management Plan (see Volume 2 Appendix F Nature Conservation)as applicable.

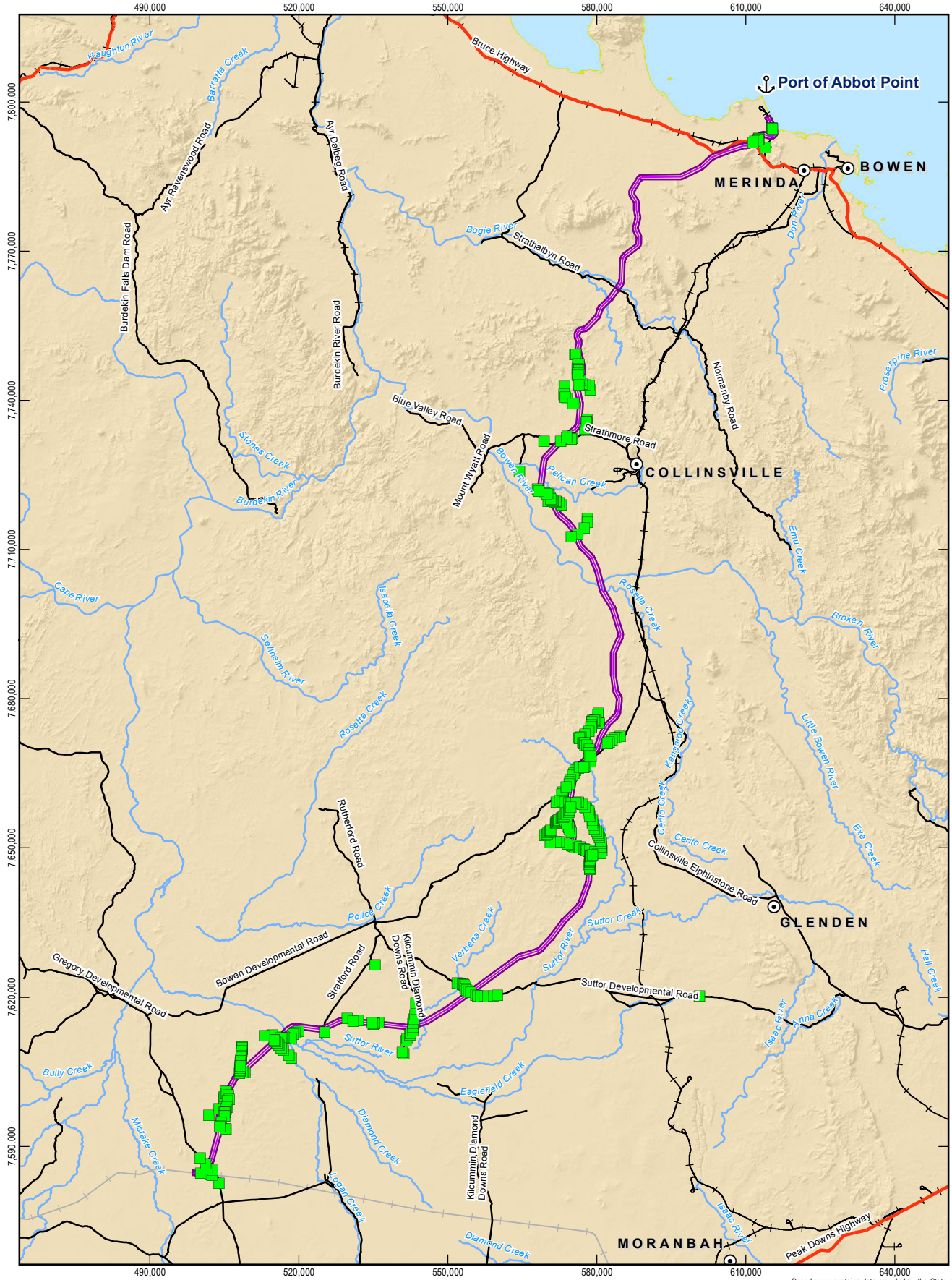
Terrestrial flora assessment

The terrestrial survey sites were selected to target vegetation communities (or REs) and habitat types considered to be representative of the highest diversity within the preliminary investigation corridor. In particular, sites considered as or likely to be 'sensitive' or 'areas of special sensitivity' as defined in the 'Sensitive Environmental Areas' section of the draft TOR (see Volume 2 Appendix A TOR cross reference) were targeted for surveys. Such sites included mapped 'endangered' or 'of concern' remnant vegetation, mapped essential habitat, vegetation that forms important habitat for threatened species, and ecosystems that provide important function such as riparian vegetation and wetlands. In addition, the identity and location of declared weeds and other exotic species was also recorded.

Flora surveys were undertaken at 350 quaternary level survey sites, using the CORVEG methodology developed by the Queensland Herbarium. Targeted searches were undertaken opportunistically where suitable habitat for threatened flora species was observed. Random meanders (Cropper 1993) were also undertaken at many quaternary survey sites and involved random traverses of vegetation while searching for threatened species and other species of interest. In addition to searches for threatened species and species of interest, at each survey site, RE mapping was ground truthed using the CORVEG quaternary methodology.

At representative sites, the condition of vegetation communities was assessed using the Vegetation Assets, States and Transitions (VAST) methodology (Thackway & Lesslie 2005).

The locations of terrestrial flora survey sites are presented in Figure 6-1.



LEGEND

- Population Centres
- Major Port
- Flora Survey Sites
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Flora survey sites

Figure 6-1

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Flora Survey Sites. Created by:MS

Terrestrial fauna assessment

Field surveys were undertaken to identify the terrestrial fauna habitat values within the preliminary investigation corridor, in accordance with the Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland (Eyre *et al.* 2012).

An integrated suite of standard fauna detection methods formed the focus of the fieldwork, with no reliance upon a single methodology. This included habitat assessments (to include condition, species associations with specific vegetation communities and the presence or absence of key micro-habitat features), timed bird surveys, diurnal active searches, nocturnal surveys (spotlighting, call playback, nocturnal active searches, and microchiropteran bat call detection), threatened species surveys, waterbody watches and assessments of habitat values of the eastern fringe of the Caley Valley Wetland, which is adjacent to the preliminary investigation corridor.

A total of 50 terrestrial fauna habitat assessments were undertaken during field surveys. A summary of the terrestrial fauna survey effort is presented in Table 6-1.

Table 6-1 Summary of fauna survey effort

Survey method	Number of sites	Person hours
Terrestrial fauna habitat assessment	50	25
Standardised bird survey	47	28
Diurnal active search	34	37
Nocturnal survey (walking and vehicle transects)	26	21
Nocturnal anabat sites	13	48
Nocturnal call playback	6	3
Bird surveys on eastern fringe of Caley Valley Wetland	3	3
Total number of person hours for fauna surveys		165

The locations of terrestrial fauna survey sites are presented in Figure 6-2 and Figure 6-3.

Surveys were also undertaken for threatened fauna species (listed under the NC Act and/ or EPBC Act) considered 'likely to occur' or 'confirmed present' within the preliminary investigation corridor. These species included:

- Black-throated finch (southern) (*Poephila cincta cincta*) (NC Act; EPBC Act)
- Squatter pigeon (southern) (*Geophaps scripta scripta*) (NC Act; EPBC Act)
- Ornamental snake (*Denisonia maculata*) (NC Act; EPBC Act)
- Brigalow scaly-foot (*Paradelma orientalis*) (NC Act)
- Striped-tailed delma (*Delma labialis*) (NC Act)
- Koala (*Phascolarctos cinereus*) (EPBC Act).

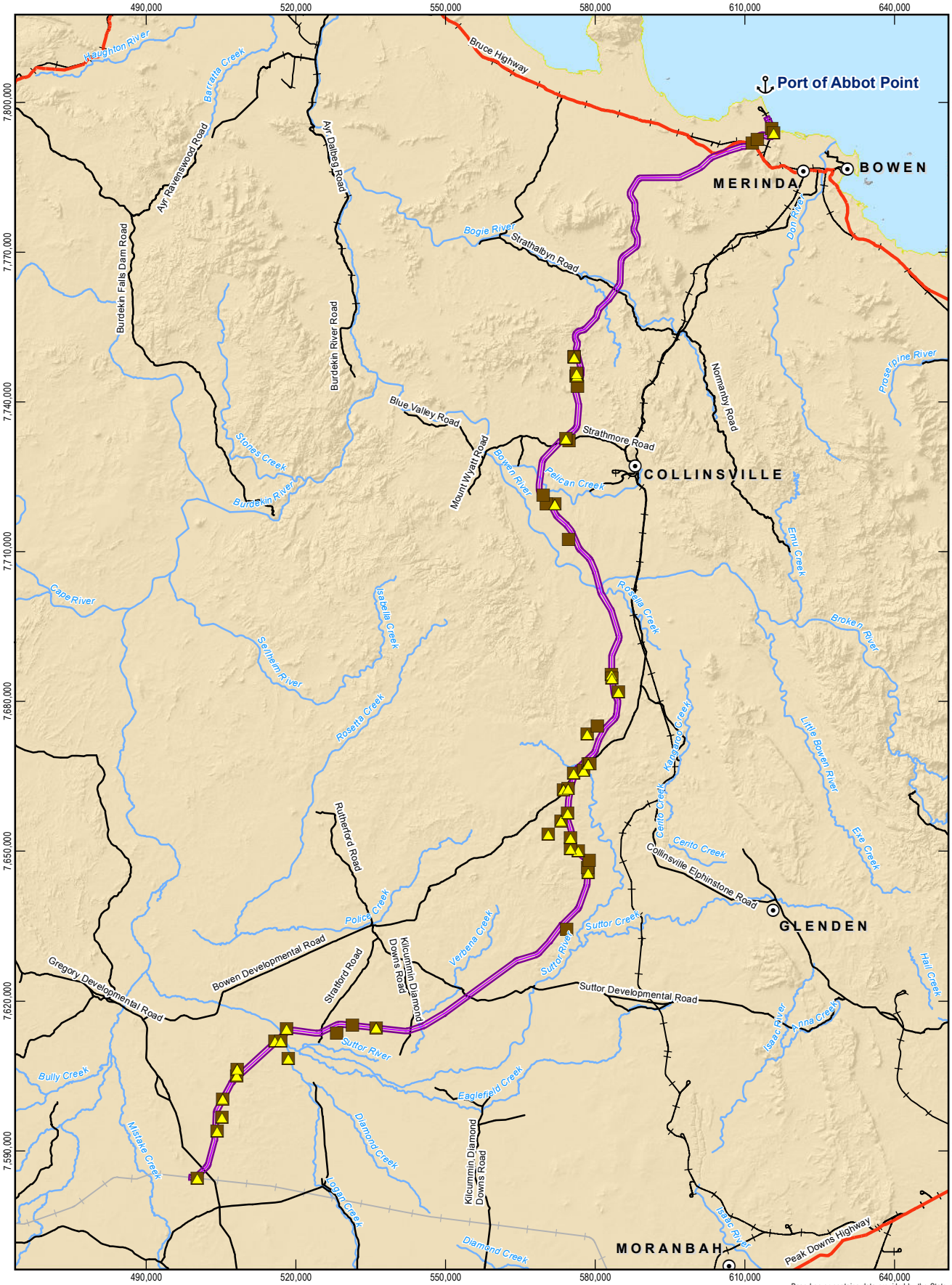
The survey locations for these threatened species are provided in Figure 6-4 and targeted survey techniques are detailed in Volume 2 Appendix F Nature conservation.

An assessment of the habitat values of the eastern fringe of the Caley Valley Wetland was also undertaken. The objective of this survey was to supplement existing information on the characteristics and values of this area for water birds, including migratory species. The survey involved a combination of habitat assessments and timed point observations at three locations where the preliminary investigation corridor occurs adjacent to the wetland.

The field survey methodology employed during the field surveys did not involve trapping for small ground-dwelling fauna. The rationale for this approach was based upon a number of drivers, as follows:

- As many sites as possible were assessed to develop a greater level of understanding of the types of habitats within and near the preliminary investigation corridor, including the characteristics and attributes of these habitats, the condition of habitats, species diversity within these habitats, and the likely value of habitats for conservation significant species. This involved increased sampling effort in those habitats that are most widespread (such as open woodland, fringing woodland and non-remnant vegetation), as opposed to focusing on a small number of detailed and localised (trapping) assessment sites.
- More time was invested in alternative fauna survey techniques that have been found to be effective means of detecting fauna including cryptic ground-dwelling species in recent project experiences in the Brigalow Belt bioregion (SEWPaC 2011a; SEWPaC 2013g; Porter 1998)
- More time was invested in targeted surveys for species of conservation significance, especially in consideration of extremely low success rates of trapping for threatened reptiles (Kutt *et al* 2003; Kutt *et al* 2012; Kutt and Fisher 2011; SEWPaC 2011a)
- Broad patterns of association between habitats and fauna species in the landscape in which the preliminary investigation corridor occurs were deciphered, through a combination of greater level of sampling effort (via accessing numerous survey sites) and an integrated suite of fauna detection methods. As a major impact of the NGBR Project could be habitat fragmentation at the landscape scale, identifying these patterns of association was considered to be an important component of the impact assessment and mitigation process.

Recent project experience and a review of relevant literature would suggest that trapping typically results in the capture of locally-abundant species whose presence could otherwise be detected using alternative survey techniques, such as spotlighting or active searching, or (at least) expected via a habitat suitability or likelihood of occurrence approach underpinned by a review of desktop information.



LEGEND

- Population Centres
- Major Port
- Fauna Habitat Assessment Site
- Diurnal Active Search Site
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project

Terrestrial fauna habitat survey sites and diurnal active search locations

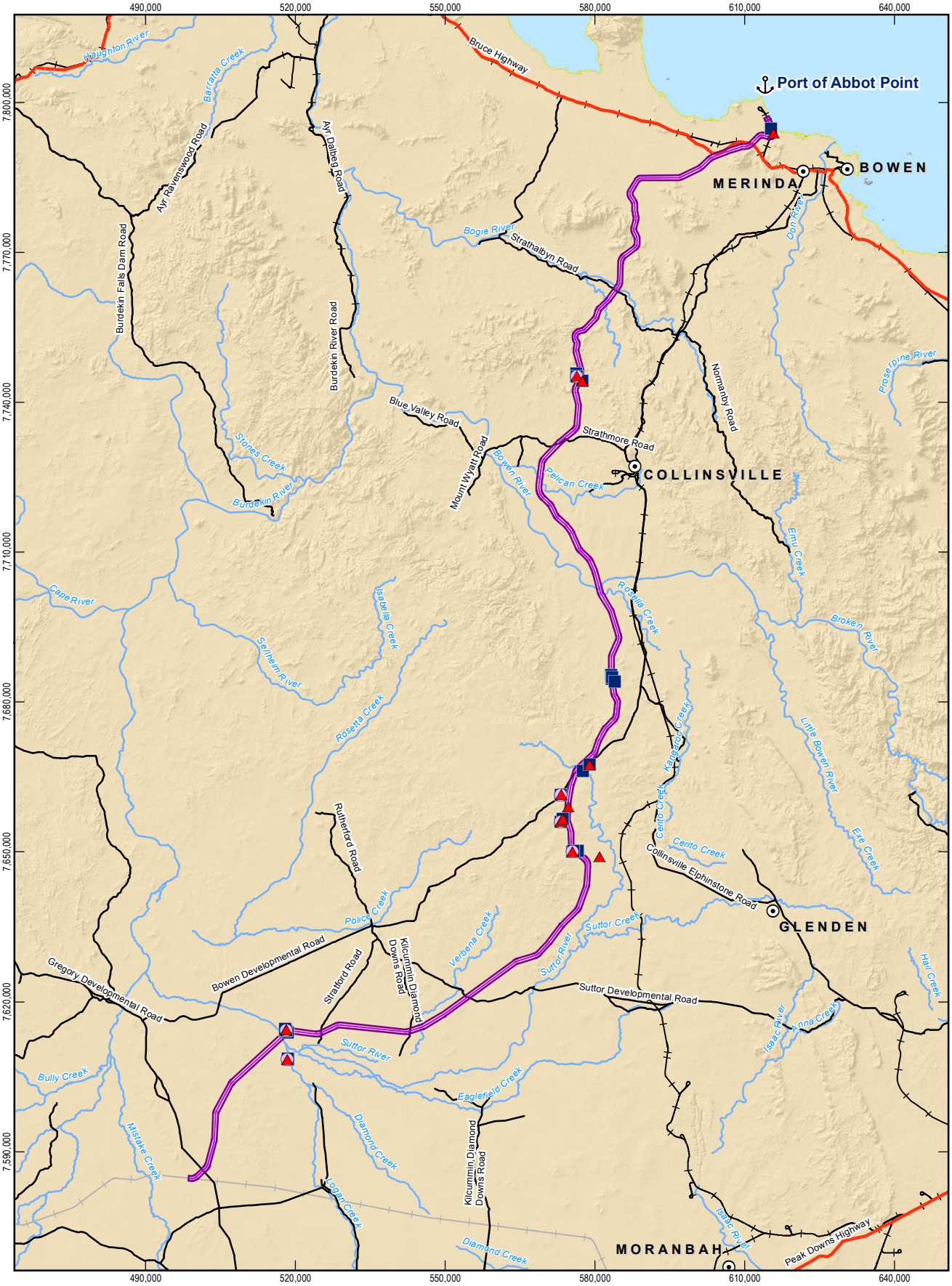
Job Number	41-26457
Revision	A
Date	22 Aug 2013

Figure 6-2

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1108_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Fauna Survey Sites/2013. Created by:MS



LEGEND

- Population Centres
- Major Port
- Anabat Location
- Call Playback Location
- Nocturnal Active Search Site
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

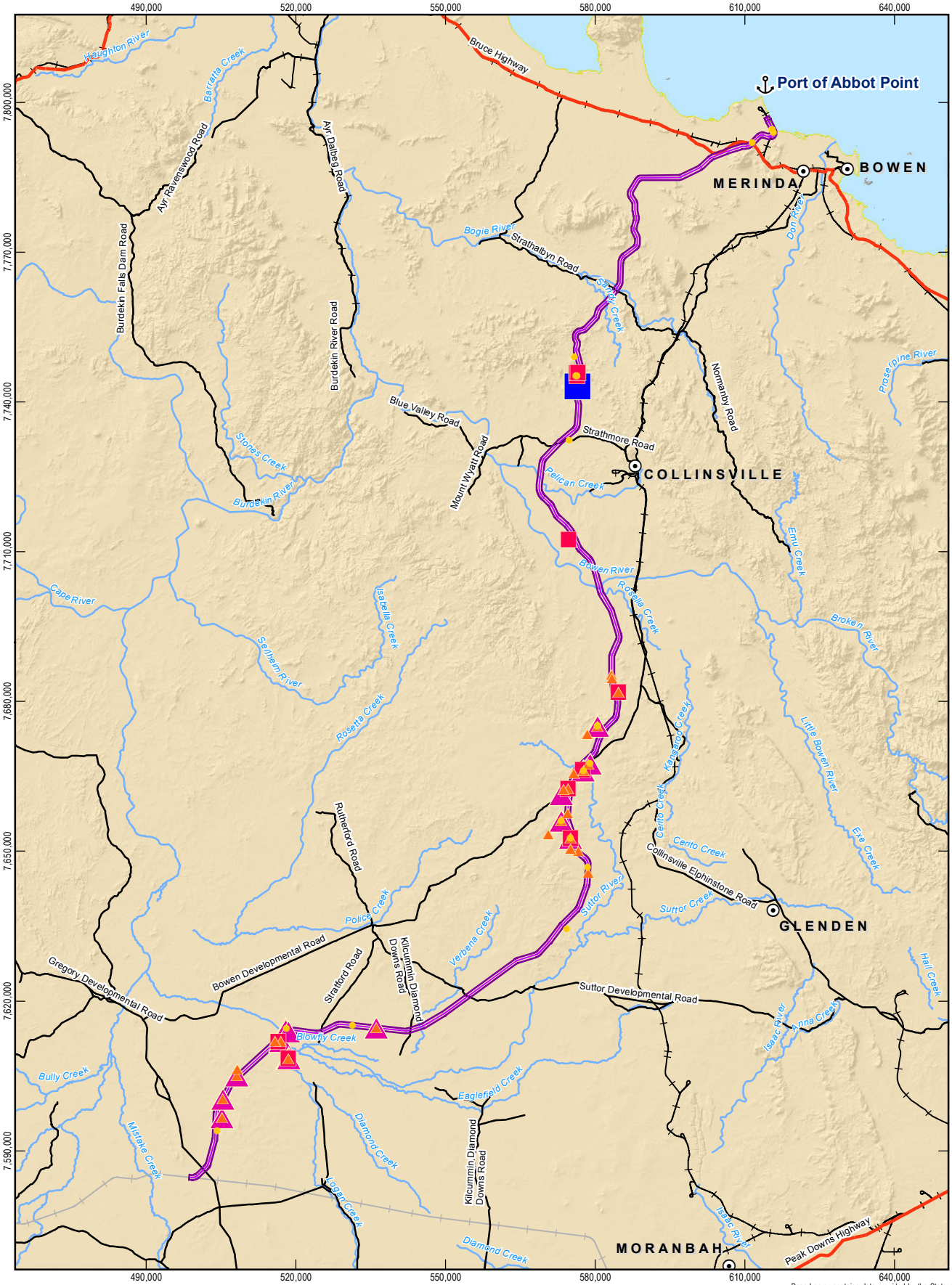
Fauna nocturnal survey sites, anabat and call playback locations

Figure 6-3

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1111_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Noturnal Survey Sites/2013. Created by:MS



LEGEND

- Population Centres
- Major Port
- Black-throated finch
- Brigalow scaly-foot
- Koala
- Ornamental snake
- Stripe-tailed delma
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number 41-26457
Revision A
Date 22 Aug 2013

Threatened species survey locations

Figure 6-4

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1114_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Targeted Species Survey Sites/2013. Created by:MS

Aquatic ecology assessment

Field surveys were conducted to identify aquatic flora, fauna and habitat characteristics within the preliminary investigation corridor and study area. For the purposes of the aquatic ecology assessment, aquatic fauna species of interest included fish, freshwater turtles, crocodiles and freshwater macroinvertebrates. Aquatic habitats were assessed in terms of their habitat diversity and extent, suitability for aquatic fauna groups, sensitivity to change, existing disturbances / modifications or barriers, riparian condition and flow characteristics. All sites were assessed using Queensland River Assessment System protocols (AUSRIVAS).

Aquatic survey sites were selected to represent the diverse range of aquatic habitats in the preliminary investigation corridor including artificial dams, wetlands, drainage lines, small streams and rivers. The locations of aquatic habitat assessment sites are presented in Figure 6-5.

6.2.4 Likelihood of occurrence assessment

The information collected from desktop and field assessments was used to identify the existing ecological values of the preliminary investigation corridor. These ecological values were in turn used to develop a likelihood of occurrence assessment for conservation significant flora and fauna species. The likelihood of occurrence assessments incorporated the following considerations for each given species:

- Known distribution
- Habitat preferences
- The presence and availability of suitable habitat in the preliminary investigation corridor
- Relative abundance
- Previous records from desktop sources (based on seasonal historical records)
- Observations of the species in the preliminary investigation corridor.

For each given species, the likelihood of occurrence was assessed using the following categories:

- **Unlikely to occur**: species has not been recorded in the region (no records from desktop searches) AND/OR current known distribution does not encompass preliminary investigation corridor AND/OR suitable habitat is generally lacking from the preliminary investigation corridor
- **May occur**: species either has or has not been recorded in the region (desktop searches) although species' distribution incorporates preliminary investigation corridor AND potentially suitable habitat occurs in the preliminary investigation corridor (but may not be particularly abundant or optimal habitat)
- **Likely to occur**: species has been recorded in the region (desktop searches) AND suitable habitat is present in the preliminary investigation corridor (species determined to be likely to occur are otherwise known to occur within the preliminary investigation corridor or wider study area, and has suitable habitat present; however were not recorded during field surveys)
- **Confirmed present**: species recorded during field surveys in the preliminary investigation corridor

Species assigned to categories unlikely to occur or may occur are not specifically assessed in the impact assessment component of this chapter, since significant impacts to these species are unlikely and the objective of the assessment is to focus on key issues that need to be taken into account in decision making (EIANZ, 2010).

6.2.5 Predictive habitat mapping

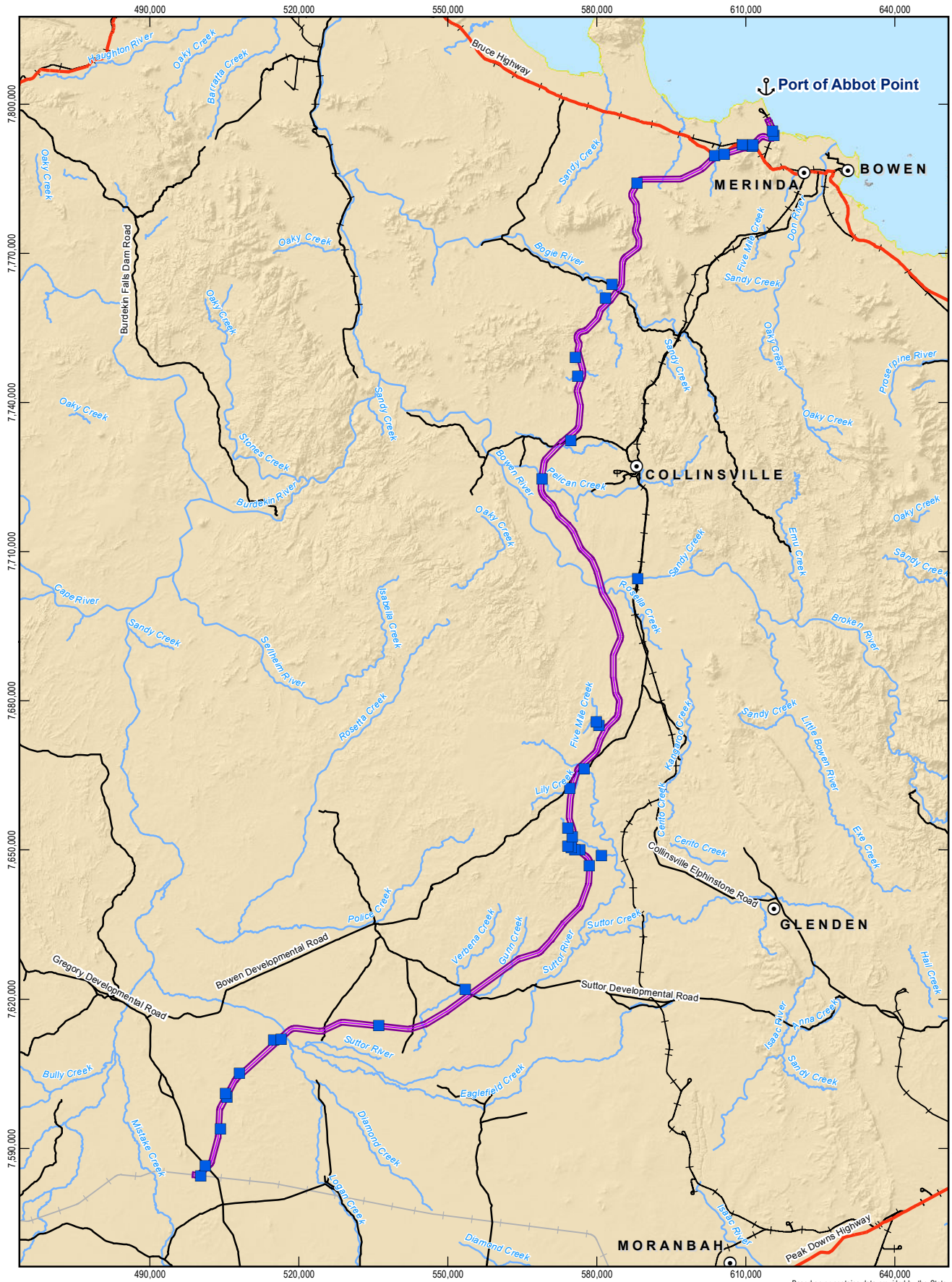
Predictive habitat mapping was undertaken for NC Act and EPBC Act listed flora and fauna species confirmed present or assessed as likely to occur in the preliminary investigation corridor. For each species, habitat requirements were identified and assessed against existing environmental information using an analysis of various habitat characteristics. This allowed for the mapping of likely suitable habitat and therefore the identification of potential habitat distribution of listed species. Where possible, potential habitat mapping was validated using field observations and publicly available sightings data.

6.2.6 Assessment of impacts

It is considered that the applied dataset is sufficiently robust for the purposes of the assessment of impacts of the NGBR Project on key ecological values across the NGBR Project:

- Survey data collected to date
- Desktop gap analysis, including
  - Data from other assessments (incorporating seasonality information, where available)
  - Broader historical records and database searches
- The conservative approach to likelihood of occurrence
- The nature of the NGBR Project (linear infrastructure).

One round of post-wet season survey has been carried out to date. Further survey work will be carried out to verify the findings of the impact assessment and survey effort to date, to include data collected during the dry season and extending to detailed pre-clearance surveys prior to construction.



1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Aquatic habitat assessment sites

Figure 6-5

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1116_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Aquatic Survey Sites/2013. Created by:MS

6.3 Existing Environment

6.3.1 Regional context

The preliminary investigation corridor traverses through the Brigalow Belt bioregion and two river basins. Approximately 150 km of the preliminary investigation corridor traverses the Burdekin River Basin, while approximately 50 km traverses through the Don River Basin (refer to Figure 6-6).

Brigalow Belt bioregion

The Brigalow Belt bioregion is a large, complex area covering approximately 365,326 km^2 of central Queensland, extending south from Townsville to Narrabri in New South Wales (Sattler and Williams 1999). The Brigalow Belt bioregion is characterised by brigalow (*Acacia harpophylla*) dominated forests and woodlands on clay soils (Sattler and Williams 1999). In addition to brigalow, other communities that characterise the bioregion are eucalypt forests and woodlands, grasslands, dry rainforests, cypress pine woodland and riparian communities (Sattler and Williams 1999).

The NGBR Project is located in the far north of the Brigalow Belt bioregion, traversing five subregions of the Brigalow Belt North bioregion (Townsville Plains, Bogie River Hills, Northern Bowen Basin, Wyarra Hills and Belyando Downs). These subregions neatly correlate to five major landscapes the preliminary investigation corridor traverses.

Burdekin River Basin

The Burdekin River Basin is the second largest river basin on the Queensland coast (NWC 2013) and covers approximately 130,109 km^2 (DEHP 2013b). The preliminary investigation corridor runs through the east of the basin, to the west of the Bowen Developmental Road and past Collinsville, ending 7.2 km from Mistake Creek (refer to Figure 6-6). Cattle grazing is the dominant land use in the area and covers approximately 96 per cent of the basin (Dight 2009). Aquatic habitats in the area are diverse, and include ephemeral creeks and drainage lines, rivers, lakes and swamps, floodplains, wetlands and mangrove forests (DEHP 2013b).

The Burdekin River Basin is subject to strong seasonality with mean annual rainfall varying between 600 to 2,500 mm, falling predominantly during the wet season (Dight 2009; NWC 2013). Severe flooding occasionally occurs within the Burdekin River Basin as a result of severe storms, cyclones and tropical low pressure systems. However, prolonged dry conditions and drought are also characteristic of the basin.

Mean annual discharge from the basin (taken from the Clare Weir in the lower Burdekin River Basin) is approximately 9.4 million ML. This accounts for approximately one third of all coastal mean annual discharge into the Great Barrier Reef along the north Queensland coast (NWC 2013). The Burdekin River Basin can be divided into three dominant catchments of relevance to the preliminary investigation corridor, namely the Suttor River, Bowen River and Lower Burdekin River.

Don River Basin

The Don River Basin is located along the central coast of Queensland and is bounded by the Clarke Range. It covers an area of approximately 3,736 km^2 from Bowen to Home Hill, south of Ayr (DEHP 2013a). The preliminary investigation corridor runs through the centre of the basin to the north of the Don River catchment, finishing at the Port of Abbot Point where it connects with

supporting infrastructure (rail loop/s and port infrastructure). Although the Don River catchment forms part of the Don River Basin, it is not traversed by the preliminary investigation corridor. The preliminary investigation corridor traverses the catchment parallel to the Don River catchment, and intersects many minor tributaries and flow paths within this basin.

Land use within the basin includes cattle grazing, horticulture and commercial fishing (DEHP 2013a). In addition, the Port of Abbot Point is an important industrial centre in the basin (NQBP 2013). The Don River Basin experiences relatively high rainfall with mean annual rainfall ranging from 1,000 to 1,600 mm (DEHP 2013a).

The basin supports a range of aquatic habitats, including coastal and sub-coastal floodplains, tree swamps, grass-sedge wetlands, mangroves and saltmarshes (DEHP 2013a). The major waterway within the basin relevant to the preliminary investigation corridor is the Elliot River (DEHP 2013a). Minor waterways of importance to the preliminary investigation corridor include Splitters Creek and Saltwater Creek.

Nationally important wetlands within the basin (and in the vicinity of the preliminary investigation corridor) include the Caley Valley Wetland at Abbot Point. National parks within the basin include Cape Upstart National Park, Mount Abbot National Park and Mount Aberdeen National Park (DEHP 2013a). The basin also discharges into the Burdekin fish habitat area, which is situated 10 km east of Ayr and over 30 km north of Abbot Point (DEHP 2013a).

Landscape corridors and connectivity

Connectivity of habitats and landscape corridors at a bioregional scale is discussed and mapped through the Brigalow Belt North Landscape Expert Panel Report (EPA 2008) and DEHP Biodiversity Planning Assessment mapping.

The Brigalow Belt North Landscape Expert Panel Report (EPA 2008) details information on areas of importance for maintaining ecological values within the Brigalow Belt bioregion. Items within this report that are relevant to the preliminary investigation corridor include:

- Mount Abbot is part of a large tract of remnant vegetation between the Bogie and Elliot Rivers. A number of threatened flora species are associated with the mountain, namely: *Croton magneticus, Ozothamnus eriocephalus and Corchorus hygrophilius.*
- Remnants of semi-evergreen vine thicket (SEVT) in the Brigalow Belt North bioregion are considered to be of State significance
- The ‘Strathmore’ and ‘Havilah’ properties (which are intersected by the preliminary investigation corridor) are of particular interest for conservation of remnant SEVT.
- Spinifex ridges between Collinsville and Mount Coolon are considered to be of significance
- Parts of the Brigalow Belt North bioregion, including the Leichhardt Range and Drummond Range, contain large tracts of contiguous remnant vegetation. These areas are classified as being of very high value as wildlife refugia.
- The eastern range limit of gidgee (*Acacia cambagei*) on alluvials extends to the Kilcummin Diamond Downs Road area
- The ecosystem association on Mt. Aberdeen is SEVT, which is of State significance. One ‘rare’ plant (*Atalaya rigida*) (delisted as per Nature Conservation (Wildlife) Amendment

Regulation (No. 1) 2009) and one vulnerable (under the EPBC Act) plant (*Taeniophyllum muelleri*) are recorded here. Remnant SEVT has a very high value rating in this region.

The biodiversity planning assessments (BPA) mapping for the Brigalow Belt bioregion was reviewed to provide an indication of the quality and value of remnant vegetation within and beyond the preliminary investigation corridor.

The preliminary investigation corridor intersects a number of wildlife corridors identified by the DEHP BPA mapping for the Brigalow Belt bioregion, as shown in Figure 6-6.

The key wildlife corridors intersected include:

- A wildlife corridor between Mount Abbot and Abbot Point. At Mount Abbot, this corridor connects with the larger Great Eastern Range wildlife corridor
- The Great Eastern Range wildlife corridor, which follows remnant vegetation on the Clarke Range north-west into the Brigalow Belt North bioregion to the Sonoma State Forest, where it tracks north to Mount Aberdeen National Park and along the coastal watershed
- A small corridor running westward from the Clarke Range to link with the Leichhardt Range in the Einasleigh Uplands bioregion. This corridor also links to the more continuous riparian corridor along the Bowen River
- The Leichhardt Range corridor runs along the watershed between the Suttor and Bowen Rivers from the Denham Range north-west to Redcliffe Tableland, and then along the Leichhardt Range, which tracks north to the Einasleigh Uplands bioregion
- An important westward link from the Denham Range east of Glenden to the Great Dividing Range in the Desert Uplands bioregion.

The following major rivers and creeks of relevance to the preliminary investigation corridor were identified as significant riparian corridors in the Burdekin catchment from BPA mapping and the *Brigalow Belt* North Landscape Expert Panel Report (EPA 2008):

- Broken and Bowen Rivers and Rosella Creek, which flow from the western side of the Clarke Range
- Suttor River upstream of Lake Dalrymple
- Logan and Diamond Creeks, which flow from the northern and western slopes of the Drummond and Denham Ranges to form a corridor down to the Suttor River.

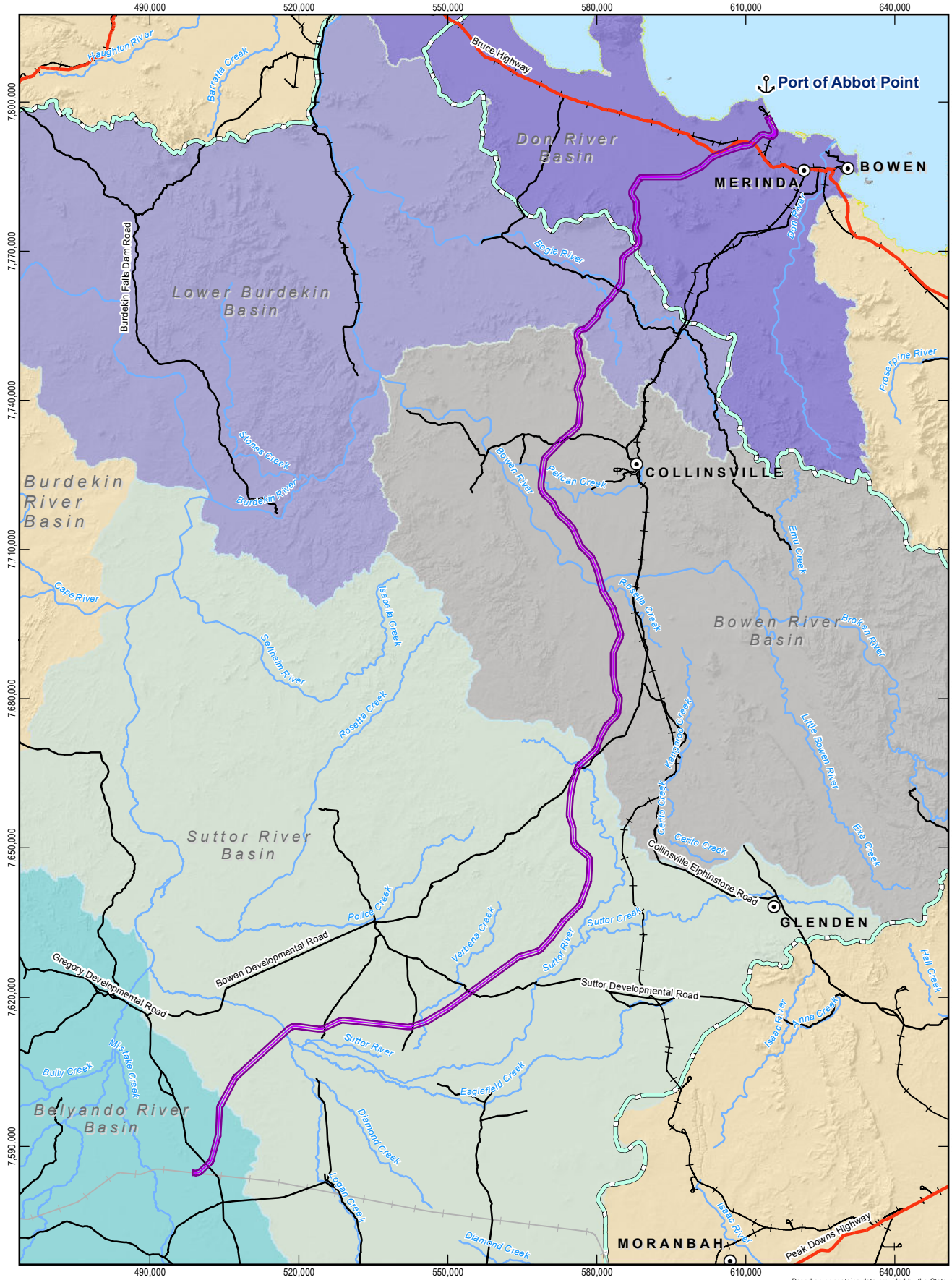
Between the Bogie River in the north and Suttor Development Road in the south, the landscape in which the preliminary investigation corridor is situated is dominated by remnant vegetation that is mapped as having high or very high context and connection values. Beyond either side of these features, remnant vegetation mapped as having high or very high context and connection values becomes more fragmented.

Protected area estate

The preliminary investigation corridor does not intersect any mapped protected area estates; however, seven occur within 10 km. The seven protected areas and their approximate locations in relation to the preliminary investigation corridor are:

- Nairana National Park (8.5 km west)
- Hells Gate Nature Refuge (nine kilometres west)
- Mount Pleasant Nature Refuge (eight kilometres east)
- Aberdeen Nature Refuge (eight kilometres east)
- Mount Aberdeen National Park (four kilometres south-east)
- Mount Abbot National Park (eight kilometres north-west)
- Abbot Bay Resources Reserve (seven kilometres north).

The location of the protected areas in relation to the preliminary investigation corridor is presented in Figure 6-8.



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- River Basins
- Belyando River
- Suttor River
- Bowen River
- Don River
- Lower Burdekin River
- Burdekin River Basin
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

0 7.5 15 30
Kilometres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

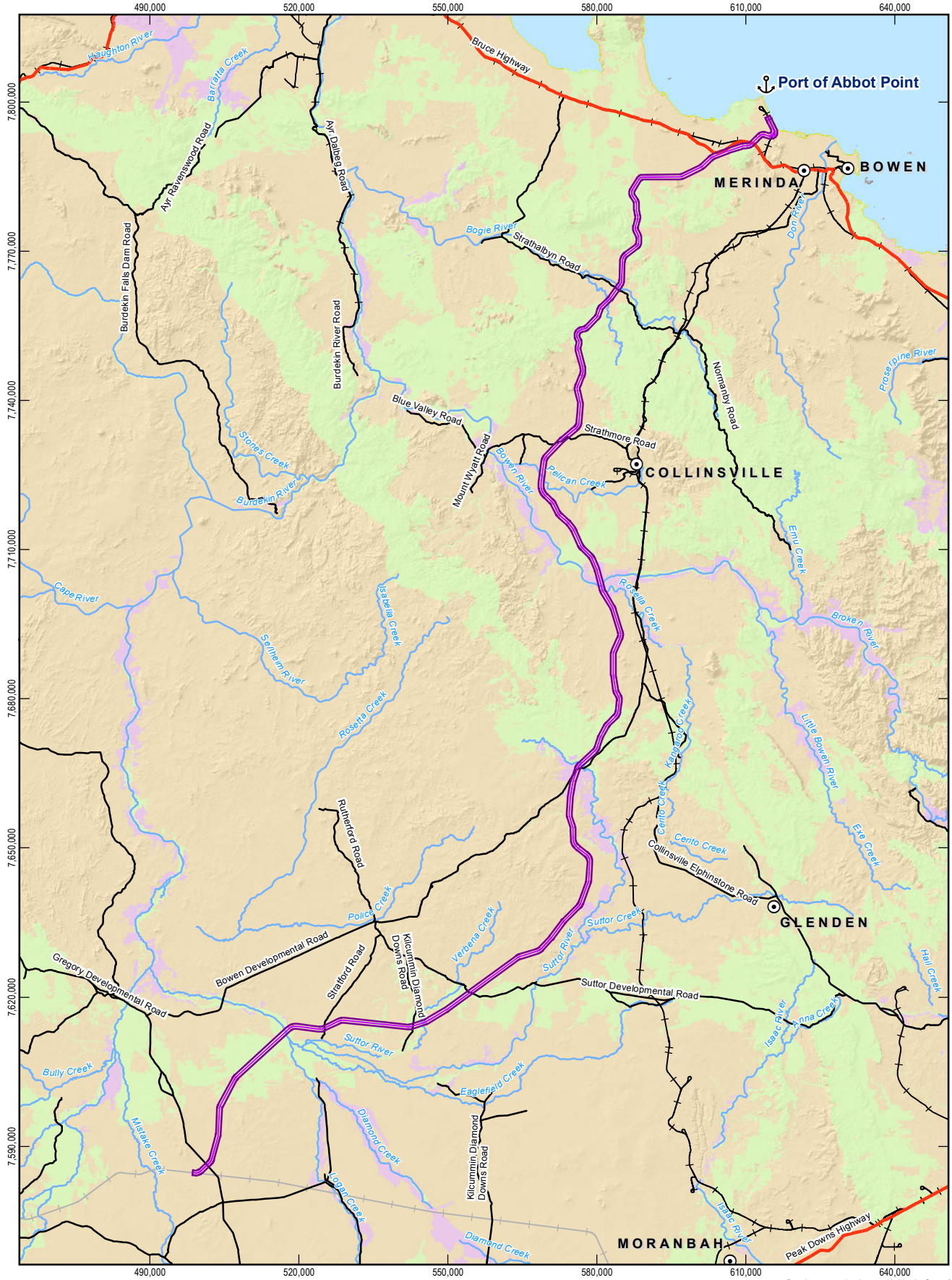
Job Number	41-26457
Revision	A
Date	22 Aug 2013

Regional context

Figure 6-6

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1153_rev_a.mxd
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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: River Basin (2010), Roads/2010. Created by:MS



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

BPA Biodiversity Significance version 1-3

Central Queensland Coast Brigalow Belt and Einasleigh Uplands BPA

J Rating	J Rating
Very High	Regional
High	State

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number 41-26457
Revision B
Date 22 Aug 2013

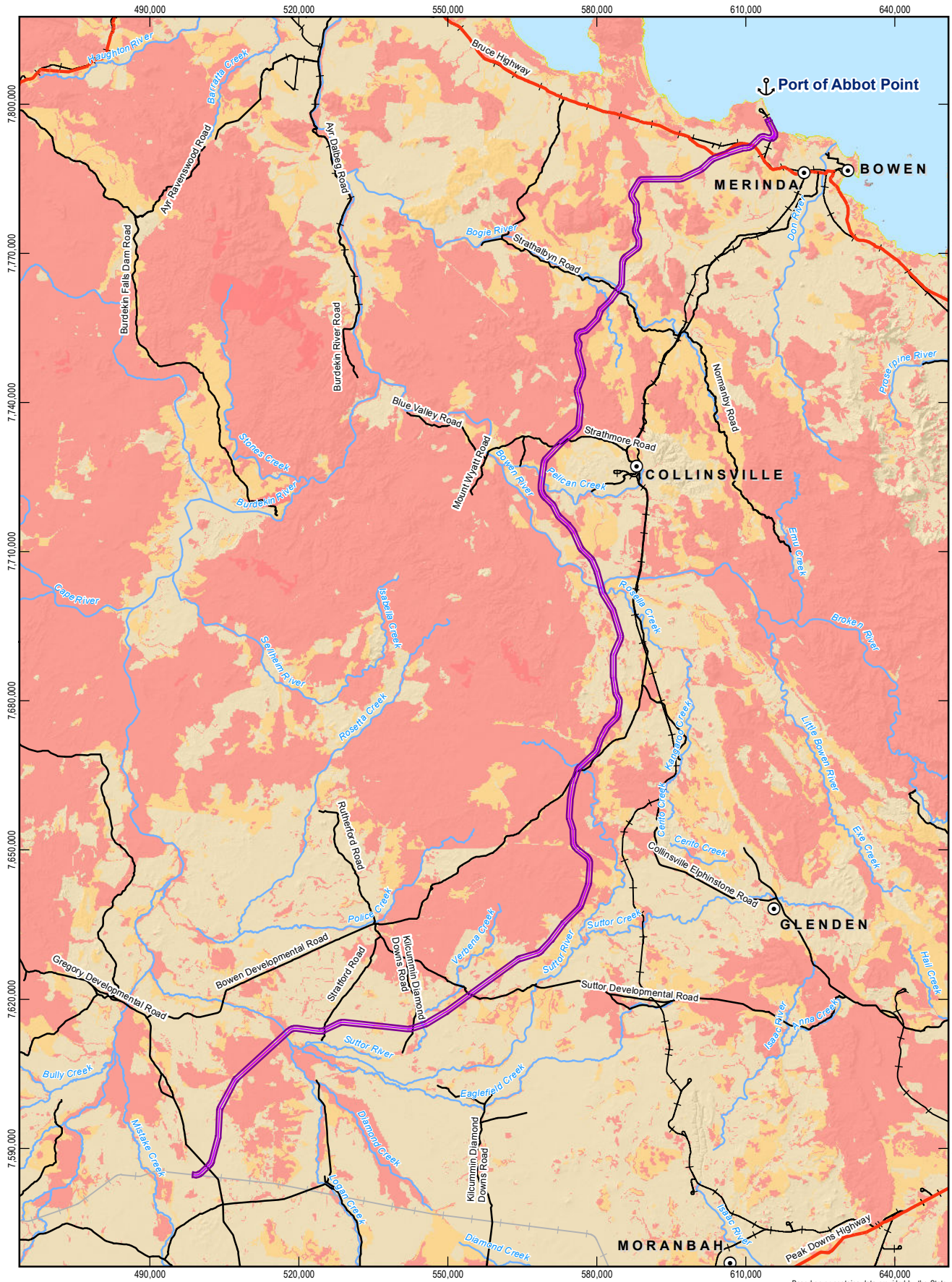
Biodiversity Planning Assessment mapping

Figure 6-7
Sheet 1

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1119_rev_b.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, BPA/2011. Created by:MS



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- BPA Biodiversity Significane v1-3 G Rating
  - Very High
  - High
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

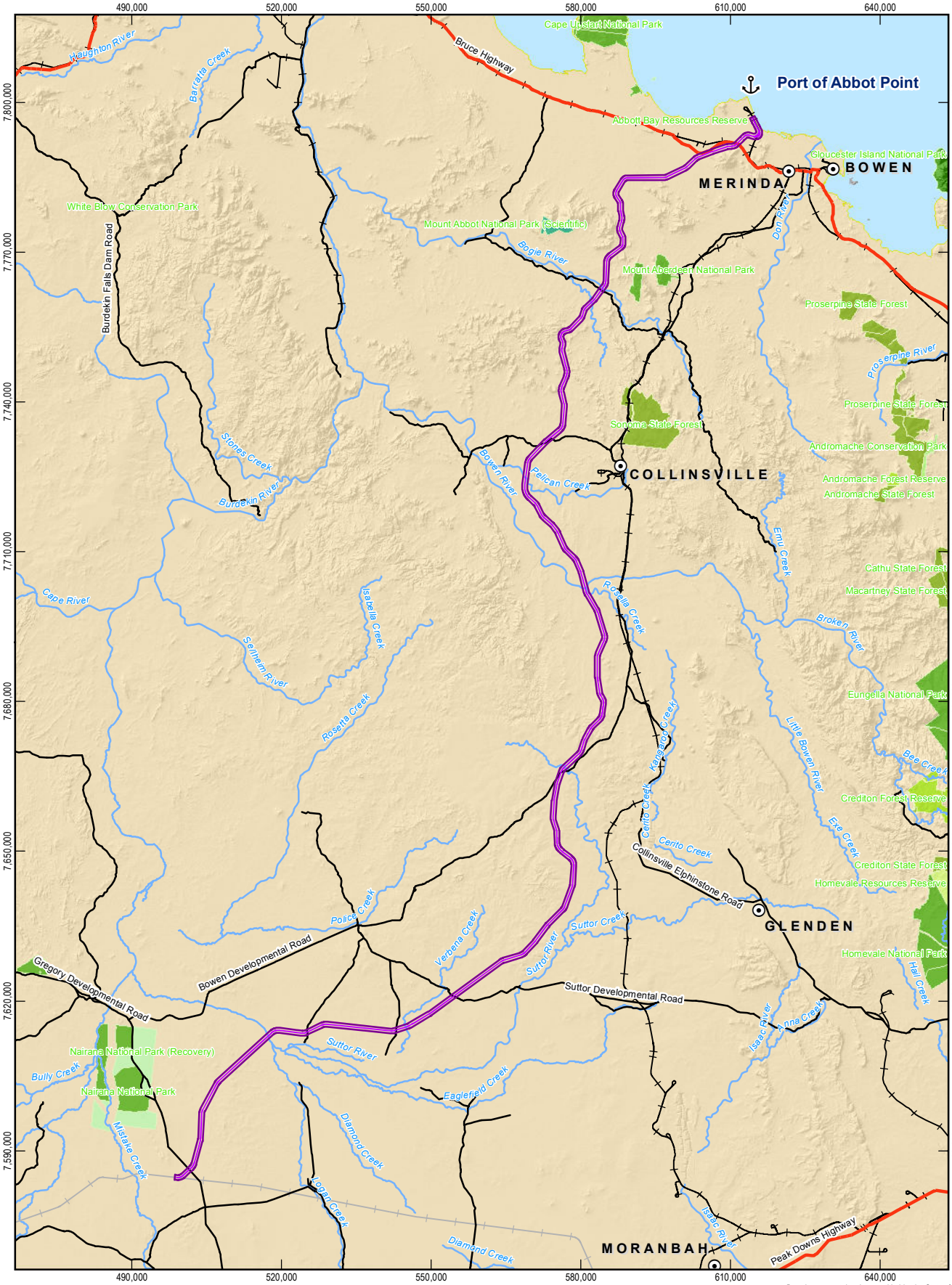
Biodiversity Planning Assessment mapping

Figure 6-7
Sheet 2

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1120_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, BPA/2011. Created by:MS



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- Protected Areas
- Conservation Park
- Forest Reserve
- National Park (Conservation)
- National Park
- National Park (Scientific)
- Resource Reserve
- State Forest
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Protected area estates

Figure 6-8

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1121_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, Protected Areas/2012, Nature Refuge/2012. Created by:MS

6.3.2 Vegetation communities and habitat

A total of 61 REs are mapped within the preliminary investigation corridor comprising seven endangered REs, 18 of concern REs and 36 least concern REs (VM Act status). These REs occur either as homogenous or mixed polygons (a mixed polygon is where two or more REs are assigned to one area).

Constituent REs of three threatened ecological communities (TEC) listed under the EPBC Act are mapped within the preliminary investigation corridor. The three TECs are:

- Brigalow (Acacia harpophylla dominant and co-dominant)
- Natural Grassland of the Queensland Central Highlands and the Northern Fitzroy Basin
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.

These TECs are considered further in Volume 1 Chapter 7 Matters of national environmental significance.

High value regrowth vegetation is mature native vegetation that has not been cleared since 31 December 1989 and is regulated under the VM Act. The preliminary investigation corridor contains high value regrowth vegetation including polygons containing endangered dominant REs, of concern dominant REs, of concern sub-dominant REs and least concern REs. The majority of regrowth vegetation within the preliminary investigation corridor occurs south of the Bowen River.

One essential habitat polygon (DNRM mapping version 3) was mapped as occurring within one kilometre of the preliminary investigation corridor. This mapped essential habitat polygon related to a single species, *Bonamia dietrichiana* (Dietrich's morning glory, near threatened under the NC Act), and is located west of Collinsville nearby to chainage 105 km. No mapped essential regrowth habitat polygons mapped within the Brigalow Belt bioregion, were intersected by, or occurred within one kilometre of the preliminary investigation corridor.

A description of the mapped REs, regulated regrowth vegetation and essential habitat occurring within and adjacent to the preliminary investigation corridor is presented in Volume 2 Appendix F Nature conservation.

The DEHP declared critical habitat register and areas of major interest register were not available at the time of writing and therefore have not been reviewed in relation to the preliminary investigation corridor. The NC Act defines critical habitat as habitat that is essential for the conservation of a viable population of protected wildlife or community of native wildlife, whether or not special management considerations and protection are required. A critical habitat may include an area of land that is considered essential for the conservation of protected wildlife, even though the area is not presently occupied by the wildlife.

A total of 22 threatened flora species (listed under the NC Act and/or EPBC Act) were identified within the preliminary investigation corridor or broader study area. The desktop database search results are provided in Appendix G of Volume 2 Appendix F Nature conservation. Two priority plant species (*Cochorus hygrophilus* and black ironbox (*Eucalyptus raveretiana*)) were identified in the Burdekin Natural Resource Management (NRM) Back on Track Actions for Biodiversity report (DERM 2010). A likelihood of occurrence assessment for threatened flora species was undertaken in accordance with the methodology outlined in Section 6.2.4. The habitat

preferences of threatened plants (under the NC Act) and their likelihood of occurrence are provided in Table 4-1 of Volume 2 Appendix F Nature conservation.

One conservation significant flora species, *Bonamia dietrichiana*, listed as near threatened under the NC Act (not listed under the EPBC Act), was considered 'likely to occur' based on previous records and potentially suitable habitat present within the preliminary investigation corridor.

A total of 333 flora species, including 35 exotic species (of which 10 are declared species), were identified during field surveys. One NC Act listed vulnerable species, black ironbox (*Eucalyptus raveretiana*), was recorded during the field program (discussed further in Section 4.2.8 of Volume 2 Appendix F Nature conservation). The locations where this species was observed are provided in Figure 6-9. Overall, 71 plant families were recorded in the preliminary investigation corridor. The most species-rich plant families represented in the preliminary investigation corridor were:

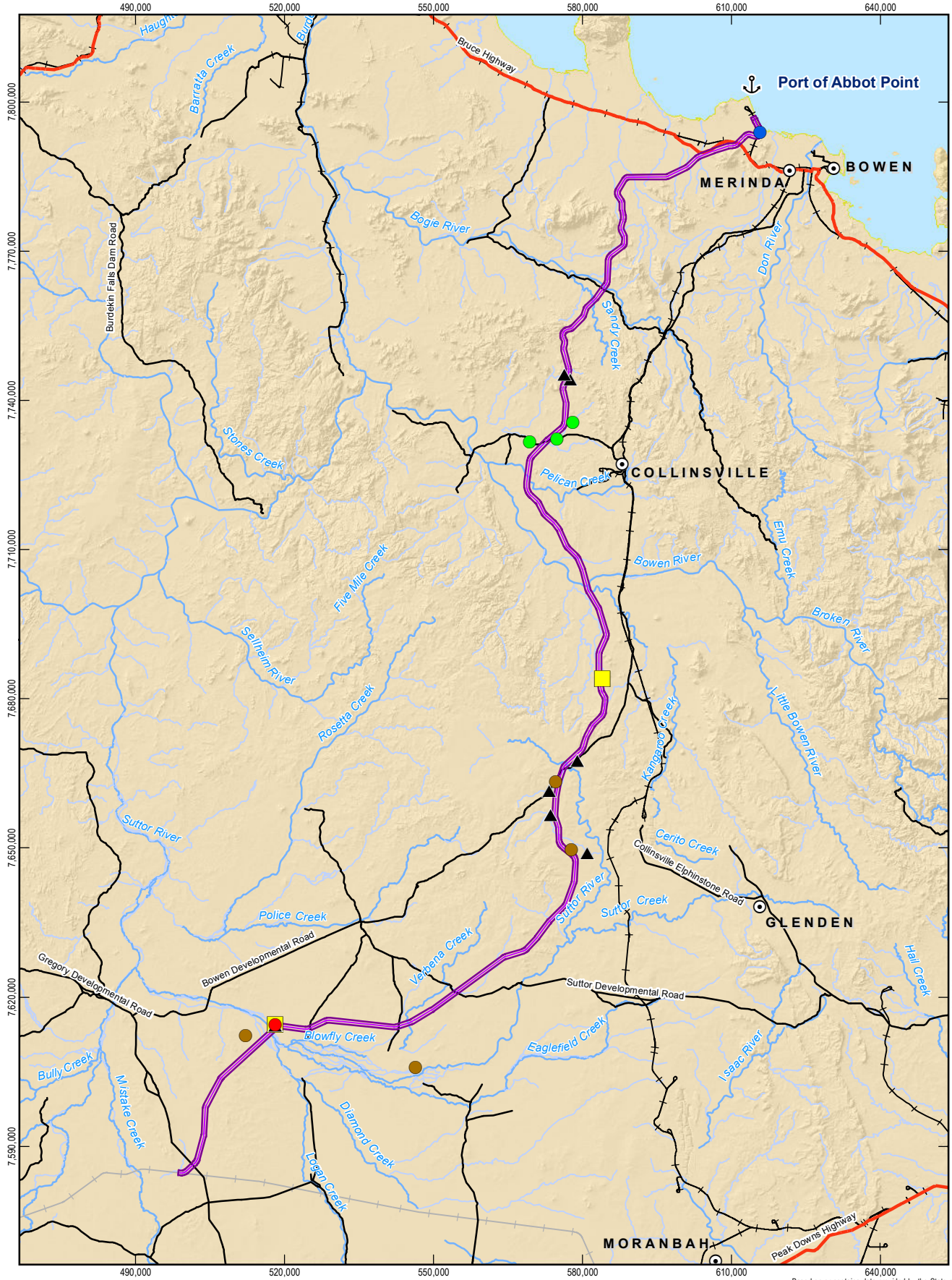
- Poaceae (75 taxa)
- Myrtaceae (32 taxa)
- Mimosaceae (18 taxa)
- Fabaceae (17 taxa)
- Malvaceae (12 taxa)
- Cyperaceae (11 taxa).

The full terrestrial flora field species list is provided in Appendix C of Volume 2 Appendix F Nature conservation.

For the purposes of understanding the general vegetation patterns within the preliminary investigation corridor, the 61 mapped REs can be reduced to a set of eight broad vegetation communities (BVCs), plus one BVC that comprises non-remnant areas. The BVCs are based on similarities in the species composition and community structure of the vegetation. Eight broad habitats which correspond with the BVCs were identified as occurring within the preliminary investigation corridor (refer Table 6-2). Each of the BVCs are summarised in Table 6-3.

Table 6-2 Broad vegetation communities and corresponding broad habitats

Broad vegetation communities	Broad habitats
Natural grassland	Grassland
Vine thicket	Semi-evergreen vine thicket
Brigalow/gidgee	Acacia dominated woodland/shrubland
Sclerophyll woodland/open forest (excluding watercourse associated vegetation)	Eucalypt woodlands
Mixed species shrubland/low woodland	Eucalypt woodlands Acacia dominated woodland/shrubland
Woodland/open forest fringing watercourses	Fringing riparian vegetation
Tidal vegetation	Coastal wetland
Wetland	Aquatic habitat
Non-remnant areas (including regrowth)	Non-remnant cleared land



LEGEND

- Population Centres
- Major Port
- Black-necked Stork
- Cotton Pygmy-goose
- Little Pied Bat
- Freckled Duck
- Squatter Pigeon (Southern)
- *Eucalyptus raveretiana*
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project

Threatened species records

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Figure 6-9

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1125_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010; GHD: Fauna Species Records/2013. Created by:MS

Table 6-3 Broad vegetation communities identified within the preliminary investigation corridor

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes	Representative photo
Natural grassland 11.3.31, **11.4.4**, **11.4.11**, **11.9.3**, **11.9.12** Includes the EPBC Act TEC 'Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin'	Entirely located on plains and lowlands, mostly on clays.	Queensland blue grass (*Dichanthium sericeum*), white speargrass (*Aristida leptopoda*), curly Mitchell grass (*Astrebla squarrosa*), hoop Mitchell grass (*Astrebla elymoides*), coolabah (*E. coolabah*), mountain coolabah (*Eucalyptus orgadophila*), *Paspalidium globoideum,* red bloodwood (*Corymbia erythrophloia*), red Flinders grass (*Iseilema vaginiflorum*).	Primarily mapped south of Pelican Creek, the natural grasslands within the preliminary investigation corridor have been almost entirely replaced by exotic pasture grasses.	 Mapped natural grassland, Myuna Station.
Vine thicket **11.2.3**, **11.11.18**, 11.12.4 Includes the EPBC Act TEC 'Semi-evergreen vine thicket of the Brigalow Belt North and Nandewar Bioregions'	Occurs on coastal dunes (11.2.3), undulating rises and gentle slopes (11.11.18) and low hills and ranges (11.12.4).	Burdekin plum (*Pleiogynium timorense*), bush tuckeroo (*Cupaniopsis anacardioides*), broad-leaved bottletree (*Brachychiton australis*), caustic vine (*Sarcostemma viminale*), *Drypetes deplanchei*, *Jasminum didymum,* pythonwood (*Gossia bidwillii*), native peach (*Ehretia membranifolia*), small-leaved water vine (*Clematocissus opaca*), wild prune (*Sersalisia sericea*).	Vine thickets on coastal dunes in the Caley Valley section of the preliminary investigation corridor were generally heavily infested with weeds, including the class two weeds prickly acacia (*Vachellia nilotica*), parkinsonia (*Parkinsonia aculeata*) and chinee apple (*Ziziphus mauritiana*). Inland vine thickets were sometimes in better condition, however many have thinned due to grazing and adjacent clearing, and often were infested with the class two weed Harrisia cactus (*Eriocereus* sp.).	 Vine thicket on loose rocks, Tabletop Station.

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes	Representative photo
Brigalow/gidgee **11.3.1**, 11.3.5, 11.4.6, **11.4.8**, **11.4.9**, **11.9.1**, 11.11.13, 11.11.19, **11.12.21** Includes the EPBC Act TEC 'Brigalow (*Acacia harpophylla* dominated and co-dominated)'	Generally plains and lowlands, mostly on clays and loams; sometimes occurs on scarps and low ridges.	Brigalow (*Acacia harpophylla*), currant bush (*Carissa ovata*), Dawson's gum (*E. cambageana*), *Enteropogon* spp., gidgee (*A. cambagei*), false sandalwood (*Eremophila mitchellii*), yellow wood (*Terminalia oblongata*), wilga (*Geijera parviflora*).	Brigalow is located south of Pelican Creek; gidgee occurs south of the Suttor Development Road. Condition for both ranges from slightly to heavily modified. Usually at least the ground layer and sometimes the shrub layer is significantly altered; in some cases, the canopy has been thinned.	 Brigalow, Avon Downs Station.
Sclerophyll woodland/open forest (excluding watercourse associated vegetation) 11.2.5, **11.3.2**, **11.3.3**, **11.3.4**, 11.3.7, 11.3.9, 11.3.10, 11.3.30, 11.3.35, **11.4.2**, 11.5.2, 11.5.3, 11.5.9, 11.5.12, 11.7.1, 11.7.3, **11.9.1**, 11.9.9, **11.9.10**, 11.10.7, 11.11.1, 11.11.9, 11.12.1, 11.12.2, 11.12.7, 11.12.9, **11.12.10**, 11.12.13, **11.12.14**	Occurs on all landform types across the corridor, most commonly on undulating to rolling country.	Browns box (*Eucalyptus brownii*), Dallachy's ghost gum (*Corymbia dallachiana*), Dawson's gum (*E. cambageana*), *E. persistens,* mountain coolabah, narrow-leaved ironbark (*E. crebra/ drepanophylla*), peppermint gum (*E. exserta*), poplar box (*E. populnea*), poplar gum (*E. platyphylla*), red bloodwood, silver-leaved ironbark (*E. melanophloia*).	This diverse BVC is found along the entire preliminary investigation corridor. Grassy woodland/open woodland is the most common type of sclerophyll community, with shrubby woodland occurring less often. Most communities are slightly to heavily modified; that is, at least one layer, almost always the ground layer, has been modified to some extent through the replacement of species by exotics. In some cases, the shrub layer has been thinned or removed by stock/clearing, which can also affect canopy species recruitment.	 Grassy open woodland, Cerito Station.

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes	Representative photo
				 Shrubby open woodland, Avon Downs Station.
Mixed species shrubland/low woodland 11.3.32, **11.3.33**, **11.3.34**, **11.4.5**, 11.7.2, 11.11.13, **11.12.15**, **11.12.16**, **11.12.18**	Various landforms – most are on plains and lowlands, some are from ranges and low mesas.	*Acacia argyrodendron, A. catenulata,* beefwood (*Grevillea striata*), lancewood (*A. shirleylii*), *A. tephrina,* bulloke (*Allocasuarina luehmannii*), false sandalwood (*Eremophila mitchellii*), *Oxychloris scariosa.*	Often located in small, discrete patches, little modified from the natural state. These communities are generally located in marginal areas (highly erodible soils of low fertility) and consequently have not often been cleared/ developed. Weed incursion is usually low.	 Lancewood tall shrubland, Disney Station.

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes	Representative photo
Woodland/open forest fringing watercourses 11.3.25, 11.3.37	Fringes watercourses.	Belalie (*Acacia stenophylla*), black ironbox (*Eucalyptus raveretiana*), black tea-tree (*M. bracteata*), carbeen (*Corymbia tessellaris*), coolabah (*E. coolabah*), creek mahogany (*Lophostemon grandiflorus*), mat rush, paperbarks (*Melaleuca dealbata, M. leucadendra, M. stenostachya*), Queensland blue gum, (weeping paperbark (*M. fluviatilis*).	This BVC is generally intact, however in areas closer to the coast, the ground and shrub layers are often moderately to heavily infested with environmental weeds, particularly hyptis (*Hyptis suaveolens*), snake weed (*Stachytarpheta jamaicensis*) and *Urena lobata*, and the class three declared weed lantana (*Lantana camara*). This BVC contains the listed vulnerable species (under both the EPBC and NC Acts) black ironbox.	 Rockingham Creek, Cerito Station.
Tidal vegetation 11.1.1, 11.1.2, 11.1.4, 11.2.2	Occurs on level tidally inundated salt pans and creek margins, and on beach foredunes.	Bead weed (*Sarcocornia quinqueflora*), beach spinifex (*Spinifex sericeus*), freshwater mangrove (*Excoecaria aggalocha*), grey mangrove (*Avicennia marina*), grey samphire (*Tecticornia australasica*), *Ipomoea pes-caprae,* prickly saltwort (*Salsola kali*), salt couch (*Sporobolus virginicus*).	This BVC is restricted within the preliminary investigation corridor to small areas subject to tidal inundation in the Caley Valley Wetland, and are intact and generally in good condition.	 Grey samphire on salt pan, Caley Valley.

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes	Representative photo
Wetland 11.3.27	Occurs in or on wetlands.	*Acacia humifusa,* broad-leaved paperbark (*Melaleuca viridiflora*), carbeen (*Corymbia tessellaris*), *Chrysopogon elongatus, Cyperus javanicus,* mat rush (*Lomandra longifolia*), *Nymphaea gigantea, Ottelia ovalifolia,* Queensland blue gum (*Eucalyptus tereticornis*).	This community includes the water and immediate terrestrial margin of wetland areas, including the Caley Valley Wetland. Caley Valley Wetland has extensive woody weed infestations (prickly acacia, chinee apple, parkinsonia) along the margins, and is being impacted by resident feral pigs.	 Caley Valley Wetland
Non-remnant areas (including regrowth) N/A	Various landforms, but mostly occurs on plains and lowlands (where soils and pasture are more suitable for farming).	Mostly exotic pasture species such as bluegrass (*Dichanthium aristatum*), buffel grass (*Cenchrus ciliaris*), creeping bluegrass (*Bothriochloa pertusa*), signal grass (*Urochloa mosambicensis*).	Non-remnant vegetation in the preliminary investigation corridor (other than in built areas or crops) is generally grazed, and heavily modified from its natural state.	 View over pasture lands, Disney Station.

[1] REs in bold are of conservation significance (of concern or endangered under the VM Act)

6.3.3 Aquatic habitats

The preliminary investigation corridor crosses a variety of aquatic habitats in a number of places. In total, 16 major and moderate waterways and approximately 120 minor waterways were intersected by the preliminary investigation corridor. The aquatic habitats assessed within the preliminary investigation corridor were categorised into the following:

Riverine: all wetlands and deep water habitats within a channel (Plate 6-1). Channels may be naturally or artificially created, periodically or continuously contain moving water, or connect two bodies of standing water (EPA 2005). A number of small riverine channels were identified within the study area. These small channels included narrow first order streams (hereafter referred to as drainage lines), which provide a pathway for flows during rainfall, but typically do not accommodate surface water for long periods. As drainage lines are isolated and ephemeral, they generally do not support aquatic communities for sustained periods of time. However, drainage lines can facilitate dispersal of aquatic organisms when surface waters are present and hydrologically connected.

Lacustrine: large, open, water-dominated systems (e.g. lakes) (Plate 6-2). Lacustrine habitats also include modified systems (e.g. dams), which have similar characteristics to natural lacustrine systems (e.g. deep, standing or slow-moving waters (EPA 2005)).

Palustrine: primarily vegetated off-channel environments (Plate 6-3). Palustrine habitats include billabongs, swamps, bogs, springs and soaks (EPA 2005). It should also be noted that gilgais are included within this category. Gilgais are microrelief depressions in cracking clay soils that form when the cycles of substrate shrinking and swelling create mounds and subsidence in the terrain (EPA 2005). These depressions then fill with rain water, and surface water may persist for some time. As a water source, gilgais can support a range of taxa; however, there are several species that are dependent or closely associated with gilgais, including a range of invertebrates and reptiles.

Plate 6-1 Riverine habitat within the preliminary investigation corridor


Plate 6-2 Lacustrine habitat within the preliminary investigation corridor

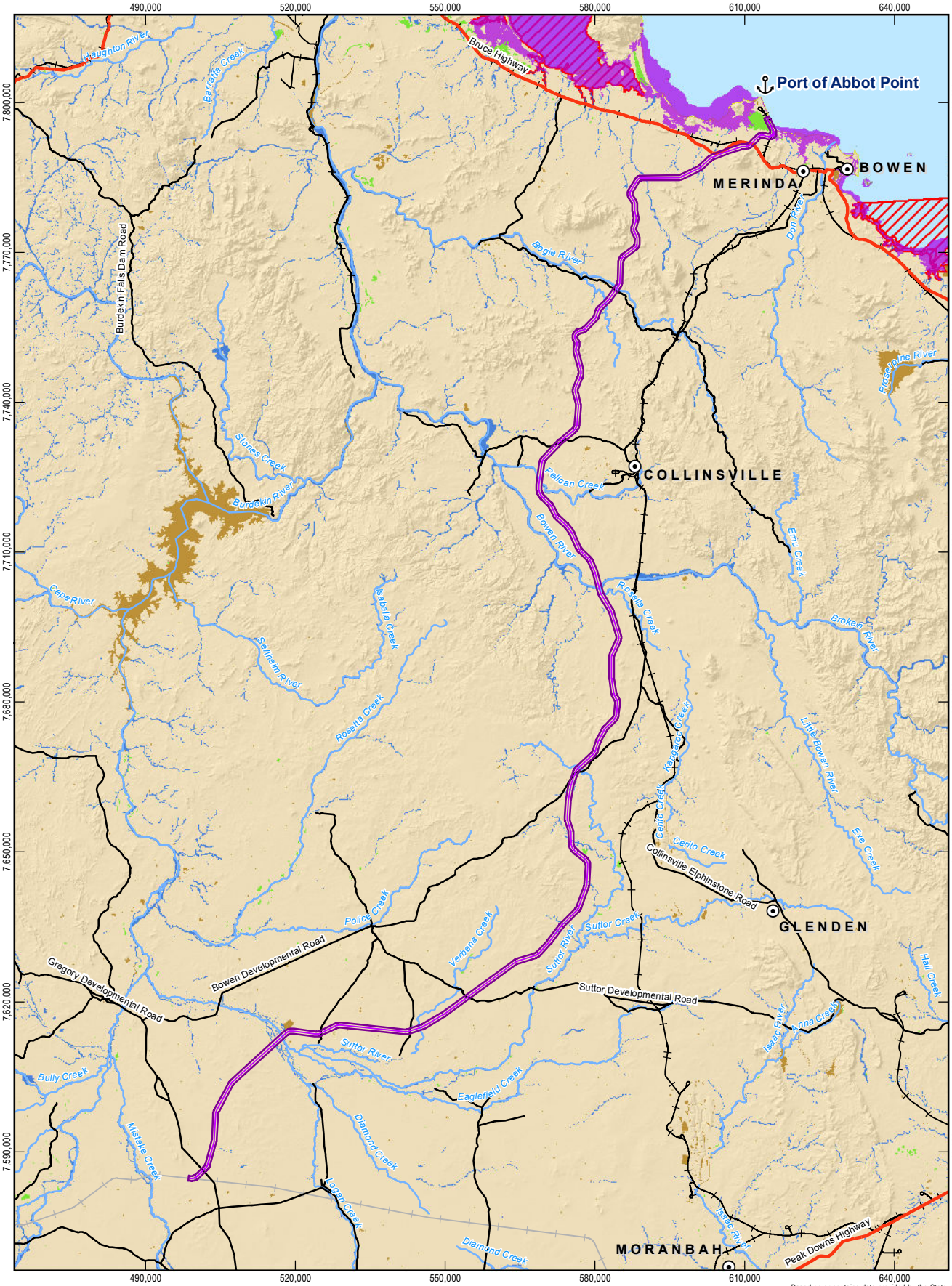

Plate 6-3 Palustrine habitat within the preliminary investigation corridor

The riverine, lacustrine and palustrine habitats in the preliminary investigation corridor and wider study area are shown in Figure 6-10. A summary of the aquatic habitats present at each survey site is provided in Table 4.7 of Volume 2 Appendix F Nature conservation.

No fish habitat areas declared under the *Fisheries Act 1994* occur in or within 10 km of the preliminary investigation corridor.

Aquatic habitats along the preliminary investigation corridor provided valuable habitat for fish, turtles, amphibians, waterbirds and invertebrates. In general, the diversity of the aquatic community is highly influenced by the ephemerality of surface water, the quality of surface water and the habitat diversity (Therriault and Kolasa 2000). Perennial habitats typically support the most diverse and abundant aquatic communities and provide refugial habitat in dry periods. Ephemeral habitats are dominated by species that are capable of undergoing periods of dormancy (aestivation) when surface waters disappear (Larned *et al.* 2007). Aerial dispersers (e.g. mayflies, dragonflies and waterbirds) are also likely to colonise ephemeral surface waters (Bogan and Boersma 2012).

Lacustrine habitats provide important habitat for many terrestrial species (such as waterbirds and amphibians) that depend on perennial surface water. Waterbirds were commonly observed at lacustrine habitats. Frogs were also frequently observed or were noted to be calling from the waterbody margins. Waterbodies (and adjacent vegetation) provide drinking resources for numerous terrestrial fauna species, and breeding habitat for amphibians and some bird species. Additionally, foraging habitat was provided for water birds and wading birds (including a number of threatened fauna species). Aquatic habitats also provide potential habitat for aquatic dependent mammals.



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- Habitats
- Estuarine Habitat
- Lacustrine Habitat
- Palustrine Habitat
- Riverine Habitat
- Fish Habitat Area
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

GHD

adani

Adani Mining Pty Ltd
North Galilee Basin Rail Project

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Aquatic habitats relevant to the preliminary investigation corridor

Figure 6-10

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1122_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, Fish Habitat Area, Habitat/2012. Created by:MS

Predatory species (including some birds of prey and snakes) also forage within aquatic habitats. However, in artificial waterbodies (i.e. farm dams), the general lack of habitat variability, the disturbance from land use practices and the presence of grazing and pest species did reduce the suitability for more specialised species (including some cryptic birds). Disturbance from cattle and pigs was common within aquatic habitats along the preliminary investigation corridor, but was particularly concentrated around farm dams. This disturbance impacted the aquatic habitat values of some watercourses.

Findings from the Great Barrier Reef catchments Aquatic Conservation Assessments for riverine (Inglis and Howell 2009a) and non-riverine wetlands (Inglis and Howell 2009b) identified a number of aquatic dependent flora species within the Burdekin and Don River Basins. A total of 179 aquatic dependent flora species (of which 24 are introduced) were identified as occurring in riverine and/or non-riverine wetlands within the Burdekin and Don River Basins. These species potentially occur within the preliminary investigation corridor. The Aquatic Conservation Assessment documents also identified seven aquatic flora species that are listed as threatened under the NC Act in the Burdekin and/or Don River Basins. Wildlife Online and HERBRECS searches respectively identified 59 and 65 aquatic flora species occurring within the preliminary investigation corridor. All of these species are listed as NC Act least concern (refer to Volume 1 Appendix F Nature conservation).

Thirteen aquatic flora species were identified in the field surveys. One species (black ironbox (*Eucalyptus raveretiana*)) is listed as threatened under the NC Act. Aquatic flora species identified were:

- Floating pondweed (*Potamogeton tricarinatus*)
- Curled dock (*Rumex crispus*) (introduced)
- Sedges (*Cyperus* sp., including the introduced umbrella sedge (*Cyperus involucratus*))
- Wavy marshwort (*Nymphoides crenata*)
- *Lomandra hystrix*
- *Melaleuca* sp.
- Giant waterlily (*Nymphaea gigantea*)
- Swamp lily (*Ottelia ovalifolia*)
- Black ironbox (*Eucalyptus raveretiana*)
- Rushes (*Juncus* sp.)
- *Fimbristylis* sp.
- Slender knotweed (*Persicaria* sp.)
- Blind-your-eye mangrove (*Excoecaria agallocha*).

Don River Basin

Within the Don River Basin, there is a riverine wetland RE (RE 11.3.25) and Great Barrier Reef Wetland Management Area (GBR WMA), which are listed as least concern under the VM Act (Figure 6-10). The Caley Valley Wetland within the Don River Basin is a Directory of Important Wetlands in Australia (DIWA) nationally important wetland and a GBR Wetland Protection Area (WPA); the aquatic habitat values of the Caley Valley Wetland are discussed in Volume 2 Appendix F Nature conservation and summarised below.

Caley Valley Wetland

The Caley Valley Wetland falls in the most northern extent of the preliminary investigation corridor, within the Don River Basin. The Caley Valley Wetland was modified from its natural state using the strategic placement of bunds to retain surface water and increase ponding. The Caley Valley is a DIWA nationally important wetland. A number of creeks drain directly into the Caley Valley Wetland, including Spring Creek, Tabletop Creek, Main Creek, Mount Stuart Creek, Saltwater Creek, Goodbye Creek and Six Mile Creek.

The wetland drains into Abbot Bay and the Great Barrier Reef. A narrow band of coastal dunes create a barrier between the beach and the wetland. The wetland itself is vast, with the total catchment approximately 76,750 ha (GHD 2009).

The Caley Valley Wetland has very diverse aquatic habitats, including flowing, deep and shallow water, with woody debris and abundant macrophytes. Sedges (*Cyperus* spp.), giant waterlily (*Nymphaea gigantea*) and blind-your-eye mangrove (*Excoecaria agallocha*) were all observed.

Lower Burdekin River catchment

The main watercourses in the lower Burdekin River catchment are the Bogie River and Sandy Creek. The catchment area also contains RE 11.3.25b (riverine wetland and fringing riverine wetland), which is listed as a GBR WMA and least concern under the VM Act.

Bowen River catchment

The main watercourses in the Bowen River catchment are the Bowen River and Pelican Creek. The Bowen River catchment is located half way along the preliminary investigation corridor, to the south of Collinsville. Within the Bowen River catchment is the DIWA listed Birralee-Pelican Creek wetlands, which branch off Pelican Creek and run for approximately 15 km along the upper Bowen River (SEWPaC 2013e). This wetland is situated 2.6 km west of the preliminary investigation corridor. The RE 11.3.25b (riverine wetland or fringing riverine wetland) was also present, and is listed as a least concern GBR WMA under the VM Act (E3 Consulting 2010).

Suttor River (upper and lower) catchment

The Suttor River is the main waterway in the Suttor River catchment. The river crosses the preliminary investigation corridor at two places, and as such, is described as the upper Suttor River and lower Suttor River. Riverine wetlands (RE 11.3.25) and freshwater wetlands with naturalised species (RE 11.3.27f) occur in the catchment. These are listed as least concern under the VM Act and as GBR WMA under State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments (SPP4/11).

6.3.4 Terrestrial fauna

Table 6-4 provides a summary of terrestrial fauna species predicted to occur, or previously recorded, as identified during the desktop assessments.

Table 6-4 Terrestrial fauna species diversity – desktop assessment*

	Protected Matters Search Tool (predicted to occur)	DEHP Wildlife Online database (historically recorded)	Queensland Museum specimen database (historically recorded)	Birds Australia Atlas (historically recorded)
Species diversity	N/A	23 amphibians 88 reptiles 58 mammals 280 birds	27 amphibians 74 reptiles 17 mammals 12 birds	248 birds
Threatened EPBC Act listed species[1 2]	5 reptiles 6 mammals 7 birds	1 reptile 1 mammal 1 bird	1 reptile 1 mammal	1 bird
Threatened NC Act listed species[1]	5 reptiles 3 mammals 6 birds	4 reptiles 2 mammals 11 birds	3 reptiles	9 birds
Introduced species	1 amphibians 12 mammals 7 birds	1 amphibian 1 reptile 9 mammals 5 birds	1 amphibian 2 mammals	4 birds

[1] species listed under the NC Act and EPBC Act are not mutually exclusive and may be listed under both Acts

[2] whales, marine turtles and other marine species are not included in this table

* Note that these desktop results are based on historical records (of either a known or unknown date) or predictive modelling. Dated specimen collections range in age from 1974 through to 2005, and encompass a range of seasons.

During the May/June 2013 field surveys, a total of nine amphibians, 23 reptiles, 40 mammals and 180 bird species were identified from within the preliminary investigation corridor and the wider study area (refer Table 6-5). These results showed that the eucalypt woodland, fringing riparian vegetation and acacia dominated woodland/shrubland were important habitats for terrestrial fauna.

Table 6-5 Terrestrial habitat and fauna species observed during May/June 2013

	Amphibians	Reptiles	Mammals	Birds	Total
Total species	9	23	40	180	**252**
Introduced species	1	0	8	1	**10**
Threatened species (EPBC Act)	0	0	0	1	**1**
Threatened species	0	0	1	4	**5**

	Amphibians	Reptiles	Mammals	Birds	Total
(NC Act)					
EPBC Act migratory	0	0	0	7	**7**
EPBC Act marine[1]	0	0	0	36	**36**
Habitat type					
Eucalypt woodland	7	19	20	114	**160**
Fringing riparian vegetation	7	11	28	65	**111**
Natural and artificial waterbodies	4	4	16	75	**99**
Acacia dominated woodland / shrubland	5	15	23	69	**112**
Semi-evergreen vine thicket	2	7	10	44	**63**
Grassland	0	0	0	8	**8**
Coastal wetland	0	0	0	59	**59**
Non-remnant cleared land	3	2	5	89	**99**

[1] Only bird species listed as marine under the EPBC Act are included, as these species may inhabit marine or terrestrial environments.

A full list of the species recorded during the terrestrial fauna field surveys is provided in Appendix C of Volume 2 Appendix F Nature conservation. Fauna species recorded during the field surveys are summarised below.

Amphibians

Nine amphibian species from three families were recorded from habitats within or near the preliminary investigation corridor during field surveys. No species of national, State or regional significance were recorded. One species, the cane toad (*Rhinella marina*), was detected. This introduced species was widespread and abundant across the landscape, and was the most frequently recorded amphibian species. The most diverse genus was the common tree frogs (genus *Litoria*). Bumpy rocket frogs (*Litoria inermis*) (Plate 6-4), broad-palmed frogs (*Litoria latopalmata*), green tree frogs (*Litoria caerulea*) and ornate burrowing frogs (*Platyplectrum ornatum*) were the most commonly observed species, behind the cane toad. Less frequently encountered species included the green-striped frog (*Cyclorana alboguttata*), eastern stony creek frog (*Litoria wilcoxii*) (Plate 6-4) and the spotted grass frog (*Limnodynastes tasmaniensis*).


Plate 6-4 Bumpy rocket frog (left); eastern stony creek frog (*Litoria wilcoxii*) (right)

Reptiles

A total of 23 reptile species from six families were recorded from habitats within or near the preliminary investigation corridor during field surveys. No species of national, State or regional significance were recorded. No introduced reptile species were recorded. Reptile diversity was dominated by the Scincidae family, with 12 species recorded. Of these, the most abundant species were *Carlia pectoralis* and *Cryptoblepharus pulcher pulcher*. Less frequently encountered skink species belonged to the genera *Ctenotus* (Plate 6-5), *Lerista* and *Morethia*. Geckos (family Gekkonidae and Diplodactylidae) were represented by four species from the genera of *Gehyra* and *Heteronotia*. Snake diversity was relatively low with only five species recorded, comprising two species from the Colubridae family and three from the Elapidae family (Plate 6-5). The infrequent observations of snake species was likely a reflection of the milder weather conditions during the survey period. The only other terrestrial reptile species recorded from field studies was a single dragon species, the tommy roundhead (*Diporiphora australis*).


Plate 6-5 Black-striped snake (*Cryptophis nigrostriatus*) (left), copper-tailed skink (*Ctenotus taeniolatus*) (right)

Mammals

A total of 40 mammal species from 17 families were observed in habitats within or near the preliminary investigation corridor. The following two NC Act listed mammals were detected:

- Little pied bat (*Chalinolobus pictatus*) – near threatened
- Echidna (*Tachyglossus aculeatus*) – special least concern – evidence of this species (characteristic diggings and scats) was detected at one location within the preliminary investigation corridor during field surveys.

Eight introduced mammals were recorded from habitats within or near the preliminary investigation corridor:

- Pig (*Sus scrofa*)
- Wild dog (*Canis familiaris*)
- Dingo (*Canis familiaris dingo*)
- Feral cat (*Felis catus*)
- Horse (feral) (*Equus caballus*)
- Chital deer (*Cervus axis*)
- Cattle (wild) (*Bos primigenius*)
- European rabbit (*Oryctolagus cuniculus*)

Ground-dwelling mammals

The native ground mammal fauna was dominated by macropods (family Macropodidae). The eastern grey kangaroo (*Macropus giganteus*) was commonly observed in woodland and cleared habitats. The red kangaroo (*Macropus rufus*) was only recorded within the southern third of the preliminary investigation corridor. Smaller macropods including the agile wallaby (*Macropus agilis*), common wallaroo (*Macropus robustus*) (Plate 6-6), spectacled hare-wallaby (*Lagorchestes conspicillatus*) and swamp wallaby (*Wallabia bicolor*) were also observed. The rufous bettong (*Aepyprymnus rufescens*) was frequently observed during nocturnal surveys.

Scats and diggings of two common ground-dwelling mammals, the echidna (scats and diggings in termite mounds) and northern brown bandicoot (*Isoodon macrourus*) (characteristic conical diggings), were observed as well as water rat (*Hydromys chrysogaster*) tracks. Two species of arboreal mammals were recorded, namely the greater glider (*Petauroides volans*) and the common brushtail possum (*Trichosurus vulpecula*).

Bats

One species of microchiropteran bat was observed during field surveys - the eastern cave bat (*Vespadelus troughtoni*). A large roost of this species was observed within a disused donga during active searches within semi-evergreen vine thicket near Abbot Point (Plate 6-6).

No flying-fox species were recorded during field surveys. Twelve microchiropteran bat species were recorded from echolocation call analysis of anabat data from field surveys. These bats comprised a range of common woodland and open country species, including two species from the family Emballonuridae (sheath-tail bats), four species from the family Molossidae (freetail bats) and 11 species of the family Vespertilionidae (evening bats). One NC Act listed bat, the near threatened little pied bat (*Chalinolobus picatus*), was recorded and positively identified. The little pied bat is discussed in more detail in Section 6.3.5.


Plate 6-6 Common wallaroo (left); roost of eastern cave bats (right)

Birds

A total of 180 bird species from 68 families were recorded from habitats within and near the preliminary investigation corridor during field surveys. One introduced bird species, the rock dove (*Columba livia*), was observed during field surveys. A number of NC Act listed birds were detected during field surveys, including the:

- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- Black-necked stork (*Ephippiorhynchus asiaticus*)
- Cotton pygmy-goose (*Nettapus coromandelianus*)
- Freckled duck (*Stictonetta naevosa*)
- Seven birds listed as migratory under the EPBC Act special least concern under the NC Act
- Thirty-six birds listed as marine under the EPBC Act.

The avian fauna observed in the study area generally comprised a mix of common and widespread woodland, grassland, wetland and water birds. Honeyeaters (family Meliphagidae) were the most diverse assemblage, with 18 species recorded. Other families included:

- Birds of prey (families Accipitridae and Falconidae) – 13 species
- Ducks, swans, geese, teals (family Anatidae) – 10 species
- Butcherbirds, magpie, woodswallows (Plate 6-7) (family Artamidae) – 10 species
- Gerygones, thornbills, scrubwrens (family Acanthizidae) – 10 species
- Parrots (families Cacatuidae and Psittacidae) – nine species.

Bird densities were dominated by species that travel in large flocks and that have broad habitat preferences. Budgerigars (*Melopsittacus undulatus*) Plate 6-7) were the most frequent bird observed, often being recorded in flocks of greater than 10 individuals. Other species recorded at high densities include the diamond dove (*Geopelia cuneata*), galah (*Eolophus roseicapillus*), pale-headed rosella (*Platycercus adscitus*), red-winged parrot (*Aprosmictus erythropterus*) and zebra finch (*Taeniopygia guttata*). Duck species at farm dams and waterbodies including the plumed whistling duck (*Dendrocygna eytoni*), Pacific black duck (*Anas superciliosa*) and the freckled duck (*Stictonetta naevosa*).

Plate 6-7 Black-faced woodswallow and a flock of budgerigars (left); emus (right)

The eastern fringe of the Caley Valley Wetland provides habitat for large and diverse bird community (

Plate 6-8). The wetland areas comprised both open and closed brackish palustrine habitats dominated by open water and stands of marsh vegetation, respectively. The open water and stands of vegetation provided high value habitat (including breeding habitat) for a variety of waterbirds. These habitats were dominated by the Threskiornithidae family (particularly royal spoonbill (*Platalea regia*) (in breeding plumage) and glossy ibis (*Plegadis falcinellus*)) and the Anatidae family (particularly Pacific black ducks (*Anas superciliosa*), whistling ducks (*Dendrocygna* spp.) and grey teal (*Anas gracilis*)).


Plate 6-8 Australian pelican (*Pelecanus conspicillatus*) and black swan (*Cygnus atratus*) with cygnets (left); large and diverse waterbird community (right)

Surveys of the Caley Valley Wetland and adjacent coastal areas through February and March 2012 (BAAM 2012) identified 60 species of waterbird (including records from desktop searches), numbering up to an estimated 24,000 individuals. This study added several other generally abundant bird species, but also a number of more notable species. These were: 12 migratory shorebird species (most notably Australian painted snipe (*Rostratula australis*), listed as vulnerable under the NC Act), seven other migratory bird species (including the NC Act listed little tern (*Sternula albifrons*), black-necked stork (*Ephippiorhynchus asiaticus*), radjah shelduck (*Tadorna radjah*) and Lewin's rail (*Lewinia pectoralis*)) (BAAM 2012). Field surveys at the edge of the Caley Valley Wetland within the preliminary investigation corridor identified 59 bird species, including the NC Act listed (near threatened) black-necked stork (*Ephippiorhynchus asiaticus*).

6.3.5 Threatened terrestrial fauna species likelihood of occurrence

A combined total of 33 threatened fauna species (listed under the NC Act or EPBC Act) were previously recorded or are predicted to occur within the preliminary investigation corridor. This includes six mammals, 10 reptiles and 17 birds. Seven birds protected under the JAMBA, CAMBA and/or Bonn conventions, listed as migratory under the EPBC Act and special least concern under the NC Act were confirmed from field surveys. Thirty-six birds listed as marine under the EPBC Act (not NC Act listed) were also observed. Platypus (*Ornithorhynchus anatinus*) (special least concern wildlife under section 34(3) of the Queensland Nature Conservation (Wildlife) Regulation 2006) may also occur in the preliminary investigation corridor. A likelihood of occurrence assessment for threatened terrestrial fauna species was undertaken in accordance with the methodology outlined in Section 6.2.4 and is provided in Volume 2 Appendix F Nature conservation.

Eleven listed threatened fauna species were considered likely to occur in habitats within and near the preliminary investigation corridor, based on distribution, previous records and habitat suitability from the likelihood of occurrence assessment (refer Volume 2 Appendix F Nature conservation). Predictive habitat mapping for these species, based on the methodology outlined in Section 6.2.5, is presented in Appendix F of Volume 2 Appendix F Nature conservation. Observations from field surveys, in combination with desktop information on these 11 species, indicated that eucalypt woodland, acacia dominated woodland and shrubland, and fringing

riparian vegetation may provide habitat for the black-chinned honeyeater (*Melithreptus gularis*), square-tailed kite (*Lophoictinia isura*), common death adder (*Acanthophis antarcticus*) and little pied bat (*Chalinolobus picatus*). Eucalypt woodlands and fringing riparian vegetation were considered likely to provide habitat for the koala; these habitats were present throughout the preliminary investigation corridor. Potential habitat for the black-throated finch (southern) was observed in and near the northern and central sections of the preliminary investigation corridor. Suitable habitat was within fringing riparian vegetation and eucalypt woodlands featuring an understorey of suitable native grasses, where water is locally available. Coastal wetlands within and near the preliminary investigation corridor (especially the Caley Valley Wetland) is likely to provide habitat for the Australian painted snipe, little tern and eastern curlew.

The ornamental snake is a cryptic species with relatively specific habitat associations with brigalow woodlands, riparian areas and, in particular, gilgais. Therefore the distribution of potential habitat for ornamental snake is likely to be patchy within the preliminary investigation corridor. The NC Act listed brigalow scaly-foot occurs in a range of remnant to non-remnant open forest to woodland areas generally coinciding with land zones 3, 4, 5, 7, 8, 9 and 10 (SEWPaC 2013b). Potentially suitable habitat for this species can be associated with eucalypt woodland and acacia dominated woodland/shrubland. These habitats occur within and near the preliminary investigation corridor, particularly south of Collinsville.

Threatened marine and migratory species (listed under the EPBC Act) are addressed in Volume 1 Chapter 7 Matters of national environmental significance.

Five threatened terrestrial fauna species (NC Act listed) were confirmed present during field surveys within and near the preliminary investigation corridor (refer Table 11 of Volume 2 Appendix F Nature conservation):

- Squatter pigeon (southern) (*Geophaps scripta scripta*) – vulnerable (NC Act); vulnerable (EPBC Act)
- Black-necked stork (*Ephippiorhynchus asiaticus*) – near threatened (NC Act)
- Cotton pygmy-goose (*Nettapus coromandelianus*) – near threatened (NC Act)
- Freckled duck (*Stictonetta naevosa*) – near threatened (NC Act)
- Little pied bat (*Chalinolobus pictatus*) – near threatened (NC Act) – this species' echolocation call was positively identified on anabat devices at five locations within the preliminary investigation corridor during field surveys. Potential calls for this species (not reliably identified from anabat data) were also recorded at a further three locations.

Squatter pigeon (southern)

A total of eight individual squatter pigeons were recorded during field surveys at four locations within the preliminary investigation corridor (refer Figure 6-9). All records of this species from field surveys were from the Suttor River floodplain in the southern half of the preliminary investigation corridor. Squatter pigeons were typically encountered from eucalypt woodland with a grassy understorey, and non-remnant cleared land habitat types. Squatter pigeons were recorded in pairs at each location.

Details of the squatter pigeon (southern) field survey records are presented in Appendix C of Volume 2 Appendix F Nature conservation. Potential habitat for this species occurs throughout the preliminary investigation corridor. Squatter pigeons are associated with eucalypt woodland, fringing riparian vegetation and non-remnant cleared lands/regrowth areas (occurring on land

zones 3, 4, 5, 7 and 10) within three kilometres of water (SEWPaC 2013a). Predictive habitat mapping for this species is presented in Appendix F of Volume 2 Appendix F Nature conservation.

Black-necked stork

An individual black-necked stork was observed during the field survey within the Caley Valley Wetland at the northern end of the preliminary investigation corridor. Historical and recent records of black necked stork across the Caley Valley Wetland are frequent, with numbers of 10 or more adult and immature birds recorded during BAAM (2012) surveys across a variety of wetland habitats in the area. No breeding sites have been located in the area.

This species is also likely to occur in larger watercourses and dams in the natural and artificial waterbodies habitat type within and near the preliminary investigation corridor. Potential habitat for this species occurs throughout the preliminary investigation corridor. Details of the black-necked stork field survey record are depicted on Figure 6-9 and are presented in Appendix C of Volume 2 Appendix F Nature conservation. Predictive habitat mapping for the black-necked stork is presented in Appendix F of Volume 2 Appendix F Nature conservation.

Cotton pygmy-goose

The cotton pygmy-goose was recorded from one location during field surveys. Six individuals of this species were observed at one large dam/ waterbody located on the Suttor River flood plain within the preliminary investigation corridor. No recent population size data is available for this species. The Burdekin River Basin is considered a major centre for cotton pygmy goose populations. Potentially suitable habitat for this species is patchily distributed throughout the preliminary corridor within natural and artificial waterbodies and coastal wetland habitat types. The cotton pygmy-goose field survey records are depicted on Figure 6-9 and are also presented in Appendix C of Volume 2 Appendix F Nature conservation. Predictive habitat mapping for the cotton pygmy-goose is presented in Appendix F of Volume 2 Appendix F Nature conservation.

Freckled duck

The freckled duck was recorded at farm dam locations within or near the preliminary investigation corridor on two separate occasions. A total of 60 individuals (15 and 45 individuals respectively) were observed from two farm dam locations within the natural and artificial waterbodies habitat type in the southern half of the preliminary investigation corridor. This species generally occurs in southern Australia and is a vagrant visitor to northern Queensland. The species typically breeds in large temporary floodwater filled swamps in the Bulloo and Lake Eyre Basins and the Murray Darling Basin. It is known to disperse during times of inland drought (Marchant and Higgins 1990). As a result, habitats within and near the preliminary investigation corridor are unlikely to support large breeding populations of this species. The freckled duck field survey records are shown in Figure 4-1 in Volume 2 Appendix F Nature conservation. Predictive habitat mapping for the freckled duck is presented in Appendix F of Volume 2 Appendix F Nature conservation.

Little pied bat

The little pied bat was positively identified in fringing riparian vegetation (two locations), natural and artificial waterbodies (two locations) and acacia dominated woodland/shrubland (one location). Potential calls for this species (identified as probably this species, but not able to be reliably identified from Anabat data) were also recorded within fringing riparian vegetation and natural and artificial waterbodies. Recorded calls of the little pied bat were not limited to one specific habitat type or area within the preliminary investigation corridor (refer Figure 4-1 in

Volume 2 Appendix F Nature conservation). This indicates that the species is likely to be present through much of the landscape in which the preliminary investigation corridor occurs. The microbat call identification report is contained within Appendix C of Volume 2 Appendix F Nature conservation. Predictive habitat mapping for the little pied bat is presented in Appendix F of Volume 2 Appendix F Nature conservation.

6.3.6 Aquatic fauna

A total of 55 fish species are expected to occur within the Burdekin and Don River Basins, based on known presence and distributions described in Pusey *et al*. (2004), and Carter and Tait (2008). A full fish species list is presented in Appendix E of Volume 2 Appendix F Nature conservation, which also includes a summary of the biology and habitat requirements of each species. The fish community within the study area is likely to consist of a diverse range of species, given the broad range (i.e. lacustrine, palustrine, riverine and estuarine) of habitats.

The only threatened fish species known to occur in the Burdekin and Don River Basins are the freshwater sawfish (*Pristis microdon*) and the green sawfish (*Pristis zijsron*), which are both listed as vulnerable under the EPBC Act. However, these species are not likely to occur within the preliminary investigation corridor due to the artificial barriers (dams and weirs) that prevent dispersal. The freshwater sawfish (*Pristis microdon*) is also listed a priority conservation species in the Burdekin NRM Region Back on Track Actions for Biodiversity (medium rank for the North Queensland Dry Tropics region, and high rank for DERM). There are an additional 11 fish species of AquaBAMM conservation priority (Inglis and Howell 2009a; Inglis and Howell 2009b).

A number of fish species were observed within the study area during targeted fish surveys, including:

- Sooty grunter (*Hephaestus fuliginosus*)
- Spangled perch (*Leiopotherapon unicolor*)
- Eastern rainbowfish (*Melanotaenia splendida splendida*)
- Flyspecked hardyhead (*Craterocephalus stercusmuscarum*)
- Sailfin glassfish (*Ambassis agrammus*)
- Barramundi (*Lates calcarifer*)
- Seven-spot archerfish (*Toxotes chatareus*)
- Pacific blue-eye (*Psuedomugil signifer*)
- Unidentified gudgeons (*Hypseleotris spp.*)
- Unidentified gudgeons (unknown genera)
- Unidentified gobies (unknown genera).

The above list was generated from targeted fish surveys and therefore should not be considered as a true representation of the potential fish community within the preliminary investigation corridor. A comprehensive list of the potential and confirmed fish community of the Burdekin and Don River Basins is provided in Appendix E of Volume 2 Appendix F Nature conservation.

The Burdekin and Don River Basins are known habitat for up to five freshwater turtle species (Cann's long-necked turtle (*Chelodina canni*); eastern snake-necked turtle (*Chelodina*

longicollis); Irwin's turtle (*Elseya irwini*); Krefft's river turtle (*Emydura macquarii krefftii*); saw-shelled turtle (*Wollumbinia latisternum*)) and one crocodile species (*Crocodylus porosus*) (Inglis and Howell 2009a; Inglis and Howell 2009b). Of the six potentially occurring aquatic reptile species, only Krefft's river turtle (*Emydura macquarii krefftii*) was observed in the preliminary investigation corridor. In previous field surveys, freshwater turtles were not observed within the Burdekin River catchment; however, the Bogie River was identified as potential habitat for Irwin's turtle (*Elseya irwini*) (GHD 2012). Additionally, the gilgais were considered to provide habitat suitable for Cann's long-necked turtle (*Chelodina canni*).

While none of the turtle species are listed as threatened under the NC Act, Irwin's turtle (*Elseya irwini*) is a priority species in the Burdekin NRM Back on Track Actions for Biodiversity (North Queensland Dry Tropics rank high and DERM rank high). Suitable habitat for this species exists in a number of riverine habitats that are crossed by the preliminary investigation corridor, and so this species is considered as being likely to occur in the preliminary investigation corridor.

Suitable habitat for the Cann's long-necked turtle (*Chelodina canni*), eastern snake-necked turtle (*Chelodina longicollis*) and saw-shelled turtle (*Wollumbinia latisternum*) exists for these species throughout the preliminary investigation corridor and therefore these species are considered likely to occur.

The estuarine crocodile (*Crocodylus porosus*) is listed as vulnerable under the NC Act and migratory and marine under the EPBC Act. It is considered that the estuarine crocodile is likely to occur in the preliminary investigation corridor where large permanent pools of water are present within the major rivers of the Burdekin Basin. It has previously been recorded within the Burdekin River Basin (SEWPaC 2013c). This species may also occur within deeper tidal creeks associated with the Caley Valley Wetland.

Two species of aquatic macroinvertebrates (the freshwater crab (*Austrothelphusa transversa*) and the freshwater mussel (*Alathyria* sp.)) were observed within the preliminary investigation corridor and wider study area. The most commonly observed species was the freshwater crab (*Austrothelphusa transversa*). Freshwater mussels and mussel shells were also frequently observed along the banks of waterways. A number of coastal and estuarine crab species were observed during previous surveys of the Caley Valley Wetland, and included mud crabs (*Scylla serrata*), semaphore crabs (*Heloecius cordiformis*), fiddler crabs (*Uca* sp.) and shore crabs (family Grapsidae) (E3 Consulting 2010).

Table 4-12 of Volume 2 Appendix F Nature conservation provides a summary of the aquatic fauna species previously observed, and observed during May and June 2013 surveys in the preliminary investigation corridor and wider study area.

6.3.7 Wetland protection areas and nationally important wetlands

Wetlands of high ecological significance in Great Barrier Reef catchments are identified as wetland protection areas. The SPP 4/11 outlines a code for assessing prospective developments that are planned in wetlands of high ecological significance. The preliminary investigation corridor intersects only one wetland protection area, the Caley Valley Wetland (Figure 6-11). This wetland protection area is described in Inglis and Howell (2009b) under DEHP's AquaBAMM criteria as:

- Wetland class: palustrine

- Salinity: hypo-saline
- Priority ecosystems and special features:

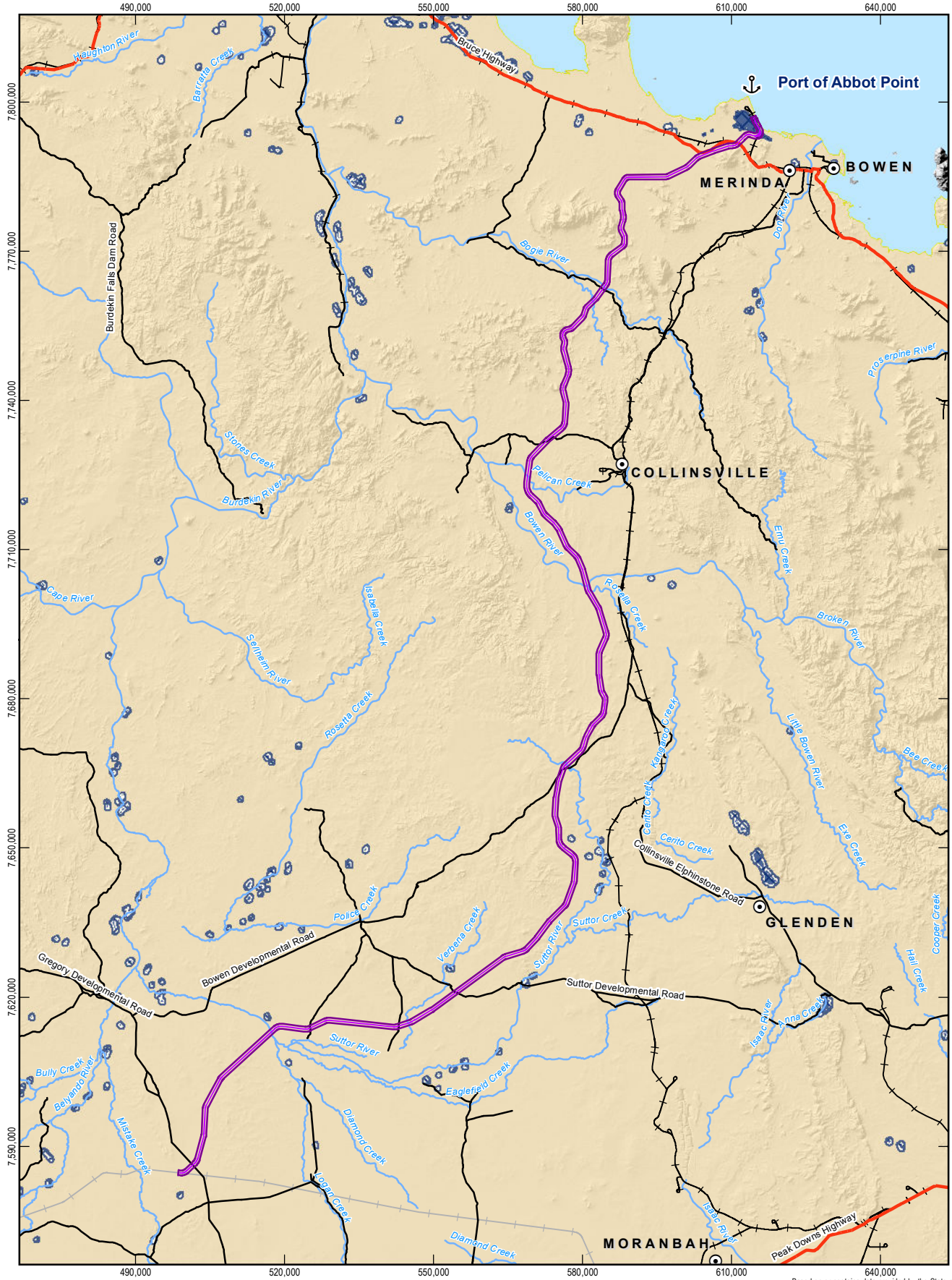
Flora: seasonal palustrine/swamps of the floodplain with native macrophyte communities (RE 11.3.27)

  - Fauna: Caley Valley Wetland special feature – large coastal wetland with a saline influence and old marine sediments, wetlands provide important habitat for waterbirds including migratory species, wetlands contain significant limestone formations
  - Wetland ecosystems: Splitters Creek special feature – contains good diversity of flora species in an intact riparian zone, good connectivity with estuarine areas providing good habitat for crocodiles and various species of bird and fish
- AquaBAMM conservation value (or AquaScore): rated as very high.

A total of eight nationally important wetlands listed on the DIWA occur within, or in regional proximity to the preliminary investigation corridor, including:

- Abbot Point – Caley Valley Wetland (within the Don River Basin, within the preliminary investigation corridor)
- Southern Upstart Bay wetland (within the Don River Basin, downstream of the preliminary investigation corridor)
- Bowen River: Birralee – Pelican Creek wetland (within the Bowen River catchment, downstream of the preliminary investigation corridor)
- Burdekin delta – Lower Burdekin (within the Lower Burdekin River catchment, downstream of the preliminary investigation corridor)
- Junction of the Bogie River and Kirknie Creek aggregation (within the Lower Burdekin River catchment, downstream of the preliminary investigation corridor)
- Lake Dalrymple (within the Suttor River catchment, downstream of the preliminary investigation corridor)
- Scartwater aggregation (within the Suttor River catchment)
- Burdekin-Bowen junction and Blue Valley Weir aggregation (within the Lower Burdekin and Bowen River catchments, downstream of the preliminary investigation corridor).

The preliminary investigation corridor, due to its 1,000 m width, crosses the western part of the DIWA listed Abbot Point – Caley Valley Wetland (Figure 6-12); however, the final rail corridor is not expected to enter any part of this wetland. No other DIWA listed wetlands occur within the preliminary investigation corridor; however, the Southern Upstart Bay wetland and Bowen River: Birralee – Pelican Creek wetland are within 4.5 km and 2.6 km respectively (Figure 6-12). All other DIWA listed wetlands are more than 20 km from the preliminary investigation corridor.



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- Wetland Protection Area
- Wetland Protection Area Trigger
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project

Wetland protection areas relevant to the preliminary investigation corridor

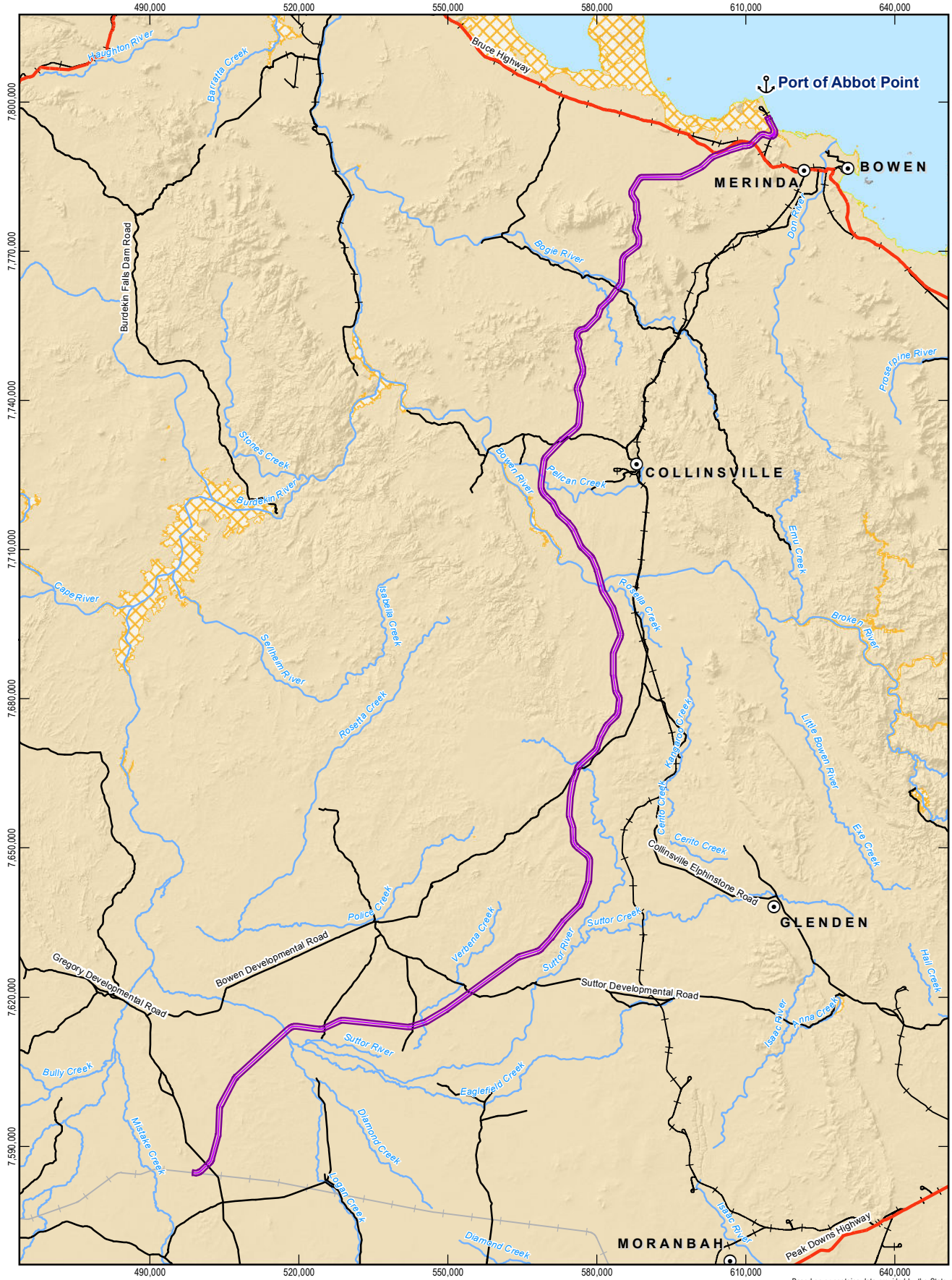
Job Number	41-26457
Revision	A
Date	22 Aug 2013

Figure 6-11

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1123_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, Wetland Protection Area/2011. Created by:MS



LEGEND

- Population Centres
- Major Port
- Highway
- Main Road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- Directory of Important Wetlands
- North Galilee Basin Rail 1000m Corridor
- North Galilee Basin Rail 100m Corridor

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

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

N

GHD adani

Adani Mining Pty Ltd
North Galilee Basin Rail Project
Nationally important wetlands relevant to the preliminary investigation corridor

Job Number	41-26457
Revision	A
Date	22 Aug 2013

Figure 6-12

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1124_rev_a.mxd

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: GA: Populated Places, Railway, Watercourse/2007; Adani: NGBR Corridor 13/05/2013 NGBR Corridor 06/06/2013, Camichael Rail Project/2012; DNRM: Roads/2010, DOIW/2012. Created by:MS

6.3.8 Existing threatening processes

The landscape in which the preliminary investigation corridor occurs has been historically, and continues to be, exposed to a diverse array of threatening processes. Sattler and Williams (1999) identified continued vegetation clearing, high total grazing pressure and exotic species as the major threats to biodiversity in the Brigalow Belt bioregion. The Burdekin NRM Back on Track Actions for Biodiversity report (DERM 2010) details a variety of threatening processes impacting upon priority terrestrial and aquatic taxa in the region. These include (DERM 2010):

- Clearing of vegetation
- Feral animals (terrestrial and aquatic)
- Baiting
- Disease
- Vehicle collisions with wildlife
- Inappropriate fire regimes
- Inappropriate grazing regimes
- Linear infrastructure development and maintenance
- Mining
- Urban development
- Weeds (terrestrial and aquatic)
- Flow regime disruption (including disruptions to flow regimes and groundwater extraction)
- Water quality alteration.

These threatening processes are mostly related to the land use in the Brigalow Belt bioregion. Historical vegetation clearing has occurred in parts of the landscape to facilitate agricultural and mining industries, and associated infrastructure (such as roads and railways). Vegetation clearing has resulted in direct mortality of flora and fauna, habitat loss, habitat fragmentation and the erosion and sedimentation of watercourses. The introduction of non-indigenous grazing animals (mainly cattle) has resulted in terrestrial and aquatic habitat degradation throughout the preliminary investigation corridor. The presence and abundance of feral animals and exotic plants was reflected in the management practices of properties throughout the preliminary investigation corridor. In general, riparian areas throughout the landscape appeared to be particularly susceptible to weed invasion, with a number of weed infestations noted. Introduced fauna or evidence of introduced fauna was common, particularly in riparian areas surrounding watercourses.

Five priority reptiles, five priority birds and three priority mammals were identified in the Burdekin NRM Back on Track Actions for Biodiversity report (DERM 2010). Table 5-1 of Volume 2 Appendix F Nature Conservation identifies ‘Back on Track’ priority species relevant to the preliminary investigation corridor, including their regional-specific threats.

Introduced flora

The information gathered from desktop sources included predictive weed mapping information (based on climate suitability) over the region and historical confirmed records of weed species in the preliminary investigation corridor. The desktop review for weed species identified 38 species

of declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) (including four aquatic, semi-aquatic or aquatic dependent Weeds of National Significance) that have been recorded within the preliminary investigation corridor. These species are listed in Volume 2, Appendix F Nature conservation.

A total of 35 introduced plant species were recorded during field surveys, including nine declared weeds under the LP Act (Class 2 and Class 3, refer Table 6-6). In addition, two introduced aquatic plants were identified at two sites – the umbrella sedge (*Cyperus involucratus*) at Pelican Creek, and curled dock (*Rumex crispus*) at a farm dam.

Table 6-6 Declared weeds recorded in preliminary investigation corridor

Scientific name	Common name	Location in corridor
Class 2		
Cryptostegia grandiflora	Rubber vine	Prevalent in creeks and waterways primarily north of the Bowen River.
Harrisia martini	Harrisia cactus	Commonly encountered in semi-evergreen vine thicket and brigalow throughout the corridor, less frequently present in sclerophyll vegetation.
Opuntia stricta and O. tomentosa	Prickly pear	Encountered across the entire corridor but always with a very sparse distribution (only ever seen as isolated individuals) in most habitat types.
Parkinsonia aculeata	Parkinsonia	Abundant at Caley Valley on dune scrub, but rare elsewhere within preliminary investigation corridor – generally restricted to river banks and riparian areas.
Parthenium hysterophorus	Parthenium	This species was frequently noted along roadsides and scattered throughout paddocks in the entire preliminary investigation corridor, particularly on clay and clay loams.
Sporobolus pyramidalis	Giant rat's tail grass	Isolated occurrence within preliminary investigation corridor; recorded only from Bakara Station in Oaky Creek, but also known to occur in Sandy Creek.
Acacia nilotica (now *Vachellia nilotica*)	Prickly acacia	Abundant at Caley Valley on dune scrub, but not recorded elsewhere.
Class 3		
Lantana camara	Lantana	Primarily located in the Collinsville area, with a particular infestation known from the northern bank of the Bowen River.

Introduced fauna

An assessment of the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) maps illustrating the density and distribution of various pest species within the preliminary investigation corridor indicated the following:

- Wild dogs, feral cats and cane toads are considered to be widespread and common
- European rabbits are considered to be widespread and occasional
- Feral pigs are considered to be widespread and common in the middle section of the preliminary investigation corridor, and common to occasional abundance throughout the rest of the preliminary investigation corridor
- Feral horses are considered to be occasional and localised in the southernmost part of the preliminary investigation corridor
- The chital deer (*Axis axis*) is considered to be localised and occasional in a small area to the north and west of Collinsville
- European fox (*Vulpes vulpes*) is considered to be widespread and occasional throughout the landscape in the northern half of the preliminary investigation corridor and widespread and common throughout the landscape in the southern half
- The feral water buffalo (*Bubalis bubalis*) is mapped as being of localised distribution and occasional density in one small area west of Collinsville.

Other introduced mammals that occur in the landscape include the house mouse (*Mus musculus*), black rat (*Rattus rattus*) and brown hare (*Lepus europeaus*). Tilapia (*Oreochromis mossambicus*), three spot gourami (*Trichogaster trichopterus*) and mosquitofish (*Gambusia holbrooki*) currently occur within the Burdekin River Basin (Pusey *et al.* 2004; Carter and Tait 2008). Tilapia (*Oreochromis mossambica*) has been observed in previous surveys of the Suttor River, Bowen River and Pelican Creek, and the mosquito fish (*Gambusia holbrooki*) has been observed in the Caley Valley Wetland catchment (E3 Consulting 2010; GHD 2010).

Ten introduced terrestrial vertebrates were recorded in habitats within and near the preliminary investigation corridor, including:

- One amphibian – cane toad
- Eight mammals – wild dog, dingo, feral cat, European rabbit, feral pig, wild horse, chital deer and feral cattle
- One bird – rock dove.

Cattle, pigs, and their pugging and wallowing areas were frequently noted within a range of habitats throughout the preliminary investigation corridor.

6.4 Potential impacts and mitigation measures

This section assesses the potential impacts of the NGBR Project on the nature conservation values outlined in Section 6.3. The potential impacts to nature conservation as a result of developing the NGBR Project, specifically the footprints associated with the final rail corridor and ancillary infrastructure, include vegetation clearing, disturbances of watercourses and changes to surface water flows, increased anthropogenic activity leading to disturbance and the introduction of weeds.

6.4.1 Construction

Terrestrial vegetation communities

During construction, the NGBR Project will require clearing of approximately 4,215 ha of vegetation, of which approximately 2,571 ha is mapped remnant vegetation (VM Act). The mapped remnant vegetation encompasses 61 RE types within the Brigalow Belt bioregion. The total area of expected impact on endangered, of concern and least concern REs is summarised in Table 6-7.

The area required for clearing is based on the NGBR Project footprint containing a nominal 100 m final rail corridor as well as ancillary infrastructure areas.

Table 6-7 Vegetation clearing impacts on regional ecosystems

RE status	Clearing amount
Endangered	145 ha
Of concern	210 ha
Least concern	2,216 ha
Total	2,571 ha

Vegetation clearing will require removal of a number of high conservation status REs (i.e. endangered, of concern and threshold REs). However, the individual REs that will likely undergo the greatest extent of clearing are least concern REs 11.12.1 (622 ha) and 11.5.3 (296 ha) which together equate to approximately 22 per cent of the total clearing extent required during construction (including non-remnant land), and 35 per cent of the 2,571 ha of mapped remnant vegetation expected to be cleared.

Table 6-8 summarises the extent of clearing for the NGBR Project compared to the amount of RE present within the bioregion and subregion. REs listed as least concern have not been included in Table 6-8, with the exception of threshold REs. The Regional Vegetation Management Code for Brigalow Belt and New England tablelands defines threshold REs as ‘ecosystems that are at risk of the remnant extent falling below 30 per cent of its pre-clearing extent, or having a remnant extent of less than 10,000 ha.

Table 6-8 Vegetation clearing impacts on high conservation status REs

RE	Area of proposed clearing	Bioregion current extent[1]	Current extent within subregion[2]	% of subregion extent[3]
Endangered REs				
11.3.1	18.1 ha	80,610 ha	18,566 ha	0.09%
11.4.8	20.8 ha	71,155 ha	33,096 ha	0.06%
11.4.9	48.4 ha	95,498 ha	42,823 ha	0.11%
11.9.1	0.1 ha	54,890 ha	5,400 ha	<0.01%
11.9.12	42.9 ha	4,078 ha	2,940 ha	1.45%
11.11.18	2 ha	4,350 ha	534 ha	0.37%
11.12.21	12.9 ha	6,481 ha	698 ha	1.84%
Of concern REs				
11.2.3	33.7 ha	2,508 ha	1,306 ha	2.58%
11.3.2	65.3 ha	517,452 ha	70,285 ha	0.09%
11.3.3	17.7 ha	281,071 ha	66,410 ha	0.02%
11.3.4	33.2 ha	183,695 ha	41,119 ha	0.08%
11.3.33	9.9 ha	1,859 ha	1,811 ha	0.54%
11.3.34	1.6 ha	9,382 ha	9,365 ha	0.01%
11.4.2	1.7 ha	34,532 ha	8,997 ha	0.01%
11.4.5	0.4 ha	13,081 ha	12,785 ha	<0.01%
11.4.6	0.07 ha	34,622 ha	25,979 ha	<0.01%
11.9.10	25.4 ha	80,779 ha	19,208 ha	0.13%
11.11.13	4.5 ha	49,863 ha	7,983 ha	0.05%
11.12.10	2.8 ha	9,193 ha	9,193 ha	0.03%
11.12.14	1.2 ha	3,093 ha	2,992 ha	0.04%
11.12.15	1.6 ha	2,400 ha	2,328 ha	0.06%
11.12.16a	1.6 ha	5,240 ha	5,240 ha	0.03%
11.12.18	0.4 ha	1,546 ha	1,005 ha	0.03%

RE	Area of proposed clearing	Bioregion current extent[1]	Current extent within subregion[2]	% of subregion extent[3]
Least concern threshold RE				
11.3.5	30.4 ha	54,832 ha	36,926 ha	0.08%
Of concern threshold RE				
11.4.11	8.1 ha	23,771 ha	23,375 ha	0.03%

[1] Figures calculated from DEHP 2013: 'current extent' is from 2009
[2] Current extent within subregion is the sum of each REs current extent from all of the subregions/provinces traversed by the alignment
[3] % = proposed clearing extent as % of subregion current extent

Approximately 44.4 ha of regulated high-value regrowth vegetation will be cleared during construction. Of this, approximately 10.1 ha is categorised as being high value regrowth containing an endangered RE, 10 ha is high value regrowth containing an of concern RE, and 24.3 ha is high value regrowth that is a least concern RE.

In addition to the area of remnant vegetation and regulated regrowth vegetation that will be impacted within the construction footprint, a further 1,643 ha of non-remnant land (predominantly utilised for grazing purposes) will be utilised for construction of the NGBR Project. This equates to a total of 39 per cent of the total clearing area of the NGBR Project.

For the purposes of understanding the general vegetation patterns within the preliminary investigation corridor, the 61 mapped REs were reduced to eight BVCs based on similarities in the species composition and vegetation communities (refer Section 6.3.2). As each BVC corresponds with a broad fauna habitat type (refer Table 6-2), the extent of each BVC potentially impacted by vegetation clearing is assessed in the terrestrial fauna habitat assessment section of this chapter.

The NGBR Project will require clearance of EPBC Act listed Threatened Ecological Communities. These impacts are discussed separately in Volume 1 Chapter 7 MNES.

Vegetation surveys for the NGBR Project were undertaken in accordance with the Regional Vegetation Management Code for Brigalow Belt and New England. Part S of this management code outlines clearing performance requirements for coordinated projects. Table 6-9 provides an overview of Part S requirements and a cross reference to where relevant information is discussed within the EIS. A detailed assessment against Part S of the Regional Vegetation Management Code will be provided as part of a future development application for clearing of assessable native vegetation under the VM Act.

Table 6-9 Part S of the Regional Vegetation Management Code for Brigalow Belt and New England

Performance requirement	Relevant information
Wetlands *To regulate the clearing of vegetation in a way that prevents the loss of biodiversity and maintains ecological processes—maintain the current extent of assessable vegetation associated with any natural significant wetland and/or natural wetland to provide:* • water quality by filtering sediments, nutrients and other pollutants; and • *aquatic habitat; and* • *terrestrial habitat.*	In total, 10.6 ha of wetland vegetation will require clearing however no permanent aquatic habitat within DIWA listed nationally important wetlands will be directly disturbed. Further information regarding the potential impacts on wetlands as a result of the NGBR Project can be found in Section 6.3.7 and Section 6.4.1.
Watercourses *To regulate the clearing of vegetation in a way that does not cause land degradation, prevents the loss of biodiversity and maintains ecological processes—maintain the current extent of assessable vegetation associated with any watercourse to provide:* • *bank stability by protecting against bank erosion; and* • *water quality by filtering sediments, nutrients and other pollutants; and* • *aquatic habitat; and* • *terrestrial habitat.*	The preliminary investigation corridor crosses a variety of aquatic habitats including 16 major and moderated waterways and approximately 120 minor waterways. Construction of the NGBR Project will require works within and around waterways and ephemeral streams resulting in the potential loss or damage to riparian or aquatic habitat. In particular, the construction of bridge structures, pipe culverts and box culverts will require clearing riparian vegetation and potential disturbance of in-stream habitat. In total, 42.77 ha of riparian vegetation will require clearing. The majority of aquatic habitats within the preliminary investigation corridor are already exposed to a number of existing disturbances, including: • Erosion and scouring of stream banks due to vegetation clearing • Cattle and pig disturbance within riparian habitat • Farm activities such as tracks within the riparian habitat. Clearing of riparian vegetation would be restricted to the minimal amount necessary for construction and, wherever possible, existing cleared areas will be utilised. Any works within watercourses would be undertaken in accordance with the DEHP Guidelines for carrying out activities in a watercourse, lake or spring and, or the conditions of any riverine protection permit required for the work. A Flora and Fauna Management Plan will also be implemented that will include requirements for works within 20 metres of a

Performance requirement	Relevant information
	watercourse (i.e. stockpiling of material will not occur within 50 metres of a watercourse or drainage line). Further mitigation and management measures to minimise the potential impacts of clearing vegetation associated with watercourses are provided in Section 6.4.3.
Connectivity *To regulate the clearing of vegetation in a way that prevents the loss of biodiversity and maintains ecological processes—areas of mapped remnant vegetation are—* *a) of sufficient size and configured in a way to maintain ecosystem functioning; and* *b) of sufficient size and configured in a way to remain in the landscape in spite of any threatening processes; and* *c) located on the lot(s) that are the subject of the application to maintain connectivity to mapped remnant vegetation on adjacent properties.*	Vegetation clearing during construction has the potential to result in localised fragmentation of habitats adjacent to the NGBR Project. The NGBR Project is located in an area already highly fragmented by decades of cattle grazing which required broadscale vegetation clearing. Within this context, habitat fragmentation resulting from the NGBR Project is unlikely to have a regional impact on fauna diversity. However, it is likely to cause localised impacts, by intersecting corridors that are potentially important for local wildlife movement (e.g. along watercourses) and isolating and reducing the size of individual habitat patches. Mitigation and management measures that would be implemented to minimise the potential impacts of fragmentation on fauna movement and ecosystem function are provided in Section 6.4.3.
Soil erosion *To regulate the clearing of vegetation in a way that does not cause land degradation and maintains ecological processes—the effect of clearing does not result in—* *a) mass movement, gully erosion, rill erosion, sheet erosion, tunnel erosion, stream bank erosion, wind erosion, or scalding; and* *b) associated loss of chemical, physical or biological fertility—including, but not limited to water holding capacity, soil structure, organic matter, soil biology, and nutrients, within and/or outside the lot(s) that are the subject of the application.*	Other than the direct loss of habitat due to vegetation clearing, construction activities have the potential to indirectly degrade the quality of adjacent habitats and habitat edges, through exposure to sedimentation and erosion. The potential impacts of sedimentation during construction are discussed in detail within Volume 1 Chapter 5 Topography, geology, soils and land contamination Section 5.4.1. An erosion and sediment control plan will also be prepared and implemented prior to construction commencing to minimise the potential impacts of erosion and sedimentation (refer Section 6.4.3). This will include measures for the management of runoff from the cleared construction areas to minimise the impacts of sediment laden runoff entering adjacent water courses and drainage lines. Stormwater management measures during construction will include provision of sedimentation ponds and the diversion of clean water around construction areas where identified during the design

Performance requirement	Relevant information
Salinity *To regulate the clearing of vegetation in a way that does not cause land degradation and maintains ecological processes—clearing does not contribute to—* *a)waterlogging; or* *b) the salinisation of groundwater, surface water or soil.*	Salinity has been identified as one of the main water quality issues within the Burdekin Basin and conditions are expected to worsen in the future as a result of vegetation clearing and its effects on the hydrological balance of the region. Vegetation clearing may alter local water drawdowns therefore resulting in changes to the water table which could result in an increased salinity risk within low-lying areas.. The potential impacts of salinity are discussed further in Volume 1 Chapter 5 Topography, geology, soils and land contamination Section 5.4.1.
Conserving remnant vegetation that are endangered REs and of concern REs *To regulate the clearing of vegetation in a way that conserves remnant vegetation that are endangered regional ecosystems and of concern regional ecosystems—maintain the current extent of endangered regional ecosystems and of concern regional ecosystems.*	The NGBR Project will require clearing of approximately 4,215 ha of vegetation, of which approximately 2,571 ha is mapped remnant vegetation (VM Act). The mapped remnant vegetation encompasses 61 RE types within the Brigalow Belt bioregion, including 145 ha of endangered RE and 210 ha of concern RE. Potential impacts of the NGBR Project on REs are discussed further in Section 6.4.1.
Essential habitat *To regulate the clearing of vegetation in a way that prevents the loss of biodiversity—maintain the current extent of essential habitat.*	No essential habitat polygons were mapped as occurring within the preliminary investigation corridor. One essential habitat polygon (DNRM mapping version 3) was mapped as occurring within one kilometre of the preliminary investigation corridor. This mapped essential habitat polygon related to a single species, *Bonamia dietrichiana* (Dietrich's morning glory, near threatened under the NC Act), and is located west of Collinsville near chainage 105 km. No mapped essential regrowth habitat polygons mapped within the Brigalow Belt bioregion, were intersected by, or occurred within one kilometre of the preliminary investigation corridor.
Conservation status thresholds *To regulate the clearing of vegetation in a way that prevents the loss of biodiversity and conserves remnant vegetation that are regional ecosystems—maintain the current extent of regional ecosystems listed in Table 5 of the Code.*	The NGBR Project will require clearing of approximately 4,215 ha of vegetation, of which approximately 2,571 ha is mapped remnant vegetation (VM Act). Corridor clearing widths within areas of high ecological value, such as riparian corridors, will be minimised and rehabilitated to restore connectivity to a level that considers the requirements of maintaining permanent infrastructure. All cleared areas which are no longer required will be rehabilitated in a way that facilitates the movement of fauna. Potential impacts of the NGBR Project on species diversity and prevalence is considered in Volume 1 Chapter 6 Nature conservation.

Performance requirement	Relevant information
Acid sulfate soils *To regulate the clearing of vegetation in a way that does not cause land degradation and maintains ecological processes in the coastal subregions of the Brigalow Belt Bioregion, and the Marlborough Plains subregion (11.14)—clearing activities do not result in disturbance of acid sulfate soils or changes to the hydrology of the location that will either:* *a) aerate horizons containing iron sulfides; or* *b) mobilise acid and/or metals.*	Construction works may impact acid sulfate soils if confirmed present during pre-construction soils survey investigations. Under State Planning Policy 2/02 Planning and Managing Development Involving Acid Sulfate Soils, acid sulfate soils must be considered where surface elevation is at or below 20 m AHD. Two portions of the study area are at or below 20 m AHD: • The initial 9.3 km portion (chainages 3.4 km to 12.7 km), which has multiple minor ephemeral creeks, including Saltwater Creek. • A 400 m portion between chainage 19.6 km and chainage 22.0 km, which is associated with Splitters Creek. Mitigation measures that will be implemented to minimise and avoid the disturbance of acid sulfate soils during construction include: Prior to construction commencing, a detailed acid sulfate soils investigation will be undertaking for areas < 20 mAHD. An Acid Sulfate Soils Management Plan specifically tailored to construction activities will also be developed and implemented based on the results of the investigation.

Terrestrial flora and flora habitat

A total of 297 least concern (NC Act) flora species from 71 families were recorded within the preliminary investigation corridor during field surveys (refer Section 6.3.2). Individuals and/or populations of some of these species will be lost from the local environment due to vegetation clearing during construction of the NGBR Project. This has the potential to reduce genetic diversity within populations of these species, and population dynamics and ecosystem function may be altered as suitable habitat for dispersal and germination will be lost. In addition, isolation of some populations of flora species (particularly those that require outcrossing for viable seed production) may increase the risk of inbreeding depression.

One conservation significant species was recorded during field surveys, *Eucalyptus raveretiana* (black ironbox), which is listed as vulnerable under the NC Act and EPBC Act. This species was observed in riparian woodlands within the NGBR Project preliminary investigation corridor along the Elliot, Bogie and Bowen Rivers, and along Pelican and Sandy Creek. The estimated construction impact on mapped habitat that is potentially suitable for this species is 64.6 ha.

Key threatening processes for black ironbox are identified as the loss of individuals (for example through timber harvesting), the proliferation of invasive weed species, and changes to water resources (SEWPaC 2013c). The loss of individuals is dealt with below, with weeds and water resources discussed within operational impacts.

Sixty-four ha of potential habitat for the species is mapped within the NGBR Project footprint and will be cleared to facilitate construction. These potential habitat areas are those areas of riparian habitat along a total of seven creek and river corridors (Strathmore Creek, Pelican Creek, Bogie River, Bowen River, Sandy Creek, Crush Creek, Elliott River) comprising REs

11.3.25 and 11.3.37, where black ironbox is generally found to be co-dominant with other Eucalypt species. This is likely to represent an over-estimation of the actual occurrence of black ironbox within the NGBR Project footprint, as it is not certain that the species will be present within every occurrence of the mapped REs within the preliminary investigation corridor and based on previous survey experience in the region its occurrence is consider less likely south of the Bowen River.

Furthermore, in terms of the actual impact to black ironbox during construction, clearance at creek crossings is only likely to result in the loss of a few individual black ironbox trees, at most, at each crossing point where RE 11.3.25 or 11.3.37 is present. Given that the REs will be present as a fringing band along the creek or river, it will remain present on either side of the cleared footprint, as will individual black ironbox trees within those areas.

It is therefore considered unlikely that the clearance will result in significant impacts to an important population of the species, either through causing long-term decreases in population sizes or significantly reducing the area of overall occupancy available to that species.

As identified in Section 6.3.2 one conservation significant flora species, *Bonamia dietrichiana*, listed as near threatened under the NC Act (not listed under the EPBC Act), was considered likely to occur based on previous records and potentially suitable habitat present within the preliminary investigation corridor. The estimated construction impact on habitat that is suitable for this species is 626 ha.

Terrestrial fauna and fauna habitat

Vegetation clearing during construction of the NGBR Project will result in the direct loss of habitat for a variety of birds, reptiles, mammals and frogs. Direct loss of vegetation includes the removal of structural features (i.e. mature vegetation, hollow-bearing trees and hollow logs) that provide microhabitats and resources for fauna. Loss of these habitat features creates a loss of perching, foraging and den/nesting resources for native species. This is likely to reduce the number of individual animals that can be accommodated in a given area and will likely increase competition for resources such as food and shelter in remaining remnant habitats. Hollow-bearing trees are recognised as a limited resource in most grazing lands due to previous clearing and therefore the loss of these habitat features is considered to be a major threat to Australia's biodiversity (Gibbons and Lindenmayer 2002). The types of fauna habitat and total area that would be cleared during construction within the final NGBR Project footprint will include:

- 84.2 ha of native pastures or grasslands
- 44.4 ha of vine thicket
- 138.1 ha of brigalow shrubland to open forest
- 1,851.8 ha of eucalypt open woodland
- 354.5 ha of mixed species shrubland/low woodland
- 42.7 ha of open woodland fringing watercourses and on flood plains
- 10.1 ha of tidal vegetation
- 10.6 ha of wetland vegetation

- 1,554.9 ha of open cleared land and regrowth.

In addition to these habitat types, 17 major watercourses are likely to be impacted by construction activities. These natural and artificial water bodies provide a source of water for birds and macropods. Consequently, construction activities will reduce the local availability of these habitats.

The loss of terrestrial fauna habitat as a result of the NGBR Project will reduce localised resource availability for a range of fauna species, including:

- Amphibians – particularly suitable habitat types include: open woodland fringing watercourses and on flood plains; wetland vegetation; and mapped watercourses and cattle troughs
- Reptiles – particularly suitable habitat types include: brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; and open woodland fringing watercourses and on flood plains
- Birds – suitable habitat types include: native pastures or grasslands; vine thicket; brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; open woodland fringing watercourses and on flood plains; wetland vegetation; tidal vegetation; and open cleared land and regrowth
- Mammals – suitable potential habitat types include: native pastures or grasslands; vine thicket; brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; open woodland fringing watercourses and on flood plains; wetland vegetation; tidal vegetation; and open cleared land and regrowth.

The NGBR Project will result in the direct loss of potential habitat for five EPBC Act-listed threatened fauna species confirmed present or considered likely to occur within the preliminary investigation corridor (refer Table 6-10). The potential impact of the NGBR Project on these species is discussed in Volume 1 Chapter 7 MNES.

The NGBR Project will also result in the direct loss of potential habitat for 16 NC Act-listed threatened fauna species that were confirmed present or considered likely to occur within the preliminary investigation corridor. The direct impact on potential habitat for fauna species listed under the NC Act is summarised in Table 6-10.

Table 6-10 Loss of potential habitat for threatened fauna

NC Act-listed fauna species	EPBC Act status	NC Act status	Total clearing extent within the final NGBR Project footprint [1]
Confirmed present			
Squatter pigeon (southern)	Vulnerable	Vulnerable	1,788 ha
Black-necked stork	Not listed	Near threatened	458.8 ha
Cotton pygmy-goose	Not listed	Near threatened	63.2 ha
Freckled duck	Not listed	Near threatened	63.2 ha
Little pied bat	Not listed	Near threatened	2,509 ha
Likely to occur			
Australian painted snipe	Vulnerable, marine, migratory (CAMBA)	Special least concern	45.5 ha
Black-chinned honeyeater	Not listed	Near threatened	2,260 ha
Black-throated finch (southern)	Endangered	Endangered	2,143 ha
Brigalow scaly-foot	Not listed	Vulnerable	1,992 ha
Common death adder	Not listed	Near threatened	2,509 ha
Eastern curlew	Marine, migratory (Bonn Convention, JAMBA, CAMBA, ROKAMBA)	Near threatened	45.5 ha
Estuarine crocodile	Marine, migratory (Bonn Convention)	Vulnerable	62.8 ha
Koala ((QLD, NSW and ACT populations)	Vulnerable	Special least concern	2,390 ha
Little tern	Marine, migratory (Bonn Convention, JAMBA, CAMBA, ROKAMBA)	Endangered	45.5 ha
Ornamental snake	Vulnerable	Vulnerable	246.5 ha
Square-tailed kite	Not listed	Near threatened	2,413 ha

[1] Total clearing extent is based on the broad vegetation community/ fauna habitat types as they apply to each species. However, the exceptions are black throated finch (which had its mapped potential habitat refined through mapping only those REs that known records of species have been obtained) and the squatter pigeon (which had its habitat mapped based on REs characterised by open woodland and forest vegetation).

Dust, noise and light impacts on terrestrial fauna

Other than the direct loss of habitat due to vegetation clearing, construction activities have the potential to indirectly degrade the quality of adjacent habitats and habitat edges, through exposure to increased noise, vibration, light, dust, sedimentation and erosion. Exposure to these impacts may alter habitat composition (i.e. reduced flora diversity and simplified ecosystem structure) and quality (i.e. reduced availability of forage resources, increased exposure to predators), 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.

Indirect construction impacts on habitat quality will vary in their spatial extent. Dust and sedimentation impacts caused by road activity are typically restricted to within 40 m of a road edge, while noise impacts can penetrate further than 200 m from the road (Goosem 2007). Edge effects associated with runoff and sedimentation may extend further in circumstances where local topography increases the potential for run-off (e.g. where remnant vegetation occurs downslope or downstream of the construction footprint).

The operation of plant and equipment during construction may disrupt local fauna behaviour, largely as a result of increased exposure to light, noise, dust, vehicles and people. Behavioural disruption may have direct consequences (i.e. increased susceptibility to predation due to increased noise reducing prey vigilance, or increased light increasing prey detectability) or indirect consequences (i.e. habitat degradation reducing local resource availability therefore increasing foraging dispersal distances for fauna). In addition, there is potential for localised disturbance to wildlife behaviours and dynamics such as foraging, breeding and nesting. However, impacts related to construction will be transient and temporary in nature, therefore edge effects are expected to be minimal and of relatively short duration.

Mitigation and management measures that would be implemented to minimise and avoid potential dust, light, noise and sedimentation impacts during construction of the NGBR Project are discussed in Volume 1 Chapter 10 Air quality, Chapter 4 Scenic amenity and lighting, Chapter 12 Noise and vibration and Chapter 5 Topography, geology, soils and land contamination respectively.

Terrestrial habitat fragmentation

Vegetation clearing during construction has the potential to result in localised fragmentation of habitats adjacent to the NGBR Project. Fragmentation can increase the isolation of wildlife populations, by reducing their capacity to move between habitat remnants. Wildlife subject to high levels of habitat fragmentation typically become more reliant on local resources and more vulnerable to impact from local catastrophes such as fires and localised flooding (Gilpin and Soule 1986). Habitat fragmentation tends to have a delayed and cumulative impact, resulting in a gradual decline in species diversity. Species particularly susceptible to fragmentation impacts are generally smaller, ground-dwelling animals that have a limited capacity for dispersal. The nature and severity of habitat fragmentation impacts also tends to vary depending on the level of existing fragmentation within the landscape. When landscapes are relatively intact, species declines are moderate, and directly attributed to habitat loss (Andren 1994). At high levels of

fragmentation, losses are more severe and attributed to the reduced size and increased isolation of habitat remnants (Andren 1994; Marsh and Trenham 2001).

The NGBR Project impacts an environment that is already highly fragmented by decades of broadscale vegetation clearing. Within that context, habitat fragmentation resulting from the NGBR Project is unlikely to have a regional impact on fauna diversity. However, it is likely to cause localised impacts, by intersecting corridors that are important for local wildlife movement (e.g. along watercourses) and isolating and reducing the size of individual habitat patches.

Key patches of intact remnant vegetation along the preliminary investigation corridor are associated with the Clarke and Leichhardt Ranges, which occur within identified wildlife corridors. Remnant vegetation within these areas is dominated by sclerophyll woodland and open forest.

Terrestrial fauna mortality and injury

The clearing of native vegetation during construction has the potential to directly impact fauna if they are accidentally struck by vehicles, machinery or falling vegetation. Fauna particularly at risk include those that shelter in hollow-bearing trees, beneath logs, rocks and bark (i.e. arboreal mammals, nocturnal birds, reptiles and frogs), ground animals that typically hide rather than flee in response to approaching danger (i.e. bandicoots, quails and pigeons) and nocturnal species that are inactive during daylight hours and therefore less inclined to disperse away from diurnal clearing activities. This includes conservation significant species, such as the ornamental snake and brigalow scaly-foot.

Other activities associated with construction, such as vehicle movements and operation of machinery, have the potential to cause additional sources of wildlife mortality wherever an interaction between vehicle/machinery and fauna occurs. Livestock and wildlife that are highly mobile are also at increased risk of being trapped or injured in open pits or trenches within construction areas. The potential incidence of direct mortality would be minimised during construction through the implementation of the mitigation measures outlined in Section 6.4.3.

Aquatic habitat

As discussed in Section 6.3.3, the preliminary investigation corridor crosses a variety of aquatic habitats including 16 major and moderated waterways and approximately 120 minor waterways. Riparian vegetation and in-stream habitats are important as they provide protection from predators as well as foraging and nesting resources for aquatic fauna including fish, turtles and macroinvertebrates. Construction of the NGBR Project will require works within and around waterways and ephemeral streams resulting in the potential loss or damage to riparian or aquatic habitat. In particular, the construction of bridge structures, pipe culverts and box culverts will require clearing riparian vegetation and potential disturbance of in-stream habitat. The methodology for construction of these watercourse structures is provided in Volume 1 Chapter 2 Project Description. Typical concept design drawings for watercourse crossing structures are provided in Volume 2 Appendix T Typical watercourse crossing structures and the indicative location of these structures is provided in Figure 2-2 of Volume 1 Chapter 2 Project description, In areas of perennial water, temporary work platforms consisting of loose rock over geofabric will be established to provide access to any intermediate piers. It is expected that no more than one intermediate pier per bridge structure would fall within an area of perennial water. Temporary low flow pipes would be used where required to maintain drainage flow paths and

fish movements. Coffer dams may also be required around any intermediate piers to support substructure works. Following construction, any temporary work platforms within the waterway will be removed and the waterway reinstated and rehabilitated by the construction contractor in accordance with conditions of the works approval permits. Further detail regarding site specific information for waterway barriers including compliance with self-assessable codes and the duration of the disturbance will be developed during detailed design. In total, 42.77 ha of riparian vegetation and 10.6 ha of wetland vegetation will require clearing. The construction of the NGBR Project is also likely to fill in a number gilgai depressions along the final rail corridor. Gilgai depressions hold water for extended periods of time in comparison to the surrounding land and provide temporary habitat to terrestrial and aquatic species.

The majority of aquatic habitats within the preliminary investigation corridor are already exposed to a number of existing disturbances, including:

- Erosion and scouring of stream banks due to vegetation clearing
- Cattle and pig disturbance within riparian habitat
- Farm activities such as tracks within the riparian habitat.

Despite the disturbed nature of many of the waterways, they support a range of aquatic communities. As such, clearing of riparian vegetation would be restricted to the minimal amount necessary for construction and, wherever possible, existing cleared areas will be utilised. Any works within watercourses would be undertaken in accordance with the DEHP Guidelines for carrying out activities in a watercourse, *lake or spring* and, if a riverine protection permit is required for any of the works, the conditions of that permit. A Flora and Fauna Management Plan will also be implemented that will include particular requirements for works within 20 metres of a watercourse (material stockpiles will be excluded within 50 m of a watercourse) and the requirement for a fauna spotter to be present during vegetation clearing to check/clear feeding areas, roosting or nesting sites, Other standard mitigation and management measures that would be implemented to minimise potential impacts on aquatic habitats are outlined in Section 6.4.3.

The final rail corridor intersects the DIWA listed Abbot Point - Caley Valley Wetland immediately north of Saltwater Creek. The preliminary investigation corridor, however, is located within 100 m of the eastern part of the DIWA listed Abbot Point - Caley Valley Wetland, within 4.5 km of the Southern Upstart Bay wetland and within 2.6 km of the Bowen River: Birralee - Pelican Creek wetland. All other DIWA listed wetlands are greater than 20 km from the preliminary investigation corridor.

The clearing of riparian vegetation has the potential to indirectly impact adjacent aquatic habitats through increased erosion and therefore sediment transport downstream during rainfall events. The potential impacts of erosion and sedimentation on water quality and proposed mitigation and management practices is discussed in detail within Volume 1 Section 9 Water resources. The removal of riparian vegetation may also expose aquatic habitats to a potential increase in weed invasion.

The existing turbidity and total suspended solids in the Suttor and Bowen River catchments are up to four times the value of the relevant water quality objective for the protection of aquatic ecosystems at a number of sites along the preliminary investigation corridor (refer Volume 1 Chapter 9 Water Resources). The loss of riparian vegetation, land-use practices and presence

of cattle and pig disturbance may contribute to the high turbidity at these sites. Although aquatic ecosystems in ephemeral systems are likely to be adapted to peaks in high turbidity during some periods, an increase in the magnitude or the frequency of these peaks in turbidity due to construction activities has the potential to have a detrimental effect on aquatic habitats.

In aquatic ecosystems, increased suspended sediment loads can reduce light penetration, clog fish and invertebrate gills, decrease water temperature, lead to a reduction in dissolved oxygen concentrations and introduce sediment-bound contaminants into the water (Dunlop *et al.* 2005). Increased turbidity can also reduce photosynthesis in submerged macrophytes and benthic and planktonic algae. Increased sediment loads can also reduce the capture rates of visual predators (e.g. raptors and fish) that rely on their prey being visible. When sediment settles out, it may bury habitat and smother sedentary organisms.

Disturbance of previously contaminated sites and accidental spills or leaks associated with construction activities have the potential to occur within the vicinity of watercourses resulting in contaminants being transported to the aquatic environment via rainfall runoff. These contaminants can result in both short and long-term degradation of water quality and can be toxic to aquatic organisms. Any introduction of contaminants has the potential to influence both the local surface water quality and aquatic habitats at the point source as well as downstream.

Salinity has been identified as one of the main water quality issues within the Burdekin Basin and conditions are expected to worsen in the future as a result of vegetation clearing and its effects on the hydrological balance of the region. The use of groundwater for dust suppression during construction may cause an increase in soil salinity and water conductivity. Ion rich water entering a waterway may result in a loss of sensitive species, mass mortality events and a change in community structure.

During design of the NGBR Project, the width and length of waterway crossings has been reduced to the absolute minimum required to minimise disturbance to aquatic habitats. Where water crossings are absolutely necessary, potential impacts on aquatic habitats would be minimised or mitigated through the implementation of the mitigation and management measures outlined in Section 6.4.3. To limit the degradation of downstream aquatic habitat during construction, mitigation and management will focus on reducing the potential mobilisation of sediments or pollutants, and limiting sediment transport from exposed areas, through the implementation of a construction erosion and sediment control management plan, as outlined in Volume 1 Chapter 5 Topography, geology, soils and land contamination.

Aquatic habitat fragmentation

The existing hydrology of aquatic habitats within the study area has been previously altered as a result of existing road crossings, dam and weirs, and human-made bund walls within the Caley Valley Wetland near Abbot Point. Suitable aquatic passageways for aquatic fauna is important to prevent declines in species abundance, species distribution truncation, localised extinction and a reduction in species diversity (Marsden and Power 2007).

The construction of waterway crossings has the potential to disturb and impair the movement of aquatic fauna within a waterway by creating temporary barriers to migration up and downstream. Temporary barriers to fish movement may be required during construction of bridge and culvert structures, to create suitably stable and dry working conditions. Construction activities for bridge and culvert structures will be scheduled during the dry season where

possible to minimise impacts to fish movement. The design of temporary in-stream barriers would allow fish passage, particularly where the barrier will be in place for months rather than days or weeks, or will be in place through the wet season. At the completion of construction works within the waterway, the in-stream barrier would be removed and the waterway bed and banks returned to their original profile and stability so that long-term fish passage at the site is not compromised once the temporary barrier is removed. Therefore, the temporary barriers required during construction are not anticipated to have long term effects on aquatic fauna abundance or distribution and no aquatic species or habitats of conservation significance would be affected by the temporary barriers.

An application under the *Fisheries Act 1994* will be obtained where culvert or bridge installation requires works within a defined waterway.

Aquatic fauna and communities

Construction activities including vegetation clearing or chemical spills have the potential to impact on the water quality of local waterways and aquatic fauna. Increased suspended sediment loads can clog fish and invertebrate gills, smother bottom dwelling invertebrates (Dunlop *et al.* 2005) while chemical spills may result in direct fauna mortality.

During construction, water will be required for a number of activities including concrete batch plants, earthworks compaction and dust suppression and consumption at construction camps (refer Volume 1 Chapter 2 Project description). As identified in the NGBR Project Construction Water Supply Strategy (refer to Volume 2 Appendix H3 Construction Water Supply Strategy) the potential water sources comprise a combination of groundwater bores, surface water storage, local Council supplies, river extraction existing ponds and existing in stream and off stream storages.

The extraction of water from rivers and surface water storage can reduce the base flow of the watercourses and potentially impact aquatic communities including sensitive downstream aquatic habitats (Abbot Point – Caley Valley Wetland, Southern Upstart Bay wetland and Bowen River: Birralee – Pelican Creek wetland). However, the NGBR Construction Water Supply Strategy concluded that impacts to surface water environmental values based on water supply options for the construction phase are likely to be negligible, given they are temporary, and will be minor in comparison to effects of the overall construction and operation of the rail line. Therefore, impacts on aquatic communities are likely to be minimal depending on the timing and amount of water extracted from aquatic ecosystems.

The total construction water requirement for the NGBR Project is anticipated to be approximately 22,000 kilolitres of water per day during peak periods. This water requirement is to be distributed across the 300 km final rail corridor. This volume of water is considered to be minimal in the context of the regional catchments and localised impacts may include very slight, undetectable decreases in flow. Aquatic communities that inhabit these ephemeral aquatic ecosystems are tolerant of highly variable flow conditions. As such, small decreases in flow are unlikely to impact aquatic communities within the preliminary investigation corridor.

Direct injury or mortality to aquatic fauna due to machinery strike, particularly during vegetation clearing in riparian areas or construction of watercourse crossings, will be avoided and minimised through the implementation of a Flora and Fauna Management Plan. The Flora and Fauna Management Plan will include requirements such as a fauna spotter/catcher to be

present during vegetation clearing to check and move any turtles from the area (refer Section 6.4.3). Prior to construction commencing, consultation with the Department of National Parks, Recreation, Sport and Racing will also be undertaken to obtain historical data on previously conducted turtle nesting surveys in the region.

Groundwater dependent ecosystems

Extraction of water from groundwater bores during construction has the potential to cause minor localised drawdown of groundwater with potential impacts on groundwater dependent ecosystems along the preliminary investigation corridor. Surface features, which are considered to be subject to a “high potential for groundwater interaction”, include:

- Bogie River
- Sandy Creek
- Pelican Creek
- Bowen River
- Verbena Creek
- Suttor River.

These watercourses maintain a series of semi-permanent to permanent waterholes during dry periods and are likely to be groundwater dependent to a degree. A spring is also located on Mount Lookout (aquatic survey site 16 (AQ16)) within the Suttor River catchment. The impacts of reduced base flow as a result of drawdown of the groundwater table on groundwater dependent ecosystems may include:

- Alteration of environmental flow and in-stream conditions for aquatic communities
- Changes in vegetation composition, creating conditions favourable to the introduction of grasses, forbs and weed species
- A general reduction or loss of refugia, breeding, roosting and foraging habitat for fauna.

Construction of the NGBR Project will require an average of approximately 22,000 kL/day. This water requirement is to be distributed across the 300 km final rail corridor. However, water for construction would be sourced from a number of sources including town water supplies and therefore the amount of construction water sourced from groundwater supplies would be much less. Given the volume of groundwater anticipated to be used during construction, it is unlikely groundwater levels or flows would be noticeably affected. Therefore, groundwater extraction is unlikely to impact groundwater / surface water interaction and groundwater dependent ecosystems.

Introduction or spread of weeds

Increased access to areas during construction activities and associated construction practices, such as vegetation clearing and soil disturbance, can facilitate the introduction and spread of weed species. Weed species may have adverse impacts on the flora and fauna diversity of a region and disrupt ecosystems by outcompeting and replacing native species, thereby altering species diversity and potentially disrupting ecosystem function. A total of 35 introduced flora taxa were recorded within the preliminary investigation corridor, five of which are listed as Weeds of National Significance and nine of which are declared weeds under the LP Act. .

New weed species can also be introduced through activities associated with construction, such as the use of contaminated materials (i.e. for fill required for construction) or machinery.

While nine declared weeds under the LP Act were recorded during field surveys, they were not found to be prevalent across much of the preliminary investigation corridor. Watercourses and associated riparian vegetation in particular are sensitive receptors for weeds and small infestations can be spread over long distances if seeds enter waterways. An increase in the prevalence of weeds within the construction footprint and potentially beyond to the surrounding landscape may in turn reduce the quality of habitats for some fauna species.

Aquatic weeds may be transported during construction of water crossings. Machinery and vehicles working within waterways have the potential to disperse aquatic weeds between waterways and catchments if not managed in the appropriate manner. Twenty-four introduced aquatic dependent flora species were identified as occurring in riverine and/or non-riverine wetlands within the Burdekin and Don River Basins (Inglis and Howell 2009a; Inglis and Howell 2009a). These species and aquatic weeds from other catchments could be transported to waterways where weeds are not currently present. Subsequent weed infestations can affect waterways by disrupting natural flood regimes, changing aquatic habitats, reducing visual amenity and degrading water quality (DERM, 2011).

In order to reduce the dispersal and potential introduction of new weed species, active weed management will be implemented during construction of the NGBR Project (refer Section 6.4.3).

Pest fauna

Food waste produced in construction camps may provide additional resources for feral animals such as pigs, rats, mice, cats and dogs. These animals, confirmed present within the study area, may increase in abundance if food and water become more accessible (refer to Volume 1 Chapter 13 Waste). An increase in pest fauna species may lead to increased competition for resources, increased predation and increased habitat degradation (e.g. erosion caused by rabbits and damage to riparian areas by pigs). There is also potential for pest animals such as ants to be introduced to sites through importation of vehicles, equipment, soils and similar media.

Vegetation clearing through areas of continuous habitats (i.e. at watercourses) and along linear corridors can create the potential for fauna pests and feral predators to penetrate further into bushland areas.

Pigs can have detrimental effects on watercourses by rooting ploughs up to 20 m around a water body (DEEDI 2010). As an omnivorous animal, pigs will also enter waterways and consume aquatic fauna (e.g. turtle eggs, freshwater mussels and crayfish) and aquatic flora within and adjacent to waterways. As a result of wallowing and foraging in waterways, pigs can disturb the benthic zone (and benthos), suspend sediments and introduce nutrients to the water through urination and defecation. This disturbance can lead to degradation of downstream water quality and habitat for aquatic species by creating erosion (DEEDI 2010). Increased access and movement through riparian and in-stream habitat can increase the opportunity for dispersal of aquatic and terrestrial weed species.

No aquatic pest species were recorded within the preliminary investigation corridor; however tilapia (*Oreochromis mossambicus*), three spot gourami (*Trichogaster trichopterus*) and

mosquitofish (*Gambusia holbrooki*) have been recorded within the Burdekin River Basin (Allen *et al.* 2002; Pusey *et al.* 2004).

Construction activities have the potential to:

- Disturb local aquatic habitats and make them susceptible to aquatic pest invasion
- Introduce (via translocation in water trucks) aquatic pest species from other waterways

The introduction of these species can adversely impact native fish communities through direct competition for resources (food and habitat), predation, habitat alteration and the introduction of diseases or parasites (DEEDI 2011).

Active management will be undertaken during construction to manage pest fauna species as outlined in Section 6.4.3.

6.4.2 Operation

Terrestrial habitat connectivity and fauna movement

Operation of the NGBR Project has the potential to create long-term habitat fragmentation. The persistence of a cleared easement to accommodate rail infrastructure will deter some fauna movement and act as an ongoing barrier to movement, except where culverts, bridges and other underpass structures provide an appropriate means of movement across the final rail corridor. In addition, regular movements of trains and maintenance vehicles create a mortality risk that may act as a sink for local wildlife populations.

The impacts of fragmentation attributed to operation of the NGBR Project are considered to be relatively minor, within a regional context. The final rail corridor is located in a landscape that has been extensively fragmented by historical broadscale vegetation clearing. The fragmentation impacts resulting from the NGBR Project are therefore unlikely to have regional consequences. Nevertheless, fragmentation of habitat may have localised impacts, particularly where wildlife corridors, watercourses and other linear habitat links are affected. Small, ground-dwelling fauna such as amphibians, reptiles and arboreal mammals would be particularly susceptible to adverse impacts from the fragmentation of small localised habitat linkages.

Aquatic habitat connectivity and fauna movement

A large number of aquatic fauna expected to occur within the Burdekin and Don River Basins (including freshwater fish and turtles) require migration within watercourses for breeding and non-breeding purposes. Wholly aquatic species are especially vulnerable to the impacts of artificial barriers as the physical (hydrological) connectivity is reduced (Hughes 2007). Barriers to aquatic movement have the potential to:

- Reduce connectivity, where aquatic fauna are physically unable to undertake migratory or dispersal events that are essential components of their lifecycle
- Exclude aquatic fauna from critical habitats, that is, habitats that are essential for the continuation of the population/species
- Reduce population connectivity, which can reduce genetic diversity.

Bridge crossings, pipe culvert crossings and box culvert crossings are required for the NGBR Project (refer Volume 1 Chapter 2 Project description). The final design and size of these waterway structures would take into the consideration the ability of fish, turtles and other aquatic fauna to move within the watercourse in accordance with the DAFF Fish Habitat Management Codes and Policies, which require the maintenance of aquatic fauna connectivity.

Bridges that are built too low, or whose piers and footings constrict a watercourse channel, can affect hydrological flows and aquatic habitat conditions (Fairfull and Witheridge 2003). In general, the bridge structures required for the NGBR Project promote natural, unimpeded stream flow allowing the free movement of fish underneath the structure during a wide range of hydrological conditions.

The final design of the pipe culverts and box culverts proposed as part of the NGBR Project would be designed to allow for fish, turtles and other aquatic fauna to move within the watercourse. Poorly designed culverts can affect hydrological flows and aquatic habitat conditions (Fairfull and Witheridge 2003) including:

- Scouring, erosion and sedimentation both upstream and downstream of the structure as a result of increased velocities
- Localised internal ponding due to the insufficient hydraulic capacity of the culverts. Ponding of flowing water bodies creates favourable conditions for algal growth and settling of sediments.
- Inadequate lighting within a culvert may impact the behaviour of aquatic fauna
- Debris has the potential to block a culvert reducing aquatic fauna passage
- Excessive culvert length and a lack of aquatic habitat and rest areas within the culvert
- Excessive variation in water level across the culvert outlet.

The design of culvert structures would be consistent with the Culvert Fishway Planning and Design Guidelines (Kapitzke 2010), Waterway barrier works development approvals (Peterken *et al.* 2009), Fisheries Guidelines for Fish-Friendly Structures (Derbyshire 2006), Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003) and Fisheries guidelines for design of stream crossings (Cotterell 1998).

Due to the large number of waterways crossed by the NGBR Project, it has the potential to alter the characteristics of the floodplains that it intersects (refer Volume 1 Chapter 9 Water resources). Permanent alteration of floodplain hydrology as a result of the NGBR Project infrastructure has the potential to decrease the periodicity of inundation and connectivity of floodplain habitats (i.e. palustrine habitats). The ability of biota to move from one distinct ecosystem to another, such as a floodplain to a river, is referred to as lateral connectivity (DEHP 2012). Aquatic fauna can be highly reliant on the seasonal connectivity from riverine habitats to floodplains for the purposes of feeding and breeding, but also in seeking refuge during flooding events (King *et al.* 2003). In Australia, many fish and some freshwater turtles species will move out onto the inundated, highly productive floodplains, even if the periods of inundation are short, unpredictable and infrequent (King *et al.* 2003; Arthington *et al.* 2005). Aquatic communities inhabiting off-stream water bodies may depend on seasonal connectivity to the floodplain for both the augmentation of surface waters, and for gene flow through new recruits to maintain the existing genetic diversity. When a community becomes isolated, surface water quality is likely to

decrease and losses in genetic diversity may occur. Subsequently aquatic communities may not be able to adapt to environmental or biological challenges (Allendorf 1983).

The NGBR Project includes bridge structures at major waterway crossings to ensure required flood flows are achieved. A hydrology and hydraulics assessment of the proposed structures concluded that afflux levels adjacent to the final rail corridor generally meet the maximum design criteria of 0.5 m (refer Volume 1 Chapter 9 Water Resources and Volume 2 Appendix H2 Hydrology and hydraulics).

Weeds and pest fauna

Movement of people, vehicles and machinery during operation of the NGBR Project may facilitate the spread or increase the prevalence of weeds. Furthermore, there is potential for pest species to use the final rail corridor as a linear pathway for movement, leading to the introduction of pest species in previously pest-free habitats. An increase in the prevalence of these animals may adversely impact native fauna through:

- Increased competition for resources
- Increased predation (of native species by introduced animals)
- Habitat degradation (i.e. pig damage of riparian areas).

Impacts of weeds and pests are expected to be manageable, provided that the mitigation and management measures outlined in the weed and pest management plan are implemented (refer Table 6-11).

Dust, noise and light impacts on terrestrial fauna

The increased activity associated with daily movement of trains and regular visits to the rail corridor by maintenance vehicles and service personnel will cause localised, temporary and transient increases in light, noise, vibration and dust. Without mitigation measures, these factors have the potential to adversely affect local fauna by disrupting their normal behavioural activities and potentially compromising their foraging, breeding, sleeping and nesting efficiency.

Noise can have a range of adverse impacts on native fauna. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey and causing stress or avoidance reactions that may increase the risk of injury or predation, or reduce the efficiency of normal behaviours (i.e. feeding, breeding, nesting, sleeping) (Fletcher and Busnel 1978). Noise exposure, particularly if it endures, can have physiological and behavioural impacts on fauna. The nature and intensity of these impacts can vary between species and between individuals of a given species depending on the individuals' age, sex and prior exposure to noise (Fletcher and Busnel 1978). Disruption of wildlife behaviour is most ecologically damaging when it affects critical behaviours (i.e. nesting or breeding) in areas of high ecological importance (e.g. breeding colonies).

Noise impacts on wildlife will also vary depending on the nature and frequency of the noise. Studies have shown that some animals can habituate to loud noises that do not have a direct adverse outcome for the individual (Larkin *et al.* 1996). Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs

may also help mitigate its effects on birds. Algers *et al.* (1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70 dB(A)). Trains will pass all sections of the NGBR Project final rail corridor several times each day. As such, the potential for wildlife to habituate to noise is relatively high.

It is recognised that sudden noise has the potential to startle or upset domestic livestock and pets. Heggies Pty Ltd conducted a literature review as part of their assessment of blasting noise impacts on livestock for the proposed Caval Ridge Coal Mine Project (Heggies 2009). Heggies cites results from a study on the response of farm animals to sonic booms, which indicated that reactions of sheep, horses and cattle to sonic booms (125 dB to 136 dB) were considered slight to mild.

Caley Valley Wetland near Abbot Point represents an important breeding and nesting habitat for many species of wetland birds. This area is likely to be more susceptible to adverse impact from wildlife disturbance than other areas within the NGBR Project footprint. However, ongoing successful breeding and nesting of thousands of waterbirds, despite exposure to chronic, low-level industrial noise associated with the operation of existing coal handling facilities, including associated rail infrastructure, at the nearby Abbot Point coal terminal suggests a level of habituation to noise (refer to Volume 1 Chapter 12 Noise and vibration and Volume 2 Appendix J Noise and vibration).

Artificial light sources can have adverse impacts on native fauna by disrupting their capacity to forage, breed, nest and sleep, interrupting circadian rhythms and altering normal predator-prey relationships (Rich and Longcore 2006). Light sources can create an artificial foraging source for birds, amphibians and insectivorous bats, by attracting large concentrations of insects (Rich and Longcore 2006). Species that benefit from these types of artificial feeding sources are typically opportunistic, generalist species which are generally widespread and abundant (Lockwood and McKinney 1999). The final rail corridor will not be lit, with the exception of the maintenance facility. Impacts of light pollution on wildlife behaviour are therefore expected to be relatively localised and minor (refer to Volume 1 Chapter 04 Scenic amenity and lighting and Volume 2 Appendix D Scenic amenity and lighting).

Dust impacts, while wind dependent, are also typically localised in their extent, generally affecting areas within 10 m of unsealed access roads (Goosem 2007). Dust coated on leaves can reduce the photosynthetic capacity of the plants and impede plant growth. Such an impact could degrade the function and health of the vegetation community; cause plant dieback with prolonged exposure; and reduce food resource availability for fauna species utilising the affected vegetation community. As such, impacts on flora from dust has the potential to occur where vegetation is growing immediately adjacent to the final rail corridor. Long term exposure to dust may result in changes to vegetation communities immediately adjacent to the rail line, which may in turn alter habitat type and quality for fauna. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas as a result of reduced water quality.

An environmental evaluation, commissioned by Queensland Rail, reviewed the available literature for the impacts of coal dust on flora and fauna, crops and livestock. Connell Hatch (2008) concluded that a dust deposition rate of 500 mg/m^2/day can be used as a suitable threshold for negative impacts on crops, livestock and vegetation. With respect to deposition distance adjacent to the final rail corridor centreline, records indicate that the highest coal

deposition rates, of about 90 mg/m²/day, are likely to occur within the final rail corridor with rates dropping rapidly as distance from the tracks increases (i.e. 30 mg/m²/day at 10 metres from the tracks) (Connell Hatch 2008). These measured values are substantially lower than the values noted in literature as being likely to have an impact on crops and livestock. No recent literature has been found that measures such impacts on native vegetation and fauna; however, it is likely that the same conclusions would be achieved (refer to Volume 1 Chapter 10 Air quality and Volume 2 Appendix I Air quality).

Given the research outlined above, and with the implementation of the management and mitigation measures outlined in Section 6.4.3, it is unlikely that dust deposition, including coal dust, will have a noticeable impact on the flora and fauna adjacent to the NGBR Project.

Impacts of light, noise and vibration are expected to have low level and localised adverse effects on wildlife. Provided the mitigation measures outlined in Section 6.4.3 are implemented, the impacts are anticipated to be minimal.

Operational impacts on aquatic fauna

Operational activities including coal dust emissions, ongoing maintenance and chemical spills have the potential to impact on the water quality of local waterways. Physical changes in water quality have the potential to reduce the suitability of the aquatic environment for some aquatic flora and fauna species. Changes to the water quality of waterways may result in a loss of sensitive species, mass mortality events and a change in community structure.

Coal dust emissions from coal trains that are transported into waterways may impact aquatic communities. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas as a result of reduced water quality. Contamination of aquatic habitats may also occur if heavy metals are associated with deposited coal dust particles (Swer and Singh 2003). Subsequent impacts to aquatic habitats can be significant and include an overall reduction in aquatic habitat value and potential mortality of fauna species and dieback of riparian vegetation.

The NGBR Project air quality assessment identified that the maximum incremental dust deposition level will be below the deposition guideline equivalent of 2 g/m^2/month at all points in the modelling domain. Therefore, there is very low potential for significant impacts on aquatic ecosystems to occur and impacts will be limited to within the final rail corridor or immediately adjacent areas (within 200 m). Further discussion on the potential coal dust generated during operation of the NGBR Project is provided in Volume 1 Chapter 10 Air quality.

Runoff from the final rail corridor may contain dust, fuel, dissolved metals and other contaminants that can alter water quality and reduce aquatic habitat values. The waterways crossed are all moderately disturbed as a result of existing land use practices with elevated turbidity and conductivity levels. Caley Valley Wetland, which contains palustrine habitats, is likely to be more susceptible to impacts of sedimentation and runoff due to no/low flow conditions (refer to Volume 1 Chapter 19 Cumulative impacts). The implementation of suitable management and mitigation measures will reduce the likelihood of impact in this area.

An increase in vehicle traffic for the purpose of operational maintenance may also result in a minor increase in dust generation from the movement of maintenance vehicles along dirt access tracks, particularly during dry and windy conditions. Dust can settle within the waterways or in

the terrestrial environments, where runoff can mobilise settled dust to waterways and has the potential to decrease aquatic habitat value within the immediate and downstream areas primarily as a result of reduced water quality. Due to the low frequency in which access tracks will be utilised, it is considered unlikely that dust deposition impacts will occur.

Works involving operational maintenance within and adjacent to the waterways have the potential to introduce contaminants to the aquatic environment in the event there are accidental spills or leaks from equipment. If introduced, these compounds can result in both short- and long-term degradation of water quality. Any introduction of contaminants has the potential to influence both the local surface water quality at the point source as well as downstream (refer to Volume 1 Chapter 18 Hazard risk, health and safety).

Mitigation and management measures to minimise the potential impacts of the NGBR Project on water quality are provided in Volume 1 Chapter 9 Water resources. Dust mitigation and management measures are provided in Volume 1 Chapter 10 Air quality.

Fauna mortality

Throughout the operation phase of the NGBR Project, movement of trains and maintenance vehicles present a risk of fauna mortality through direct collision with wildlife. The risk to fauna posed by vehicular traffic is significantly less than the risk posed throughout the construction phase of the NGBR Project. The volume of vehicular traffic will be lower than that during the construction phase and vehicles will adhere to strict speed limits.

Impacts with trains are likely to be relatively uncommon. The final rail corridor will be fenced along its length to exclude wildlife and livestock, and fauna-friendly infrastructure will be incorporated where required within the design of bridges and culverts to allow fauna passage at designated crossing locations.

Altered fire regime on flora and fauna

Increased human activity may alter the fire regime of the local landscape. For example, the final rail corridor may act as a fire break and consequently reduce the natural fire frequency and in turn increase the fuel load which would increase the fire risk for the region. The potential for accidentally lit fires is potentially increased through the operation phase as a result of sparking during rail operation. The incidence of regulated management burns may also change in frequency. Accidental or uncontrolled fires have the potential to negatively impact upon vegetation (and habitat) within, and adjacent to, the final rail corridor in particular.

6.4.3 Summary of mitigation and management measures

The mitigation and management measures in Table 6-11 will be implemented to minimise and avoid the potential impacts of the NGBR Project on terrestrial and aquatic ecology. These mitigation and management measures will be implemented in combination with measures outlined in other chapters, including:

- Volume 1 Chapter 4 Scenic amenity and lighting
- Volume 1 Chapter 5 Topography, geology, soils and land contamination
- Volume 1 Chapter 9 Water resources
- Volume 1 Chapter 10 Air quality
- Volume 1 Chapter 18 Hazard, risk, health and safety

Table 6-11 Mitigation and management measures

Timing	Mitigation measure
Pre-construction	The layout of temporary and permanent structures and infrastructure (including construction areas, site offices, stockpile, laydown areas, access tracks and construction camps) will be designed to minimise clearing of remnant vegetation (in particular endangered, of concern and threshold REs).
Pre-construction	Fauna-friendly design principles will be incorporated the design of culverts, bridges and other watercourse structures, particularly in important habitat areas of mapped remnant vegetation and habitat potentially suitable for threatened species. This will enable the safer passage of fauna across the final rail corridor. Fauna-friendly design principles may include: • Culverts with ledges that facilitate fauna movement • Using grids that allow natural lighting • Protecting and enhancing entries and exits.
Pre-construction	Watercourse structures will be designed in accordance with relevant guidelines.
Pre-construction	The following design considerations will be applied to the detailed design of bridge structures: • Meet the fish passage requirements in accordance with the *Fisheries Act 1994* and other relevant guidelines • Avoid locating bridge piers or foundations within the main waterway channels • Design and orient bridge piers and pile caps, including those located within overbank areas, to avoid the formation of large-scale turbulence or the erosion of the bed and banks of the waterway • Minimise turbulence from bridge piers, foundations and base slabs that may lead to stream erosion or to disorientation of fish • When sizing the waterway area of the bridge, give appropriate consideration to fish passage requirements along the floodplains, including locating bridge abutments well away from the channel banks and the possible installation of floodplain culverts adjacent to the main crossing. • Maximise light penetration under the bridge or arch to encourage fish passage.
Pre-construction	The following design considerations are to be considered during the detailed culvert design (based on Fairfull and Witheridge 2003): • Meet the fish passage requirements in accordance with the *Fisheries Act 1994* and other relevant guidelines

Timing	Mitigation measure
	• Give appropriate consideration to fish passage requirements when selecting the type of culvert to be installed (box or pipe) • Align the culvert with the downstream channel to minimise bank erosion • Minimise changes to the channel's natural flow, width, roughness and base-flow water depth through the culvert's wet cells which are located within the stream bed. Wet cells should have a minimum water depth of 0.2-0.5 metres to encourage fish passage • Maximise light penetration within the wet cells by maximising the height or diameter of the cells • Debris deflector walls can be used to reduce the impact of debris blockages on fish passage while also reducing maintenance costs • In sand and gravel-based watercourses, natural bed material should either be placed along the bed of the wet cells, or allowed to deposit in these cells. The hydraulic design of these culverts should allow for this added bed roughness which facilitates upstream fish movement • In clay-based watercourses that do not experience significant movement of bed load sediment, artificial roughness units such as rounded stone, can be grouted across the bed of the wet cells to provide the desirable bed roughness and fish resting areas • The combined width of culvert array is as close to the waterway width as possible, with the minimum individual culvert length of six metres • The base of the culvert is no higher than the stream bed. Ideally the culvert base will be the stream bed (for open base culverts) or buried to sufficient depth to allow bed material to deposit and reform the natural bed on top of the culvert base.
Pre-construction	The culverts and bridges are to be designed so that minimal backwater effects or major increase in afflux are introduced. To avoid adverse impacts, it is expected that the planning and design of diversions (if required) would follow recommendations such as those in DERM (2011), including: • No change in freshwater inflow volume. • Consideration of topography, geology and potential for contamination when determining preferred diversion location. • Design diversion hydraulic and environmental parameters to match the existing natural watercourse, as determined by hydraulic modelling. • Consideration of the capacity of the channel and the capacity for the floodplain of the new diversion to cope with out-of-channel flows under flooding conditions.

Timing	Mitigation measure
	• Consideration of peak recommended design velocity, stream power and shear stress. • Consideration of the ecological function of the diversion. • Scour and erosion can be managed through design treatments such as bank stabilisation. Incorporating the above guidelines in conjunction with construction controls will limit the potential cumulative effects that scour, erosion and deposition will have on the water quality of surrounding waterways.
Pre-construction	The final rail corridor will be fenced giving consideration to the movement of fauna. Fencing design should consider: • Movement of fauna through it (excluding those instances where fenced areas seek to protect fauna from threats such as trenches and human contact) • Not using barbed wire on the top strand of fences.
Pre-construction	Habitat assessment and condition surveys will be undertaken in areas identified as potential habitat in the Draft EIS. These investigations will inform the Flora and Fauna Management Plan, Property Vegetation Management Plan and refine the Offsets Strategy.
Pre-construction	A Construction Flora and Fauna Management Plan will be developed prior to construction commencing. The Construction Flora and Fauna Management Plan will include details relevant to the general management of flora and fauna impacts as well as Species Management Plans for identified threatened species that will be impacted. Where necessary, the Construction Flora and Fauna Management Plan will incorporate flora and fauna monitoring activities. Specifically, ongoing monitoring and survey requirements necessary to assess the persistence and health of conservation significant populations will be outlined (i.e. EVNT flora and fauna species impacted by the NGBR Project).
Pre-construction	A Decommissioning and Rehabilitation Plan for areas to be temporarily disturbed during construction will be developed prior to construction commencing with the overall aim of minimising the amount of land disturbed at any one time during the construction of the NGBR Project. As soon as practicable after cleared areas are no longer required (i.e. temporary construction camps, laydown areas, quarries, borrows, turning circles and access tracks), rehabilitation will commence. Temporary construction infrastructure will be decommissioned and removed from site. The sites will then be rehabilitated to a state generally consistent with the natural environment. The Decommissioning and Rehabilitation Plan will include: • Removal of potentially hazardous stored substances

Timing	Mitigation measure
	• Remediation of any contaminated areas • Grading of disturbed surface landscapes to a state generally consistent with a natural environment (if required) and to ensure that permanent drainage lines are not compromised • Application of topsoil and revegetation with native species. Revegetation would use flora species of local provenance that were present prior to clearing commencing and species specific to the RE cleared at that site • A mechanism for rehabilitation strategies to be refined throughout the life of the NGBR Project to implement methods which have been most reliable and successful • Requirements and mechanisms for post construction monitoring and audit of rehabilitation success. Material cleared during construction is planned to be chipped, mulched and stockpiled for reuse during rehabilitation. Materials with special habitat value, such as hollow bearing logs or trees, will be selectively removed for reuse during rehabilitation, or placed in nearby bushland. Any watercourse areas crossed will be restored and rehabilitated with measures to improve connectivity and provide enhancements to suitable habitat, where referenced in the Flora and Fauna Management Plan. The Decommissioning and Rehabilitation Plan will also outline specific objectives and methodology for the following: • Seed collection • Flora regeneration • Landscape architecture (i.e. topography) • Creation of supplementary habitats (e.g. nesting boxes), where necessary.
Pre-construction	Weed mapping will be undertaken prior to commencement of construction. Mapping will cover the final rail corridor and ancillary infrastructure but will be particularly focused at high risk locations.
Pre-construction	Baseline field surveys of identified hotspots within and near construction areas will be undertaken prior to commencement of construction.
Pre-construction	Weed control will be undertaken in areas that are very heavily infested or where weeds of national significance or Class 1, 2 or 3 weeds declared under the *Land Protection (Pest and Stock Route Management) Act 2002* are present prior to disturbance.
Pre-construction	A Weed and Pest Management Plan will be developed prior to construction commencing. The weed and pest management plan will include details relating to the monitoring, management and, where necessary, eradication of weeds, disposal of green waste, and

Timing	Mitigation measure
	vehicle/plant weed wash down protocols.
Pre-construction	A Mosquito Management Plan will be developed for the construction phase of the NGBR Project. The management plan will include measures such as: • Prevent ponding of water on site, such as in stormwater drains, sediment traps, containers, water tanks, and so on • Storage containers capable of ponding water will be either discarded after use or stored under roof or stored in an inverted position when empty • Screen/cover water containers and tanks.
Pre-construction	Species specific avoidance, mitigation and management measures will be incorporated within the Flora and Fauna Management Plan. The plan will include procedures for black-throated finch (southern) proposed in consideration of the recovery actions documented in the National Recovery Plan for the Black-throated Finch Southern Subspecies and include the following : • Vegetation clearing extents will be kept to the minimum area necessary for construction to reduce the area subject to habitat fragmentation. Areas that must not be cleared or damaged would also be clearly identified on construction plans and demarcated in the field • A Coal Dust Management Plan will be developed and implemented • An Erosion and Sediment Control Plan will be developed and implemented • In response to priority action #5: the final rail corridor will be fenced along its length to exclude livestock grazing. This may lead to the herbaceous layer (particularly perennial grasses) improving in condition, enhancing the availability of seeding grasses in the landscape.
Pre-construction	Light requirements identified during the detailed design will consider positioning security lighting at permanent facilities to minimise the potential for lighting impacts on fauna.
Pre-construction	Prior to construction commencing, consultation with the Department of National Parks, Recreation, Sport and Racing will be undertaken to obtain historical data on previously conducted turtle nesting surveys in the region.
Construction	Signage will be erected in areas along the construction footprint advising staff when they are entering or leaving infestation ‘hotspots’, where additional weed hygiene inspections may be required.
Construction	Soil stripped and stockpiled from areas containing known weed infestations will be stored separately and will not to be moved to

Timing	Mitigation measure
	areas free of weeds.
Construction	Water trucks will use suitably sized mesh on intake pipes to prevent fish species being transported to different waterways.
Construction	All vehicles, equipment and materials brought onto site will need to be certified as free of weeds and weed seed containing materials and carry a weed hygiene declaration. Records of compliance with this requirement will be retained. A weed wash-down facility will be constructed onsite, where required. The requirement for weed hygiene inspections/certifications will be enforced.
Construction	All construction personnel will be inducted before working on site and made aware of their responsibility regarding protection of native flora and fauna and weed and pest management.
Construction	Clearing will be avoided where possible by placing temporary infrastructure in areas that were previously cleared, degraded or have naturally lower aboveground biomass.
Construction	The extent of vegetation clearing as well as areas requiring protection, such as areas of high ecological value along riparian corridors, will be mapped. Clearing extents will be marked-out (i.e. with flagging, etc.) and communicated to all necessary construction personnel involved prior to clearing taking place.
Construction	Lighting during night works will be positioned to minimise light spillage beyond the boundaries of construction areas. This includes consideration of directional lighting and shields where fauna may be affected.
Construction	Vegetation clearing will be undertaken progressively in a sequential manner (within each construction front) to allow more mobile fauna species to disperse away from cleared areas and clearing activities.
Construction	Corridor clearing widths within areas of high ecological value, such as riparian corridors, will be minimised where identified in the Flora and Fauna Management Plan and will be rehabilitated to restore connectivity to a level that considers the requirements of maintaining permanent infrastructure. All cleared areas which are no longer required will be rehabilitated in a way that facilitates the movement of fauna.
Construction	Upstream and downstream water quality monitoring will be undertaken during construction, on a flow-dependent basis, to monitor the physical and biological health of watercourses. Allowable threshold levels for downstream results will be determined in consultation with the DNRM prior to construction commencing and are expected to be outlined in the NGBR Project conditions of approval. The threshold limit will include a maximum acceptable per cent increase above upstream back ground levels as well as an

Timing	Mitigation measure
	acceptable maximum duration for changes to any water quality parameter. The monitoring program will implement the following strategies: • Any noticeable changes in water quality, increased turbidity or sedimentation of waterways will be immediately investigated to determine the likely cause of the change • Where degradation of water quality is a direct result of the construction operations of the NGBR Project, appropriate measures will be implemented to remedy the cause of the problem.
Construction	Works within 20 m of a watercourse will be undertaken in accordance with the Department of Natural Resources and Mines' Guideline for carrying out activities in a watercourse, lake or spring. If a riverine protection permit is required for any of the works, the conditions of this permit will be adhered to.
Construction	The following management measures will be considered and included in the Construction Flora and Fauna Management Plan for works within 20 m of a watercourse: • Areas where riparian vegetation is already disturbed will be utilised in preference to undisturbed areas • In-stream works will be undertaken in nil or low-flow conditions wherever possible, particularly for culvert installation. • Duration of in-stream works will be minimised through prior planning, such that all equipment and materials are available to allow works to be completed as quickly as possible • Equipment parking and laydown areas will be located outside streams and riparian areas • The area of disturbance within streams and riparian zones will be the minimum area required for safe working and the area of disturbance for infrastructure installation clearly marked • Surrounding riparian habitat will be progressively rehabilitated after construction is complete, where clearance is not required to be maintained for safe and effective operations. • Temporary in-stream barriers will be designed to allow fish passage, particularly where the barrier will be in place for months rather than days or weeks, or will be in place through flows or seasons that are important for fish movement • If aquatic macrophytes are present immediately downstream of the barrier, the potential for water to pass across the barrier will be maximised • Full passage for fish will be reinstated and waterway bed and banks will be returned to their original profile and stability so that

Timing	Mitigation measure
	long-term fish passage at the site is not compromised once the temporary barrier is removed • Silt curtains or other sediment control devices where they can be installed will be used to protect the waterway from sediment plumes and restrict contaminant/runoff into waterway during construction of water crossings.
Construction	Stockpiling of material will not occur within 50 metres of a watercourse or drainage line.
Construction	Any pits/trenches that are to remain open after daily site works will be fenced or covered, if possible. Where this is not possible, fauna ramps will be put in place to provide a means of escape for trapped fauna.
Construction	Temporary fencing will be erected around construction zones to exclude mobile animals from vegetation clearing and civil works areas.
Construction	Pre-clearance surveys will be undertaken in areas identified as potential habitat for threatened species, prior to commencement of clearing. In areas where these surveys indicate the presence of habitat features known or with the potential to provide habitat for these species, a fauna-spotter catcher will be engaged during clearing activities. During pre-clearance surveys, habitat features that may be used by fauna for nesting or shelter will be marked (e.g. hollow-bearing trees, log piles). Pre-demarcated habitat features identified during the pre-clearance survey will be thoroughly checked by the fauna spotter-catcher prior to vegetation clearing commencing. The spotter-catcher will facilitate the safe relocation of any fauna found into pre-determined suitable relocation sites. The spotter-catcher will record details of fauna or habitat features that have been relocated (i.e. GPS location, species or habitat relocated, description of relocation site).
Construction	Work areas will be visually checked for any trapped fauna before work commences each day.
Construction	Where practicable, small open excavations will be securely covered after daily works and when not in use by a barrier impenetrable to fauna. Fauna ramps (e.g. soil/log ramps or wooden planks) would be installed in areas of larger excavation, (e.g. open trenches), to provide a potential means of escape for trapped fauna.
Construction and operation	A register of wildlife incidents (fauna strike and mortality) will be established and maintained for the construction of the NGBR Project, recording the location and nature of the incident. This will allow for identification of trouble-spots and potential adaptive management.
Construction and operation	Procedures in the event that an animal is injured will be developed. Depending on the type and extent of injuries, animals would either be taken to the nearest veterinary practitioner or wildlife care network or humanely euthanized on site by a suitably authorised

Timing	Mitigation measure
	and trained practitioner.
Construction and operation	All vehicles and plant will stay on pre-determined routes and adhere to site construction and operation rules relating to speed limits. Speed limits would be clearly signposted so as to minimise the potential for fauna impact.
Construction and operation	Any road kill will be dragged beyond the edge of the road to reduce potential for scavengers to be struck.
Construction and operation	Where fencing is required, consideration will be given to not using barbed wire on the top strand of wire fences to reduce the risk of fauna entanglement (e.g. bats) resulting in injury or mortality.
Construction and operation	Employees will be made aware of environmental responsibilities regarding local fauna and site protocols for encountering fauna during inductions and ongoing environmental awareness training.
Construction and operation	The final rail corridor will be fenced along its length to exclude wildlife and livestock. Wildlife friendly infrastructure will be incorporated where required within the design of bridges and culverts to allow safe fauna passage.
Operation	A monitoring program will be developed and implemented to assess the success of the pre-construction and construction mitigation and management measures for flora and fauna. The monitoring program will include: • Monitoring of habitat features (i.e. hollows, logs) that have been relocated into adjacent habitat or artificial habitat (i.e. nest boxes, artificial water sources) that have been installed into adjacent habitat to compensate loss of habitat. Monitoring will be required to determine the usage of relocated/artificial habitat, such as nest boxes, by the target species and any maintenance requirements. Methods will involve a visual inspection of each habitat feature to collect data on fauna species occupancy (presence or signs), presence of pest species, any deterioration of the habitat feature, maintenance required and whether the surrounding landscape has changed. Monitoring will be undertaken 12 months after the installation period followed by a summer or winter census to account for seasonal variation in the use of the habitat features. Annual monitoring and maintenance will be undertaken thereafter for a duration of three years. • Monitoring of fauna-friendly design features incorporated into culverts, bridges and other watercourse structures. Monitoring methods will be standardised and targeted to the likely fauna species that will utilise the fauna crossing structures. Methods will likely include motion-detecting cameras with infrared flash installed, sand plots, and scat, track and scratch searches. Monitoring will commence six months after installation of fauna crossing structures(i.e. Veage and Jones 2007) and will be undertaken annually to coincide with periods that are likely to represent peaks in fauna movement and thus higher detection

Timing	Mitigation measure
	rates (i.e. spring), for a duration of three years to monitor the effectiveness of the structures. • Monitoring of rehabilitated areas to assess success against rehabilitation criteria using the BioCondition assessment methodology. Monitoring of rehabilitated areas will commence 1-2 years after establishment. It is proposed that annual monitoring and maintenance be undertaken thereafter for a duration of five years. As a result of monitoring, any incident reporting and corrective actions will be undertaken in accordance with the Environmental Management Plan framework provided in Volume 2 Appendix P Environmental management plan framework.
Operation	Permanent fencing of the final rail corridor will be maintained to minimise livestock and native wildlife from accessing the rail corridor. Consideration will be given to the use of 'spear gates' (i.e. non-lethal exit-only gates) or similar mechanisms that allow for stock to escape the rail corridor.
Operation	An Operation Weed and Pest Management Plan will be developed to manage pest and weed species during operation. The plan will address: • Management of introduced animals in and adjacent to cleared areas including monitoring and management of pest animals. • Monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols in and adjacent to cleared areas Monitoring of remnant vegetation along the edge of the final rail corridor for the presence of weeds. Eradication and/or rehabilitation/restoration to prevent the spread of these species into remnant vegetation areas

6.4.4 Offsets

Where management measures are unable to avoid, reduce or mitigate impacts to state significant biodiversity values, offsets under State legislation will be required. In particular, it is likely that offsets will be required for remnant vegetation clearing and threatened species potential habitat loss, as part of the NGBR Project.

An offset strategy for the NGBR Project is provided in Volume 2 Appendix O Offsets strategy. Calculated offset requirements for the NGBR Project are summarised in Table 6-12 and include the following residual impacts:

- Direct impact on environmental values that require offsetting under the EPBC Act Environmental Offsets Policy (EOP):
  - Clearance of (up to) three TECs protected under the EPBC Act
  - Clearance of potential habitat for five threatened species listed under the EPBC Act.
- Direct impact on environmental values that require offsetting under the Policy for Vegetation Management Offsets:
  - Clearance of endangered REs and of concern REs protected under the VM Act.
- Direct impact on environmental values that require offsetting under the Queensland Biodiversity Offsets Policy (QBOP):
  - Clearance of threshold REs, protected under the VM Act.
  - Clearance of potential habitat for 16 threatened species protected under the NC Act.
  - Clearance of watercourse vegetation, wetland protection areas (including trigger areas) and wetland REs.
- Direct impact on environmental values that require offsetting under the Queensland Marine Fish Habitat Offsets Policy (FHMOP 005.2):
  - Clearance of marine fish habitat.

Table 6-12 Ecological values with residual impact that require offsets

Environmental Value	Species/Community	Proposed Final NGBR Project Footprint Impact Area (ha)	Relevant Offset Policy
Threatened Ecological Communities	Brigalow (*Acacia harpophylla*) dominant and co-dominant	100.3	EOP
	Natural grasslands of the Queensland central highlands and the northern Fitzroy Basin	117.1 (potential)	EOP
	Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar regions	35.8	EOP
Threatened species under the EPBC Act	*Eucalyptus raveretiana*	64.6	EOP
	Australian painted snipe	45.6	EOP
	Black-throated finch (southern)	2,143.4	EOP

Environmental Value	Species/Community	Proposed Final NGBR Project Footprint Impact Area (ha)	Relevant Offset Policy
	Koala	2,390.1	EOP
	Ornamental snake	246.6	EOP
	Squatter pigeon (southern)	1,788.1	EOP
Endangered and of concern regional ecosystems	11.12.10	2.8	PVMO
	11.12.14	1.2	PVMO
	11.12.15	1.7	PVMO
	11.12.16	1.7	PVMO
	11.12.18	0.4	PVMO
	11.12.21	13.0	PVMO
	11.11.13	4.6	PVMO
	11.11.18	2.0	PVMO
	11.9.1	0.1	PVMO
	11.9.10	25.5	PVMO
	11.9.12	42.9	PVMO
	11.4.2	1.8	PVMO
	11.4.5	0.4	PVMO
	11.4.6	0.1	PVMO
	11.4.8	20.6	PVMO
	11.4.9	48.4	PVMO
	11.4.11	8.2	PVMO
	11.3.1	18.2	PVMO
	11.3.2	65.3	PVMO
	11.3.3	17.7	PVMO
	11.3.4	33.2	PVMO
	11.3.33	9.9	PVMO
	11.3.34	1.7	PVMO
	11.2.3	33.8	PVMO
Threshold regional ecosystems	11.4.11	8.2	QBOP
	11.3.5	30.5	QBOP
Endangered and of concern high value regrowth	11.12.21	2.3	QBOP
	11.4.8	1.8	QBOP
	11.4.9	5.1	QBOP
	11.12.14	0.7	QBOP
	11.12.15	1.0	QBOP

Environmental Value	Species/Community	Proposed Final NGBR Project Footprint Impact Area (ha)	Relevant Offset Policy
	11.12.18	0.2	QBOP
	11.2.3	0.5	QBOP
	11.3.4	0.9	QBOP
	11.4.5	0.8	QBOP
Listed species under the NC Act	*Bonamia dietrichiana*	832.9	QBOP
	Eucalyptus raveretiana	64.6	QBOP
	Squatter pigeon (southern)	1,788.1	QBOP
	Black-necked stork	417.7	QBOP
	Cotton pygmy-goose	63.3	QBOP
	Freckled duck	63.3	QBOP
	Little pied bat	2,494.7	QBOP
	Black-throated finch (southern)	2,143.4	QBOP
	Australian painted snipe	45.6	QBOP
	Little tern	45.6	QBOP
	Black-chinned honeyeater	2,110.8	QBOP
	Square-tailed kite	2,260.4	QBOP
	Ornamental snake	246.6	QBOP
	Estuarine crocodile	62.8	QBOP
	Brigalow scaly-foot	1,861.9	QBOP
	Common death adder	2,494.7	QBOP
	Eastern curlew	45.6	QBOP
	Koala	2,390.1	QBOP
Watercourse[1] vegetation	Stream order 1	115.5	QBOP
	Stream order 2	34.1	QBOP
	Stream order 3	31.3	QBOP
	Stream order 4	14.3	QBOP
	Stream order 5	15.2	
	Stream order 6	15.3	
Wetlands	Wetland protection area	17.7	QBOP
	Wetland protection area (trigger area)	133.6	QBOP
	Wetland RE	240.8	QBOP
Connectivity	Not applicable	3,591.5	QBOP

Environmental Value	Species/Community	Proposed Final NGBR Project Footprint Impact Area (ha)	Relevant Offset Policy
Marine fish habitat	11.1.2	8.4	FHMOP005.2
	11.1.4	1.7	FHMOP005.2

[1] Stream orders are based on the stream classification system developed by Strahler (1952). Using this method, waterways are given an 'order' according to the number of additional tributaries associated with each waterway, providing a measure for system complexity.

6.5 Conclusion

This chapter assesses the potential impacts of the NGBR Project on terrestrial and aquatic flora and fauna and identifies mitigation measures to manage potential impacts. The assessment considers the preliminary investigation corridor and the wider landscape in which this occurs, including potentially impacted downstream areas.

The preliminary investigation corridor crosses a diverse range of vegetation communities, including seven endangered REs (regulated under the *Vegetation Management Act 1999*), 18 of concern REs and the constituent REs of three endangered threatened ecological communities (as listed under the EPBC Act – natural grassland, brigalow and semi-evergreen vine thicket (only the latter two were confirmed present, natural grassland TEC may occur).

During construction, the NGBR Project will require clearing of approximately 4,215 ha of vegetation, of which approximately 2,571 ha is mapped remnant vegetation (VM Act). The mapped remanent vegetation encompasses 61 RE types within the Brigalow Belt bioregion.

The individual REs that will likely undergo the greatest extent of clearing are least concern REs 11.12.1 (622 ha) and 11.5.3 (296 ha), which together equate to approximately 22 per cent of the total clearing extent required during construction (including non-remnant land), and 35 per cent of the 2,571 ha of mapped remnant vegetation expected to be cleared.

Approximately 44.4 ha of regulated high value regrowth vegetation would be cleared during construction. Of this, approximately 10.1 ha is categorised as being high value regrowth containing an endangered RE, 10 ha is high value regrowth containing an of concern RE, and 24.3 ha is high value regrowth that is a least concern RE. In addition to the area of remnant vegetation and regulated regrowth vegetation that will be impacted within the construction footprint, a further 1,643 ha of non-remnant land (predominantly utilised for grazing purposes) will be utilised for construction of the NGBR Project. This equates to a total of 39 per cent of the total clearing area of the NGBR Project.

A total of 297 least concern (NC Act) flora species were recorded within the preliminary investigation during field surveys (refer Section 6.3.2). Individuals and/or populations of some of these species will be lost from the local environment due to vegetation clearing during construction of the NGBR Project. One conservation significant species was recorded during field surveys, *Eucalyptus raveretiana* (black ironbox), which is listed as vulnerable under the NC Act and EPBC Act. The estimated construction impact on mapped habitat that is potentially suitable for this species is 64.6 ha.

A likelihood of occurrence assessment for threatened flora species was undertaken in accordance with the methodology outlined in Section 6.2.4. One conservation significant flora species, *Bonamia dietrichiana*, listed as near threatened under the NC Act (not listed under the EPBC Act), was considered 'likely to occur' based on previous records and potentially suitable habitat present within the preliminary investigation corridor. The estimated construction impact on habitat that is potentially suitable for this species is 626 ha.

The NGBR Project will result in the direct loss of potential habitat for five EPBC Act-listed threatened fauna species confirmed present or considered likely to occur within the preliminary investigation corridor (refer Table 6-10). The potential impact of the NGBR Project on these species is discussed in Volume 1 Chapter 7 MNES.

The NGBR Project will also result in the direct loss of potential habitat for 16 NC Act-listed threatened fauna species that were confirmed present or considered likely to occur within the preliminary investigation corridor. The direct impact on potential habitat for fauna species listed under the NC Act is summarised in Table 6-10

In total, 42.77 ha of riparian vegetation and 10.6 ha of wetland vegetation will require clearing.

No aquatic habitat within DIWA listed nationally important wetlands will be directly disturbed.

A total of 35 introduced flora taxa were recorded within the preliminary investigation corridor, five of which are listed as Weeds of National Significance and ten of which are declared weeds under the LP Act. No aquatic pest species were recorded within the investigation corridor; however, tilapia (*Oreochromis mossambicus*), three spot gourami (*Trichogaster trichopterus*) and mosquitofish (*Gambusia holbrooki*) have been recorded within the Burdekin River Basin (Allen *et al.* 2002; Pusey *et al.* 2004).

Operation of the NGBR Project has the potential to create long-term habitat fragmentation. However, the impacts of fragmentation attributed to operation of the NGBR Project are considered to be relatively minor, within a regional context, as it is located in a landscape that has been extensively fragmented by historical broadscale vegetation clearing.

A total of 16 major and moderate waterway crossings are required for the NGBR Project. The final design and size of the waterway structures (including bridges, pipe culverts and box culverts) for these crossings would take into the consideration the ability of fish, turtles and other aquatic fauna to move within the watercourse in accordance with the Department of Agriculture, Fisheries and Forestry Fish Habitat Management Codes and Policies, which require the maintenance of aquatic fauna connectivity. An application under the *Fisheries Act 1994* will be sought where culvert or bridge installation works within a watercourse has the potential to disturb and impair the movement of aquatic fauna within a waterway.

By implementation the construction and operation mitigation and management measures outlined in this chapter the impacts on the identified nature conservation values are not expected to be significant in nature.

Where impacts are unavoidable offsets will be required to compensate for the residual impacts of the NGBR Project on terrestrial ecological values where these cannot otherwise be mitigated. Both Commonwealth and State government offset requirements are applicable to the NGBR Project for a range of ecological impacts including, but not limited to, vegetation clearing and threatened species potential habitat loss. An offset strategy for the NGBR Project is provided in Volume 2 Appendix O Offsets strategy.