10 Aquatic Ecology

Section 10 Aquatic Ecology

10.1 Introduction

This aquatic ecology study has gathered information on the existing values to assess potential impacts to aquatic ecosystems and species from construction and operation of the Alpha Coal Project (Rail) (herein referred to as the Project) and to derive mitigation strategies. The full report is detailed in Volume 6, Appendix F1 of this EIS.

10.1.1 Study Area and Project Footprint

The rail corridor proceeds in a generally north-easterly direction from the Alpha Coal Mine, crossing the Belyando River and several of its tributaries in the first 100 km. The railway generally crosses relatively flat lowlands before commencing a gentle climb from near Eaglefield adjacent to the Suttor River, to a point near the existing Newlands mine. This is the highest point on the railway at approximately 300 m above sea level. In the vicinity of the Newlands mine, the railway runs parallel to the Queensland Rail (QR) Northern Missing Link (NML) railway for approximately 70 km through a pass in the Leichardt Range and parallel to the Newlands Railway to a point near the Bowen River. The railway then travels in a north westerly direction on crossing the Bowen River, then passing down the Bowen River valley through mostly grazing land toward Mt Herbert. The railway passes to the west of Mt Herbert through a pass in the Clarke Range. From this point, the railway travels north-easterly crossing the Bogie River, then finally in an easterly direction entering the Abbot Point area on its western boundary.

The Project footprint considered in this assessment refers to:

- an easement 495 km long and 60 m wide;
- a series of laydown areas and construction nodes;
- local construction access tracks (that will be used during construction only); and
- local maintenance access tracks (that will be used and maintained through the operational phase).

For the purposes of this assessment, the *study area* refers to land along and up to 1 km adjacent to the Project corridor. The entire study area was not assessed due to access restrictions, rather sites were selected to represent the ecosystems where possible (refer to Section 10.1.2 below).

10.1.2 Assessment Context and Scope

Section 3.3.4 of the Project Terms of Reference (TOR) identifies the attributes and values of the freshwater aquatic environment that are to be specifically investigated in the Environmental Impact Statement (EIS). This requires a description of environmental values including the fauna and flora present or likely to be present at any time of year in the Project area. The TOR also require that potential impacts and mitigation measures be identified. Given the restricted ability to sample the expansive Project footprint year round (inaccessible during wet seasons, land holder access limitations) achievement of the Project TOR was supported by significant desktop research and targeted field investigations. Field investigations addressed a diversity of habitats and were informed by desktop assessments to provide an appropriate level of information to describe the site. To this end the following works were completed to address the TOR:

- **description of environmental values -** a description of the aquatic flora and fauna[1] present or likely to be present at any time during the year in the Project area. This included the following:
  - desktop assessment of fish, aquatic mammals, aquatic reptiles and aquatic invertebrate species occurring in waterways;
  - desktop assessment of aquatic (waterway) plants, including any declared pest plants;
  - the existence of conservation significant or otherwise noteworthy species or communities, including discussions on range, habitat, breeding, recruitment, feeding and movement requirements, and the current level of protection;
  - characterisation and value of aquatic habitats including aquatic substrate and stream type;
  - desktop assessment of wetlands listed by the Queensland Department of Environment and Resource Management (DERM) as areas of national, state or regional significance, and their values and importance;
  - assessment of Ramsar wetlands of international importance in terms of proximity to proposal and likelihood of impacts; and
  - a description of the habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the Project areas.

  Note: As discussed in Volume 3, Section 12 of this EIS, there is not considered to be a significant impact on groundwater resources within the Project footprint; hence an investigation of the presence and nature of stygofauna was not undertaken.
- **identification of potential impacts and mitigation measures** - this includes direct and indirect impacts of the Project on aquatic flora and fauna, as well as measures to mitigate the impact.

10.2 Description of Environment Values

10.2.1 Survey Methodology

The aim of this aquatic flora and fauna assessment was to provide a sufficient amount of baseline information to enable identification and assessment of the potential impacts of the Project on the existing environmental values of the Project area. To achieve this objective, the following tasks were undertaken:

- literature review: the literature review included a review of relevant scientific and grey literature[2], database searches and previously prepared technical reports. This assessment was conducted to document the known aquatic environmental values within the Project area including a list of aquatic flora and fauna species that have been historically recorded or have the potential to occur within the area; and

[1] For the purposes of this assessment, aquatic fauna are defined as animals that are entirely aquatic, or those that spend extended periods of time in the water (particularly for the purpose of foraging), and spend only limited periods of time in the terrestrial environment. This includes fish, freshwater turtles, crocodiles, aquatic macroinvertebrates and platypus. Amphibians and semi-aquatic species such as water birds are addressed in the terrestrial flora and fauna assessment report.

[2] Grey literature includes non-peer reviewed published and unpublished technical reports, government published documents and information sourced from the internet.

- field assessment: a field survey was conducted at proposed major watercourse crossings during the wet season to characterise and document the freshwater ecosystems of the study area. This assessment included detailed habitat assessments and *in situ* water quality assessments.

While the literature was used to make a general assessment across the study area, specific observations made at habitat assessment sites during the field assessment phase were used for more detailed descriptions of habitat and for the impact assessment phase.

Field assessments were conducted to determine the site-specific habitat characteristics of aquatic ecosystems within the Project area and to assess surface water quality. Twenty-two field assessment sites were selected following a review of aerial photography and Geographic information systems (GIS) watercourse mapping and a reconnaissance of the Project area. These sites were selected to provide adequate coverage of the range of aquatic ecosystems for assessment and were selected on the basis of being:

- representative of major aquatic habitats within the Project area;
- covered a geographical range of aquatic habitats;
- corresponded with proposed disturbance footprints of alignment crossings (based on preliminary alignment);
- prioritised larger watercourses that are more likely to provide aquatic habitat for much of the year; and
- were accessible (Figure 10-1 shows land parcels where no access was granted).

The field assessments were conducted between 15 – 21 April 2010 and are considered to represent post-wet season conditions. This survey period was selected to coincide as close as possible to the wet season when the aquatic ecosystems within the area are at their highest ecological productivity. Due to the extended wet season in 2010, access difficulties (i.e. as a result of high water levels and poor road access) hindered field assessments during the typical wet season summer period. The location of the field assessment sites are illustrated in Figure 10-1, while a summary of survey effort at each site is detailed in Table 10-1.

Table 10-1: Field assessment survey effort

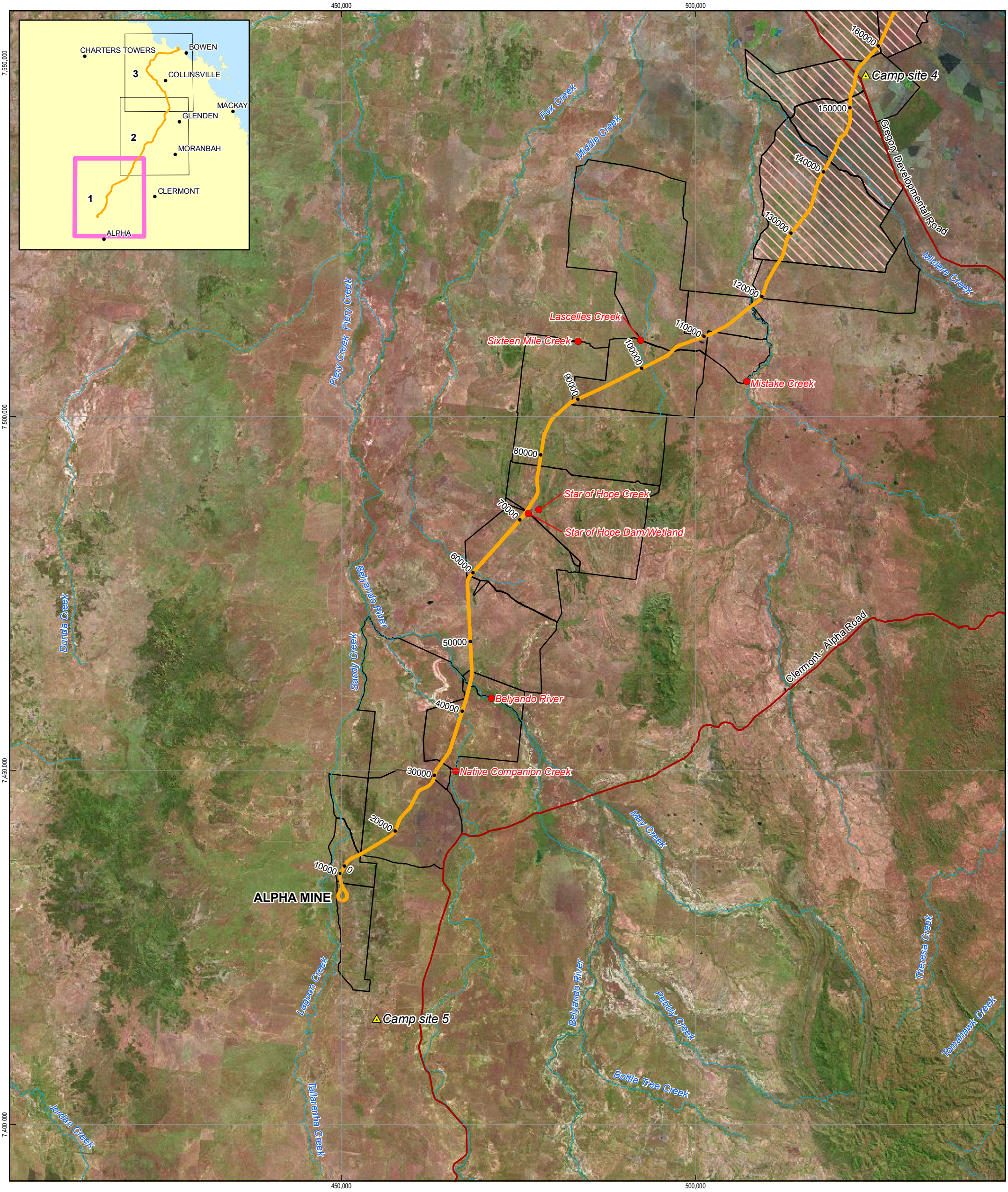
Site	Habitat Assessment	Water Quality
Lowland Riverine Habitats		
Splitters Creek	✓	✓
Elliot River	✓	✓
King Creek	✓	✓
Capsize Creek	✓	✓
Bogie River	✓	✓
Pelican Creek	✓	✓
Upland Riverine Habitats		
Suttor Creek	✓	✓
Eaglefield Creek	✓	✓
Myra Creek	✓	✓
Mistake Creek	✓	✓
Sixteen Mile Creek	✓	✓
Star of Hope Creek	✓	✓
Belyando River	✓	✓
Native Companion Creek	✓	✓
Lacustrine/Palustrine Habitats		
Artificial Dam/Wetland	✓	✓
Gilgais	✓	✓
Star of Hope Dam/Wetland	✓	✓
Other Riverine Habitats		
Brigalow Creek	✓	Dry
Herbert Creek	✓	Dry
Cattle Creek	✓	Dry
Table Mountain Creek	✓	No Access
Lascelles Creek	✓	Dry

Field assessment consisted of:

- habitat assessments at each of the 22 field assessment sites to describe the existing characteristics and values of the aquatic habitats within the Project area. The assessments were conducted in accordance with the National River Health Program, Australian River Assessment System (AUSRIVAS) methodology. Using the AUSRIVAS survey and assessment methodology (i.e. 100 m sampling length) a range of parameters were recorded; and
- in-situ surface water quality from field sites that contained water at the time of survey (i.e. 18 of the 22 sites). The physicochemical water sampling was undertaken using a hand-held electronic multi-parameter water quality meter. Parameters recorded included temperature, pH, dissolved oxygen,

conductivity, turbidity and total dissolved solids. Ten replicate water quality samples were recorded at a depth of 0.2 m below the water's surface. Where water levels were less than 0.2 m deep, a 5 - 10 L water sample was collected in a bucket and the water quality recoded ex-situ. The water quality meter was calibrated daily for accuracy and consistency in measurements.

In order to describe and assess the water quality characteristics of the survey sites, the water quality results of each site were compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) National Water Quality Guidelines (ANZECC/ARMCANZ, 2000) and the Queensland Water Quality Guideline (QWQG) (DERM, 2009a). The ANZECC/ARMCANZ values against which water quality data was assessed were for Tropical Australia while those for QWQG were for the Central Coast Queensland region. In accordance with the ANZECC/ARMCANZ and QWQG, the habitats within the study area were separated into lowland, upland and lacustrine/palustrine habitats.



LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Aquatic Assessment Site
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- Waterbody
- Cadastre
- No Land Access Permission

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Figure: 10-1
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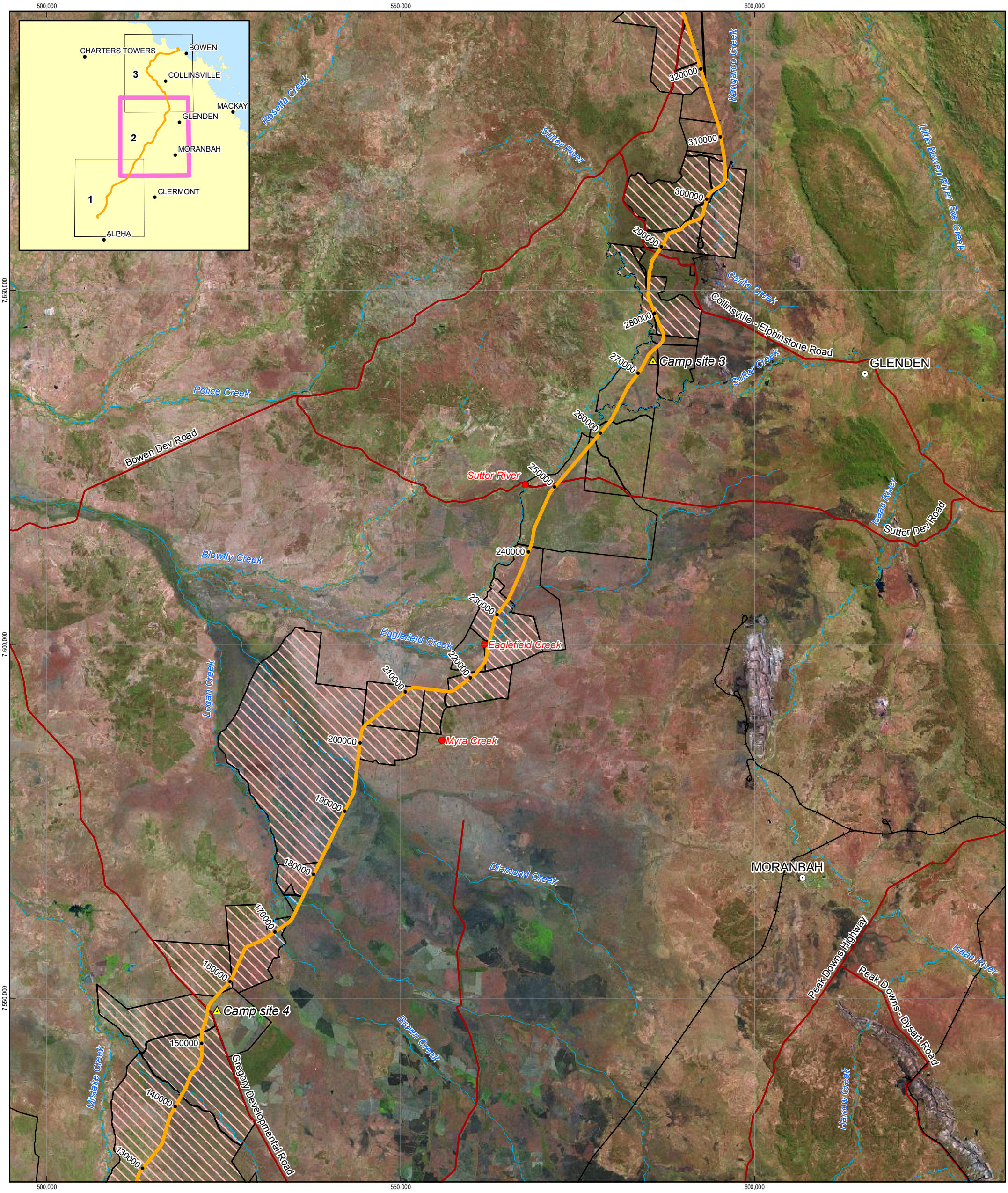

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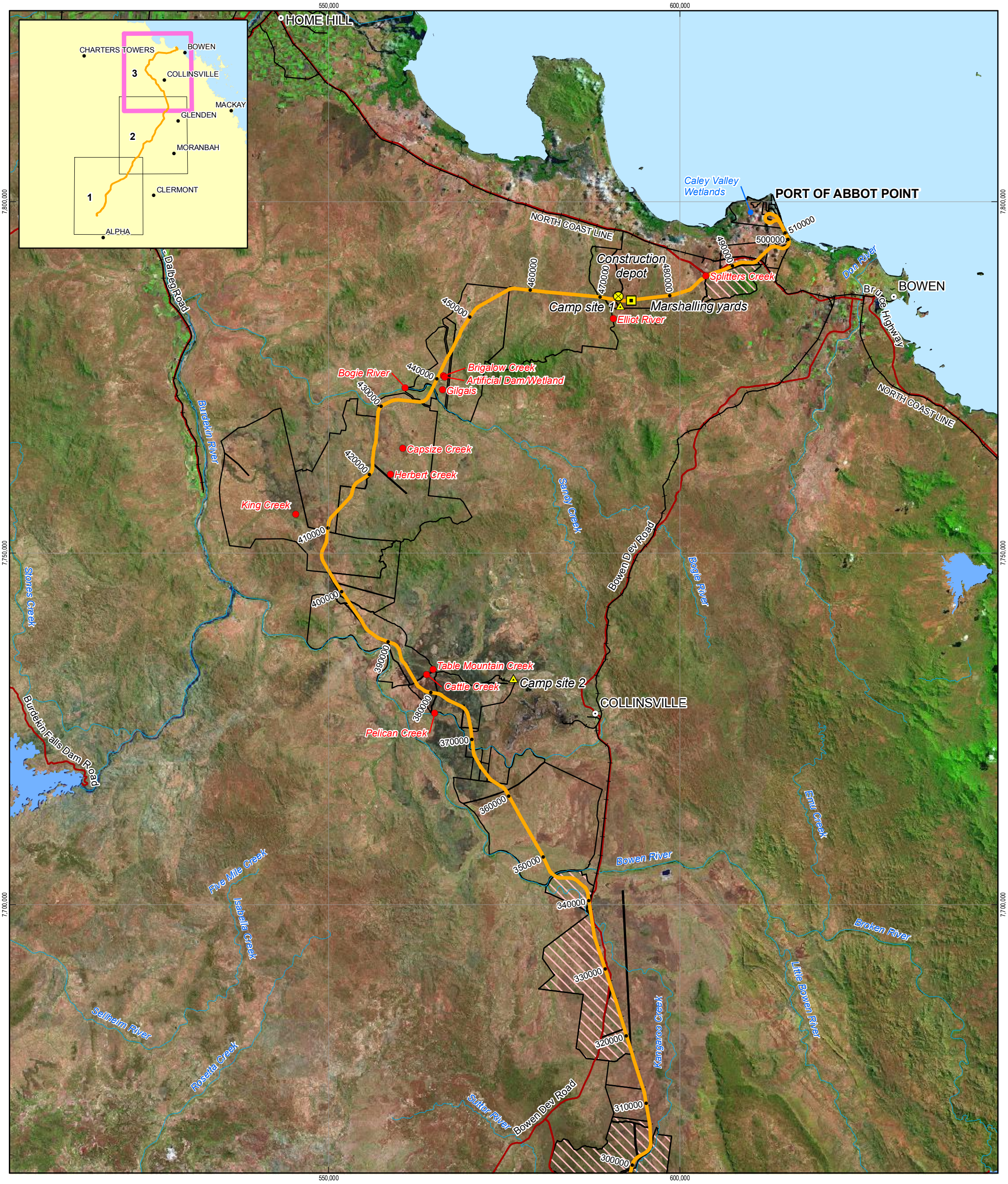

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10.2.2 Burdekin Catchment

The study area lies within the Burdekin Catchment which covers an area of 136,000 km^2 (Australian Bureau of Agricultural and Resource Economics (ABARE), 2003). The land use is dominated by cattle grazing, covering over 96% of the catchment area. Other land uses include sugar and horticulture cropping, aquaculture and mining. Water infrastructure is also a significant industry with twelve major dams and weirs occurring throughout the catchment (Department of Natural Resources and Mines (DNRM), 2002; ABARE 2003).

The catchment exhibits distinct seasonal climatic conditions with a pronounced wet summer and dry winter. Mean annual rainfall in the catchment ranges from less than 500 mm to over 2500 mm and is generally highest in the eastern coastal areas and lowest is the western and southern regions (Dight, 2009; Bureau of Meteorology (BoM) (BoM, 2010b). Water flows within the Burdekin Catchment are primarily influenced by the strong seasonality in rainfall and as such, mean annual discharge is highly variable both between and within years. Annual flows patterns within the catchment are generally characterised by short periods of increased flow between December and April, with little to no-flow occurring outside this period (NRM 2002; BoM 2010b).

Severe flooding occasionally occurs within the Burdekin Catchment as a result of intensive rainfall events associated with severe storms, cyclones and tropical low pressure systems. Prolonged dry conditions and drought are also characteristic features of the highly variable catchment.

The Burdekin Catchment as a whole is divided into six major basins of which the proposed rail alignment is located within the Bowen Broken Bogie, Suttor and Belyando basins.

Volume 3, Section 11 of this EIS also describes the hydrology of the study area.

10.2.3 Water Quality

The key parameters influencing water quality within the Burdekin Catchment are directly influenced by water flows and as such water quality varies significantly between wet and dry seasons (Commonwealth Scientific and Research Organization (CSIRO), 2002). During periods of high water flow, water quality is relatively constant throughout the river and the main influences on water quality are associated with sedimentation and the input of nutrients.

Export from the Burdekin Catchment is dominated by very high levels of fine suspended sediment. This sediment is derived from grazing related erosion that occurs throughout the catchment (Bainbridge *et al*., 2003). Total suspended sediment concentrations in areas affected by grazing generally range from 25 – 960 mg/L. Areas that have been particularly affected by the loss of riparian vegetation (e.g. Pelican Creek, Bowen River and Burdekin River) have medium total suspended sediment concentrations as high as 3000 – 6000 mg/L (Bainbridge *et al*., 2006a,b). The QWQG for suspended sediment for lowland habitats is 10 mg/L.

Outside of flooding conditions, water flows within the Burdekin Catchment generally cease or are slow flowing. Water quality during these no/low flow conditions is highly variable on a temporal and spatial scale and is largely influenced by local conditions (CSIRO, 2002). The key parameters influencing water quality during this period are turbidity, pH, temperature, salinity, oxygen levels and nutrient and contaminant levels. Land use is considered to be the main influence on these parameters at a local scale and cattle loitering in waterholes and within riparian vegetation is known to be particularly degrading to water quality (CSIRO, 2002). Disturbance to the banks and surrounds of waterholes by

cattle (e.g. hoof prints) in the study area was common and widespread and indicated heavy use of such resources by local cattle.

Salinity is currently one of the main water quality issues within the Burdekin Catchment 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. Potential impacts as a result of dryland salinity include loss of soil productivity, reduced water quality and loss of biodiversity. Vegetation clearing is suspected as the cause of dryland salinity in this area however there is little data available to confirm the extent and severity of this risk (CSIRO, 2002).

Additional impacts on water quality within the Burdekin Catchment are associated with land degradation and include soil erosion; invasion of terrestrial weeds; loss of riparian vegetation and loss of palustrine habitats. These impacts are primarily driven by grazing management practices (CSIRO, 2002). Overgrazing and inadequate fire regimes have resulted in a reduction in ground cover and increase in soil damage. These impacts have resulted in an increase in erosion with hill slope erosion the main source of sedimentation in the catchment (CSIRO, 2002).

10.2.4 Matters of National Environmental Significance – World Heritage and Ramsar Wetlands

The Burdekin Catchment flows into the Great Barrier Reef World Heritage Area, which is protected as a Matter of National Environmental Significance under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The Great Barrier Reef (GBR) covers a total area of 348,000 km^2 and supports a variety of habitats including seagrass beds, mangrove forests, sandy and muddy seabed communities, inter-reefal areas, deep oceanic water and island communities (Department of Environment, Water, Heritage and the Arts (DEWHA), 2008).

The catchment also flows into the Bowling Green Bay Ramsar Wetland via the Haughton River (refer to Volume 6, Appendix F1, Figure 3 of this EIS). The Bowling Green Bay Wetland is located 21 km north east of Ayr and has a total area of 35,500 ha. The wetland aggregation contains a diversity of habitats including seagrass beds, coastal sand dues, tidal flats, mangrove forests, highly saline supratidal salt pans, brackish to freshwater marshes, and lakes. The Bowling Green Bay Wetland is an internationally significant habitat for wader birds and provides important breeding and nursery habitat for commercially and recreationally important fish species such as barramundi (*Lates calcarifer*). The marine areas of the wetland support substantial populations of marine megafauna while the estuarine areas provide habitat for the estuarine crocodile (*Crocodylus porosus*) (DEWHA, 2010a)[3]. The Bowling Green Bay Wetland is located more than 100 km from the northern end of the proposed rail alignment.

10.2.5 Nationally Important Wetlands

A total of 35 nationally important wetlands are located in the Burdekin Catchment. The Caley Valley Wetland and the Bowen River: Birralee – Pelican Creek Wetland aggregation are located within the study area.

[3] With respect to Matters of National Environmental Significance. These habitats provide for a range of flora and fauna species not listed under the EPBC Act.

10.2.5.1 Caley Valley Wetland

The Caley Valley Wetland covers an area of around 5150 ha and is located immediately adjacent to the Abbot Point Coal Terminal facility, approximately 21 km north northwest of Bowen. The site has a high importance for waterbirds and migratory species due to its mix of permanent water, a wide range of wetland habitats, very rich food resources and sheltered roosting and breeding sites (DEWHA, 2010b). Volume 3, Section 9 of this EIS discusses the values of the area for waterbirds and migratory species.

The wetland experiences distinct seasonal changes, with wet-season filling driving a freshwater system that provides habitat for a number of aquatic species, including freshwater fish and turtles. The drying out period (during the dry season) creates a more saline environment, and restricts freshwater areas to pools that may persist depending on the duration of the dry season. The estuarine tidal channels provide potential habitat for EPBC Act listed species such as the estuarine crocodile.

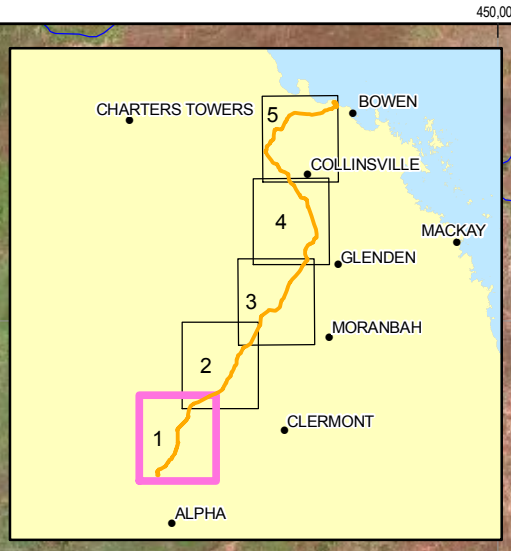
Extensive grazing occurs across the wetland complex and the adjacent Abbot Point Coal Terminal is listed as a disturbance to the site. Inappropriate grazing has lead to severe impacts on beach scrub communities and feral pig populations have some impacts on wetland margins (DEWHA, 2010b).

The proposed rail loop linking the rail corridor to the Boot Point Coal Terminal X110 Expansion area will partially encroach upon the Caley Valley Wetland in the north-eastern area. Refer to Section 10.3 below for further detail on the extent of encroachment.

10.2.5.2 Bowen River: Birralee - Pelican Creek Wetland Aggregation

The Bowen River: Birralee - Pelican Creek Aggregation is a 15 km section of the Bowen River covering an area of 1342 ha approximately 27 km west of Collinsville. This site provides a range of aquatic habitats including rapids, sand, rock or rubble bars, terraces, small waterholes, macrophytes beds, emergent wetlands and flooded palustrine evergreen forest. The main feature of this wetland is a large permanent clear waterhole in the central part of the site approximately 3.4 km in length and about 150 m wide at its widest point (DEWHA, 2010c). The large permanent waterhole is likely to provide an important dry season refuge for many fauna species (DEWHA, 2010c). Eight species of conservation significance have been recorded on the site including the estuarine crocodile. A large number of migratory bird species have also been previously recorded (DEWHA, 2010c).

This wetland site is approximately 3.5 km away from the Project alignment (refer to Figure 10-2).



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7,500,000 7,475,000 7,450,000

Fox Creek
Lestree Hill Creek
Belyando River
Sandy Creek
May Creek
Clermont - Alpha Road

100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0

ALPHA MINE

LEGEND

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- Existing Railway
- Watercourse
- Directory of Important Wetlands
- Wetland System
  - Estuarine Waterbody
  - Lacustrine Waterbody
  - Palustine Waterbody
  - Riverine Waterbody

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Kilometres

Map Projection: Universal Transverse Mercator
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Grid: Map Grid of Australia, Zone 55

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Figure: 10-2
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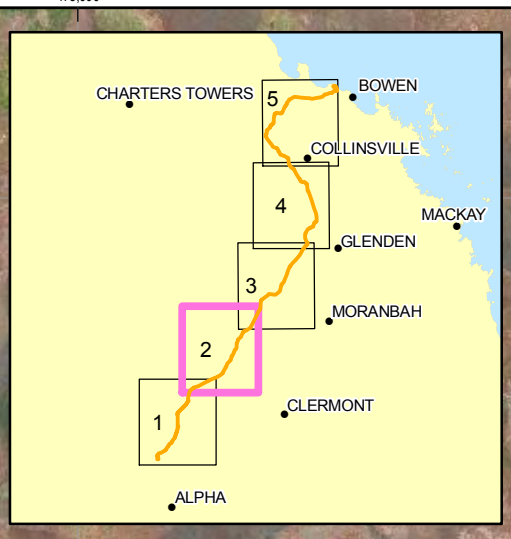

475,000
500,000
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Logan Creek
Middle Creek
Brown Creek
Fox Creek
Mistake Creek
Lascelles Creek
Gregory Developmental Road
Camp site 4
Midera Creek
Gregory Creek

190000
180000
170000
160000
150000
140000
130000
120000
110000
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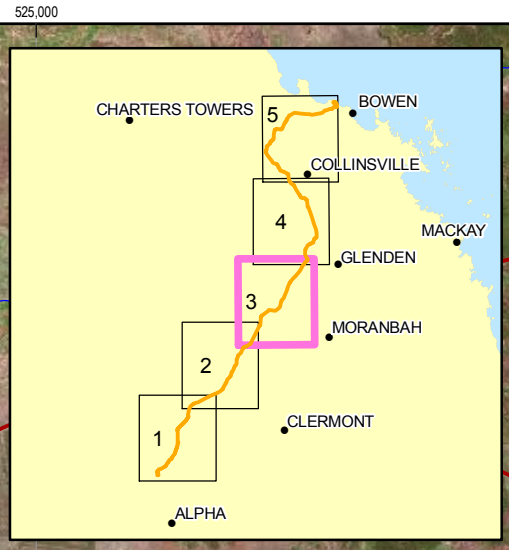

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Camp site 3

270000 260000 250000 240000 230000 220000 210000 200000 190000 180000

Verbena Creek
Suttor River
Suttor Dev Road
Blowfly Creek
Eaglefield Creek
Diamond Creek
Logan Creek

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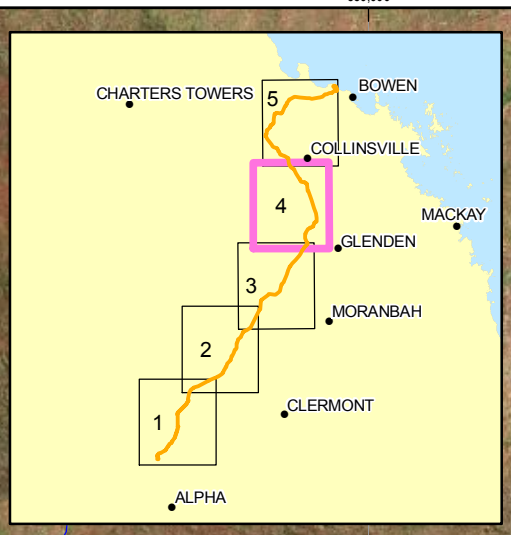

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Birralee - Pelican Creek Wetlands
Bowen Dev Road
Bowen River
Kangaroo Creek
Rosetta Creek
Suttor River
Police Creek
Cerito Creek
Collinsville - Elphinstone Road
Camp site 3

360000
350000
340000
330000
320000
310000
300000
290000
280000

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Alpha Coal Project
Environmental Impact Statement

AQUATIC HABITAT LOCATIONS

Job Number	41-22090
Revision	A
Date	21-09-2010

Figure: 10-2
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10.2.6 Fish Habitat Areas

Inshore and estuarine fish habitats which play a key role in sustaining local and regional fisheries values are declared Fish Habitat Areas and are protected under the Queensland *Fisheries Act 1994*. Fish Habitat Areas located within the Burdekin Catchment include the Bohle River, Bowling Green Bay, Burdekin River and Cleveland Bay. There are no Fish Habitat Areas located within or adjacent to the Project footprint.

10.2.7 Aquatic Habitats

Aquatic ecosystems within the Burdekin Catchment can be divided into four broad habitat types: estuarine, lacustrine, palustrine and riverine. Refer to Figure 10-2 for the distribution of the aquatic habitats.

10.2.7.1 Estuarine Habitats

Estuarine habitats occur where freshwater from riverine habitats mixes with oceanic waters to produce a brackish environment (DERM, 2009b). Estuarine habitats within the study area include mangrove and saltwater wetlands (which includes mudflats, samphire and saline lakes) and adjacent tidal creeks. These habitats are located within the Caley Valley Wetland, at the northern end of the Project alignment (refer to Figure 10-2).

10.2.7.2 Lacustrine and Palustrine Habitats

Lacustrine habitats are large, open, water bodies such as lakes and artificial dams. These habitats are generally deep and still or slow-flowing. Palustrine habitats are primarily off-stream habitats that support a high abundance of emergent vegetation. Lacustrine and palustrine habitats represent an important resource for many aquatic species.

10.2.7.2.1 Lacustrine

Due to their large size and deep water depth, lacustrine habitats are generally permanent water bodies that contain water throughout the year. These habitats provide an important refuge for fauna during the dry season when many of the other aquatic habitats have dried out. Lacustrine habitats are also likely to provide important habitat for many terrestrial species that depend on dry season water resources (e.g. waterbirds and amphibians).

10.2.7.2.2 Palustrine

Palustrine habitats include gilgais, swamps, billabongs and wetlands (DERM, 2009b). Gilgais are a type of palustrine habitat that forms in the cracking clay soils of brigalow forests. During the wet season, these small rounded depressions fill with water and become extensively covered with a high diversity of aquatic macrophytes. Aquatic fauna that are likely to utilise these habitats include macroinvertebrates such as crustaceans and small-bodies fish. Gilgais have limited value for aquatic fauna during the dry season when they completely dry out to cracking clay soils.

Palustrine habitats such as wetland and billabongs are generally seasonally inundated during the wet season and gradually dry out as rainfall declines and water levels in the main river channel subside (depending on the area and depth, these habitats may or may not completely dry out). Due to their shallow depth and still water conditions, palustrine habitats generally support a relatively high diversity of macrophytes and in-stream habitat in form of detritus, fallen branches and logs. The high

abundance of microhabitats within these environments provide seasonal breeding and larval habitat for diverse communities of aquatic and terrestrial macroinvertebrates.

Palustrine habitats within the study area include the Caley Valley Wetland (chainage 505 km) and the Bowen River: Birralee - Pelican Creek Aggregation (located ~3.5 km from the alignment adjacent to chainage 355 km to chainage 382 km (refer to Figure 10-2)). These habitats are listed as nationally important wetlands under the Australian Government's Directory of Important Wetlands (DEWHA, 2010d).

Examples of these habitats are shown in Plate 10-1 and Plate 10-2.

Plate 10-1: Artificial Dam/Wetland

Plate 10-2: Gilgais

10.2.7.3 Riverine Habitats

Riverine habitats include all aquatic habitat types that occur within a channel (i.e. natural or artificial). Riverine habitats may be periodically or permanently inundated by flowing water (DERM, 2009b). This is the predominant habitat type within the study area.

River habitats in the study area were relatively uniform and supported a low abundance and diversity of in-streams habitats. River channels in the Elliot, Bogie and Belyando Rivers were predominately dry at the time of survey. The Elliot and Bogie Rivers were dominated by sandy/gravel substrate and contained only very shallow water flows in the microhabitat low flow channels. These rivers are considered likely to support run habitats for short periods during times of increased water depth and flow. No pool or riffle habitats were evident within these rivers at the survey locations. The Belyando River was relatively narrow compared to the other river habitats assessed and supported two small isolated pools at the time of survey. Narrow sections of the river channel were considered likely to support runs during increased water levels and flows. The Suttor River was the only river surveyed that contained a large, deep, pool habitat. This river was dominated by silt/clay substrate.

Due to their ephemeral nature, river habitats within the study area generally provide low value habitat for aquatic fauna during the dry season. Habitat value during the wet season is also considered relatively low due to the low abundance and diversity of in-stream habitat features such as fallen logs and branches. The Elliot and Bogie rivers were considered to contain a particularly low abundance of microhabitats. Macrophytes were low in abundance throughout the river habitats and were dominated by semi-aquatic emergent species growing on the channel margins.

Creek habitats generally contain areas of shallower water and slower flow. They often support a more diverse array of aquatic and fringing vegetation, significant amounts of in-stream structure (woody debris) and undercut banks. The generally shallow, slow-flowing aquatic habitats associated with creeks have the potential to support faunal assemblages which are less prevalent in river habitats.

Creek habitats within the study area did not conform to the general description above. Creeks were generally dry, supported very shallow waters in microhabitat channels or contained small isolated pools. Only Mistake Creek and Table Mountain Creek contained large pool habitats capable of supporting aquatic fauna. Due to the lack of water availability in creek habitats during the dry season, these pools are considered particularly important habitat areas. Similar to the river habitats, the creeks within the study area generally contained a sandy/gravel substrate within a uniform river channel. Very little undulation occurred within the river bed and the growth of vegetation within or immediately adjacent to the river bed suggest many of these habitats only contain flowing water during flooding. The width of the creek habitats were generally smaller than that of the rivers (some exceptions, e.g. Pelican Creek), however riparian vegetation was relatively degraded resulting in low overhanging vegetation. In-stream habitat features in the form of fallen logs, undercut banks and detritus was observed in very low abundance. Due to the ephemeral nature of creek habitats within the study area, these habitats are considered to provide low value habitat for aquatic fauna during the dry season. The pool habitats that do occur in the larger creeks are likely to act as a refuge for aquatic species during these periods and provide important population sources from which the ephemeral habitats can be re-colonised during flow conditions.

Photographic examples of these habitats are shown in Plate 10-3 to Plate 10-4.

Riparian vegetation is discussed further in Volume 3, Section 9 of this EIS.

Plate 10-3: Riverine Habitat – Elliot River

Plate 10-4: Riverine Habitat – Bogie River

Plate 10-5: Riverine Habitat – Suttor River

Plate 10-6: Riverine Habitat – Belyando River

Plate 10-7: Riverine Habitat – Splitters Creek

Plate 10-8: Riverine Habitat – Brigalow Creek

Plate 10-9: Riverine Habitat Table Mountain Creek

Plate 10-10: Riverine Habitat – Pelican Creek

10.2.7.4 Habitat Dynamics

As discussed in Section 10.2.2 above, aquatic habitats within the study area are dynamic and vary over a temporal scale in association with catchment climatic conditions.

During periods of high rainfall, river habitats within the Burdekin Catchment primarily exists as deep fast-flowing channels in which many of the in-stream aquatic microhabitats (e.g. pools) are inundated as a result of a significant increase in water depth and velocity. Creek habitats also experience increased water depths and flows and for many of the ephemeral creeks, this period represents the only inundation of these habitats. Palustrine habitats may also be inundated during flooding events as river levels rise above bank height. This periodic flooding is important to recharge water levels, provide flushing and allow for biological connectivity with the main stream. As water levels recede, some of the river and creek channels are transformed into a series of pool-run sequences and the palustrine habitats again become separated from the main river channel. As the dry season continues, many of the aquatic habitats dry out and much of the system exists as a series of small isolated non-flowing pools. These isolated pools act as refugia for aquatic fauna during the dry season, however, they are often highly competitive systems with limited foraging resources and often exhibit reduced water quality conditions. Many of the river and creek habitats within the study area do not contain suitable channel conditions to support pool habitats and as a result these habitats completely dry out when flows cease.

10.2.8 Water Quality

Water quality results from each site were compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) National Water Quality Guidelines (ANZECC/ARMCANZ, 2000) and the Queensland Water Quality Guideline (QWQG) (DERM, 2009a).

Water quality of the Burdekin Catchment is summarised in Section 10.2.2 above. Presented below is a summary of the results obtained at field survey sites.

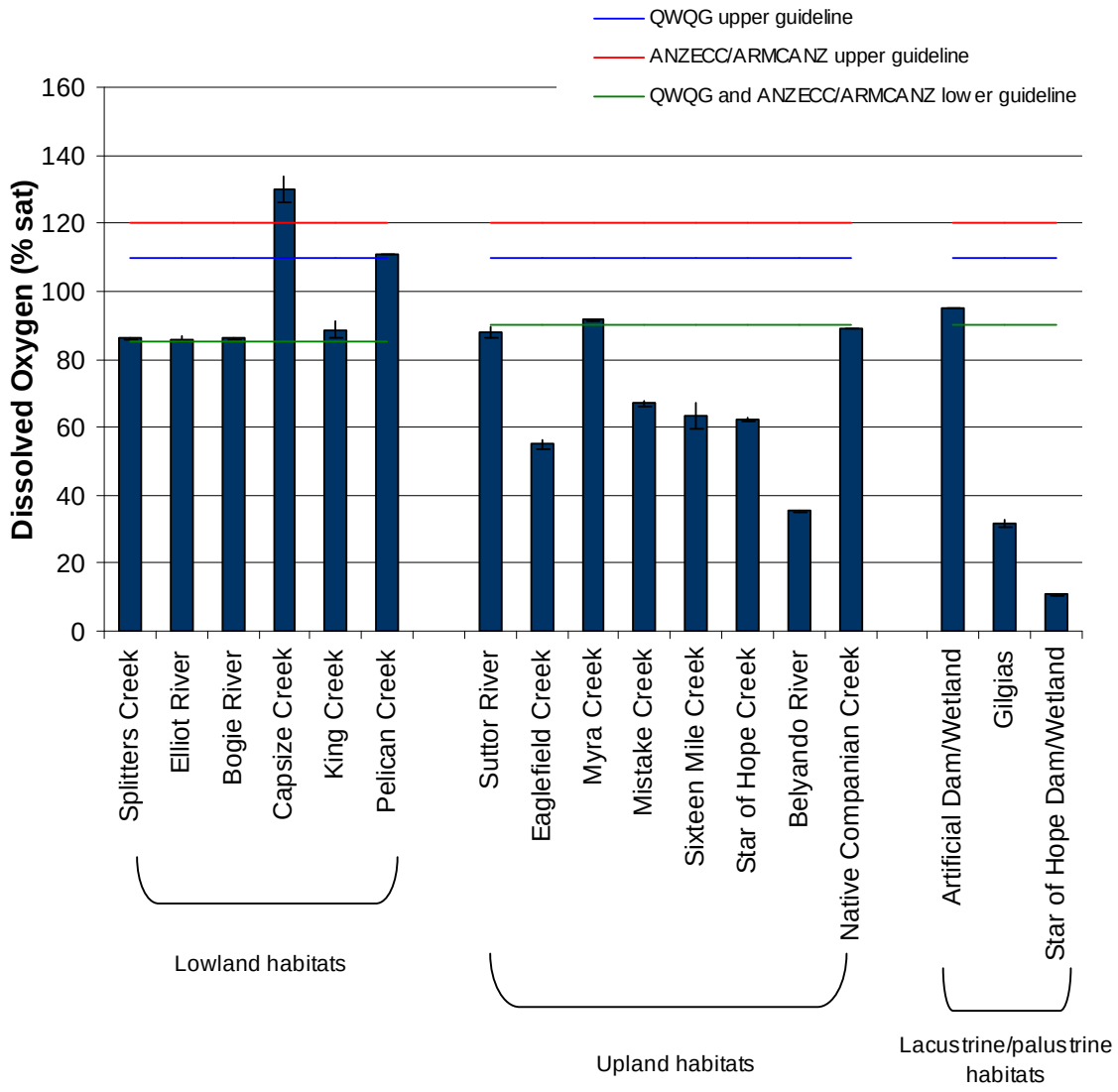
10.2.8.1 Dissolved Oxygen

Dissolved oxygen levels within the study area ranged from a mean (± standard error) of 10.89 ± 0.28% in the Star of Hope Dam/Wetland to 130.01 ± 4.03% in Capsize Creek (refer to Figure 10-3). The dissolved oxygen levels of the upland habitats were generally lower than those of the lowland habitats with the exception of Suttor River and Myra Creek.

With the exception of two sites (Myra Creek and Artificial Dam/Wetland) all were below guideline values for upland and palustrine/lacustrine habitats. Two of the three lacustrine and palustrine habitats (i.e. Gilgais and Star of Hope Dam/Wetland) were substantially below the water quality guidelines for these habitat types (QWQG and ANZECC/ARMCANZ lower: 90%; QWQG upper:110%; ANZECC/ARMCANZ upper -120%).

All lowland habitats were within guideline values except one (Capsize Creek) which was above.

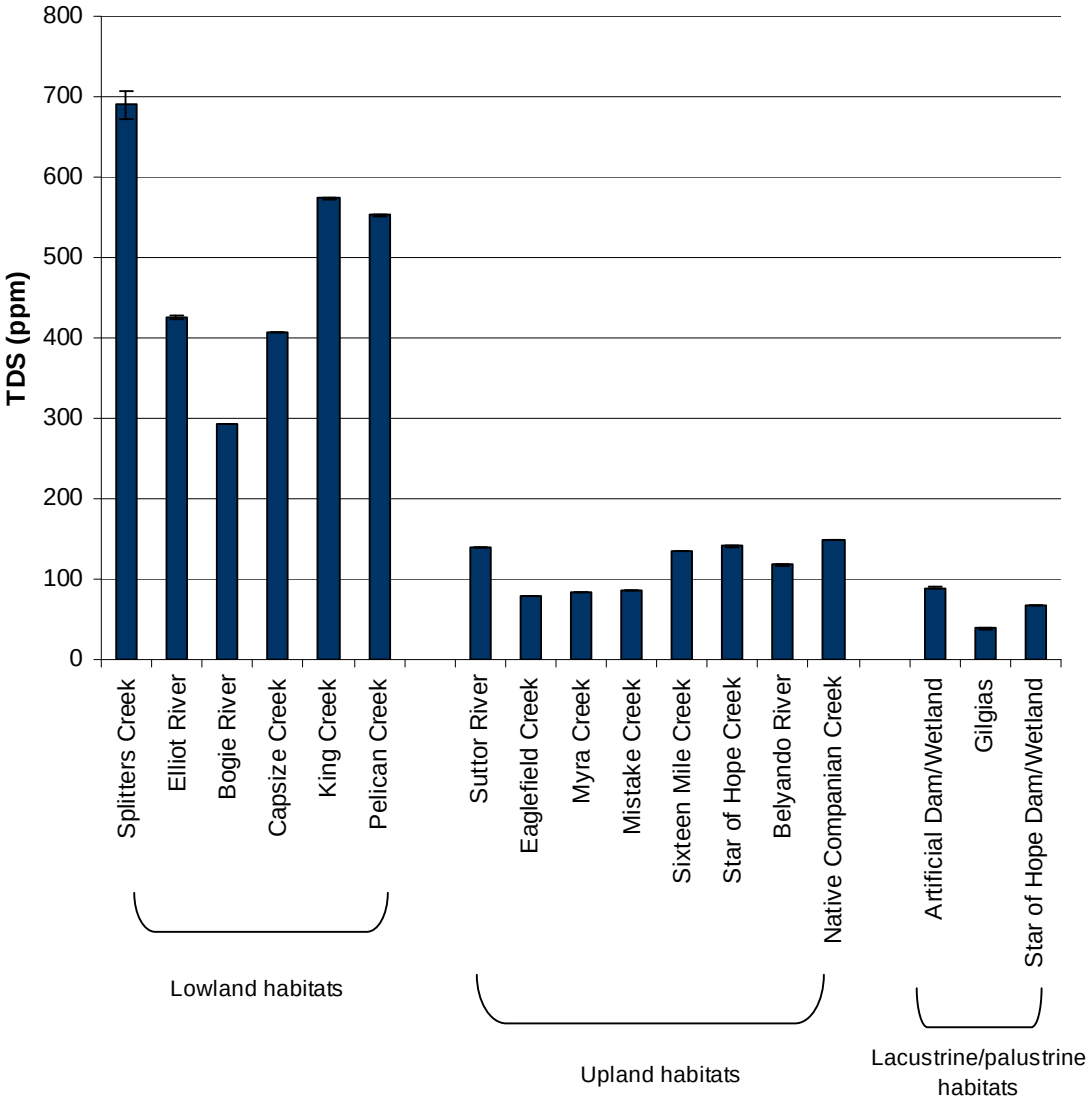
Figure 10-3: Percentage of dissolved oxygen levels of aquatic habitats in the Project area



10.2.8.2 Total Dissolved Solutes

Mean (± standard error) total dissolved solutes (TDS) in aquatic habitats within the study area varied between habitat types (refer to Figure 10-4). Lowland habitats recorded the highest levels of TDS and ranged from a low of 293.30 ± 0.45 parts per million (ppm) in the Bogie River to a high of 690.30 ± 17.42 ppm in Splitters Creek. Total dissolved solute concentrations were substantially lower in the upland and lacustrine/palustrine habitats. Values in these habitats ranged from 38.81 ± 1.25 ppm in the gilgais to 148.50± 0.17 ppm in Native Companion Creek.

Figure 10-4: Total dissolved solids (parts per million) of aquatic habitats in the Project area

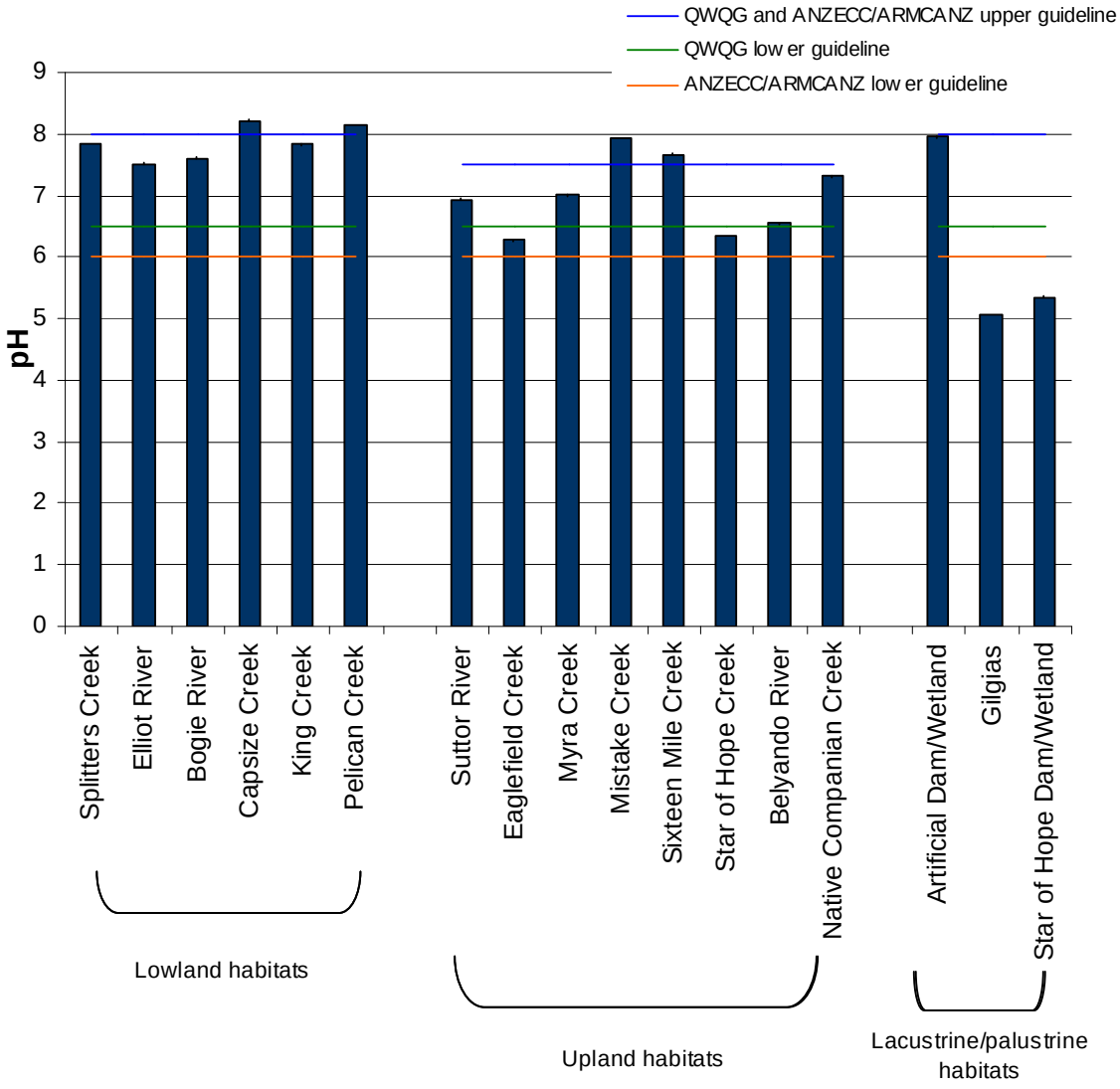


10.2.8.3 Acidity Levels

The pH of aquatic habitats within the study area ranged from a mean (± standard error) of 5.065 ± 0.010 in the gilgais to 8.218 ± 0.010 in Capsize Creek (refer to Figure 10-5). Overall pH was relatively stable between habitats, particularly the lowland habitats in which pH across all six habitats varied by a maximum of 0.627. The pH of the lowland habitats were all within the QWQG and ANZECC/ARMCANZ water quality guidelines except for Capsize and Pelican Creeks which were both above the upper guidelines values. The pH of the upland habitats was generally lower than that of the lowland habitats. Upland habitats recorded pH values below the QWQG lower guidelines in Eaglefield Creek and Star of Hope Creek and above the QWQG and ANZECC/ARMCANZ upper guidelines in Mistake Creek and Sixteen Mile Creek. The pH values of the gilgais and Star of Hope Dam/Wetland habitats were substantially lower than all other aquatic habitats and were much lower than both the

lower QWQG and ANZECC/ARMCANZ guidelines for these habitats types (i.e. QWQG lower: 6.5; ANZECC/ARMCANZ lower: 6; QWQG and ANZECC/ARMCANZ upper: 8).

Figure 10-5: pH of aquatic habitats in the Project area



10.2.8.4 Temperature

Mean temperature (± standard error) within the study area ranged from a low of 17.61 ± 0.03°C in Splitters Creek, to a high of 32.08 ± 0.02°C. Due to the low water depths within the majority of aquatic habitats surveyed, air temperature had a significant influence on water temperature measures.

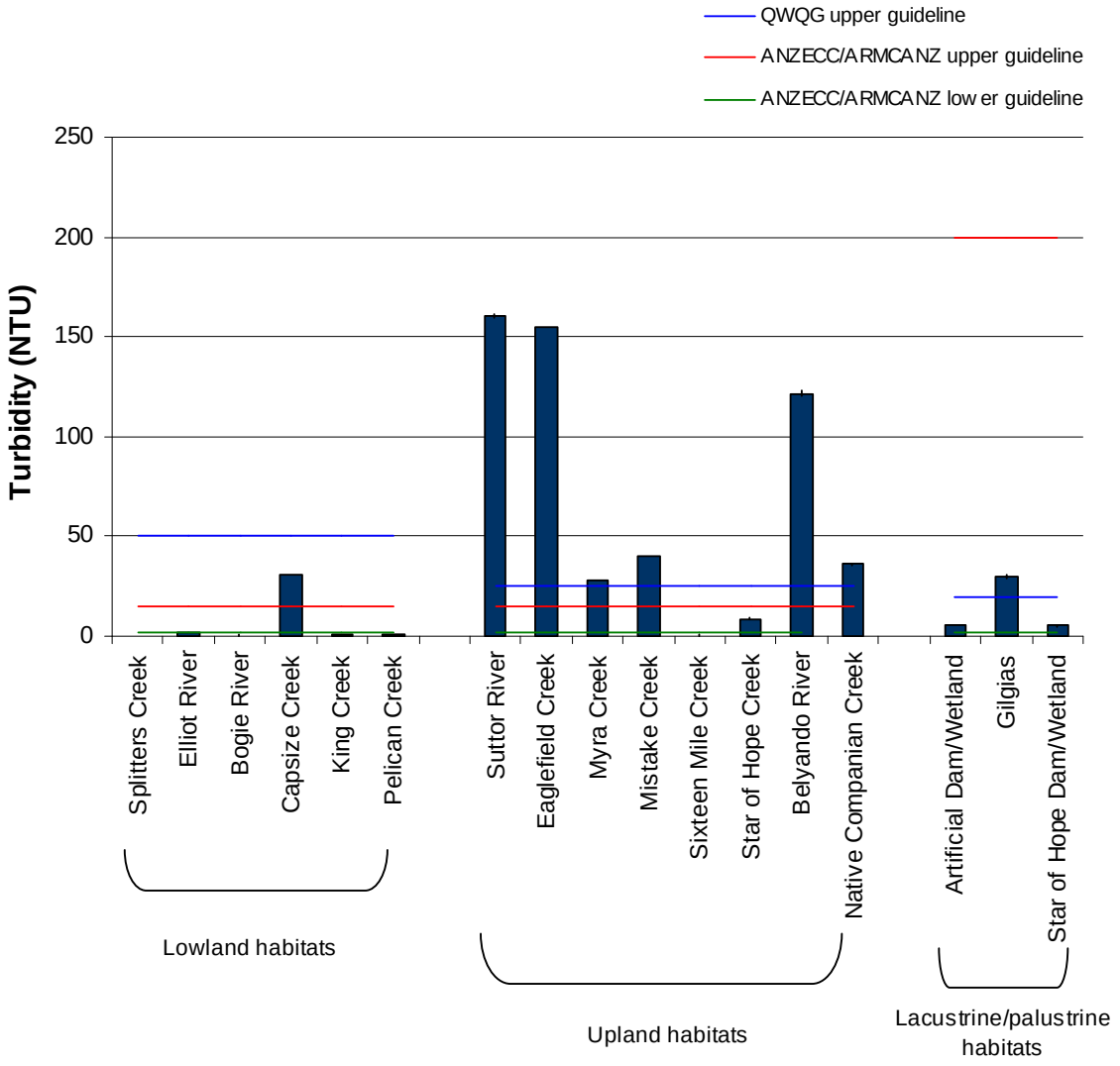
10.2.8.5 Turbidity

Turbidity values within the study areas varied substantially between lowland, upland and lacustrine/palustrine habitats (refer to Figure 10-6). Turbidity within the lowland habitats was generally low and below QWQG and ANZECC/ARMCANZ upper water quality guidelines which are 50 NTU and

15 NTU, respectively. The one exception was Capsize Creek which recorded a turbidity value of 30.88 ± 0.27 NTU. This value was above the ANZECC/ARMCANZ guideline but within the QWQG values.

Turbidity within the upland habitats at most sites was substantially higher than lowland and lacustrine/palustrine habitats. Sixteen Mile Creek and Start of Hope Creek were the only upland habitats that recorded turbidity levels below the QWQG and ANZECC/ARMCANZ upper guidelines (QWQG: 25 NTU; ANZECC/ARMCANZ: 15 NTU). Turbidity was particularly high in the Suttor River, Eaglefield Creek and Belyando River. Two of three lacustrine and palustrine habitats within the study area recorded turbidity levels below QWQG and ANZECC guidelines (QWQG: 1-20 NTU; ANZECC: 2-200 NTU). Turbidity within the gilgais was 29.7 ± 0.65 NTU. This value is above the QWQG guidelines but substantially below the ANZECC value of 200 NTU

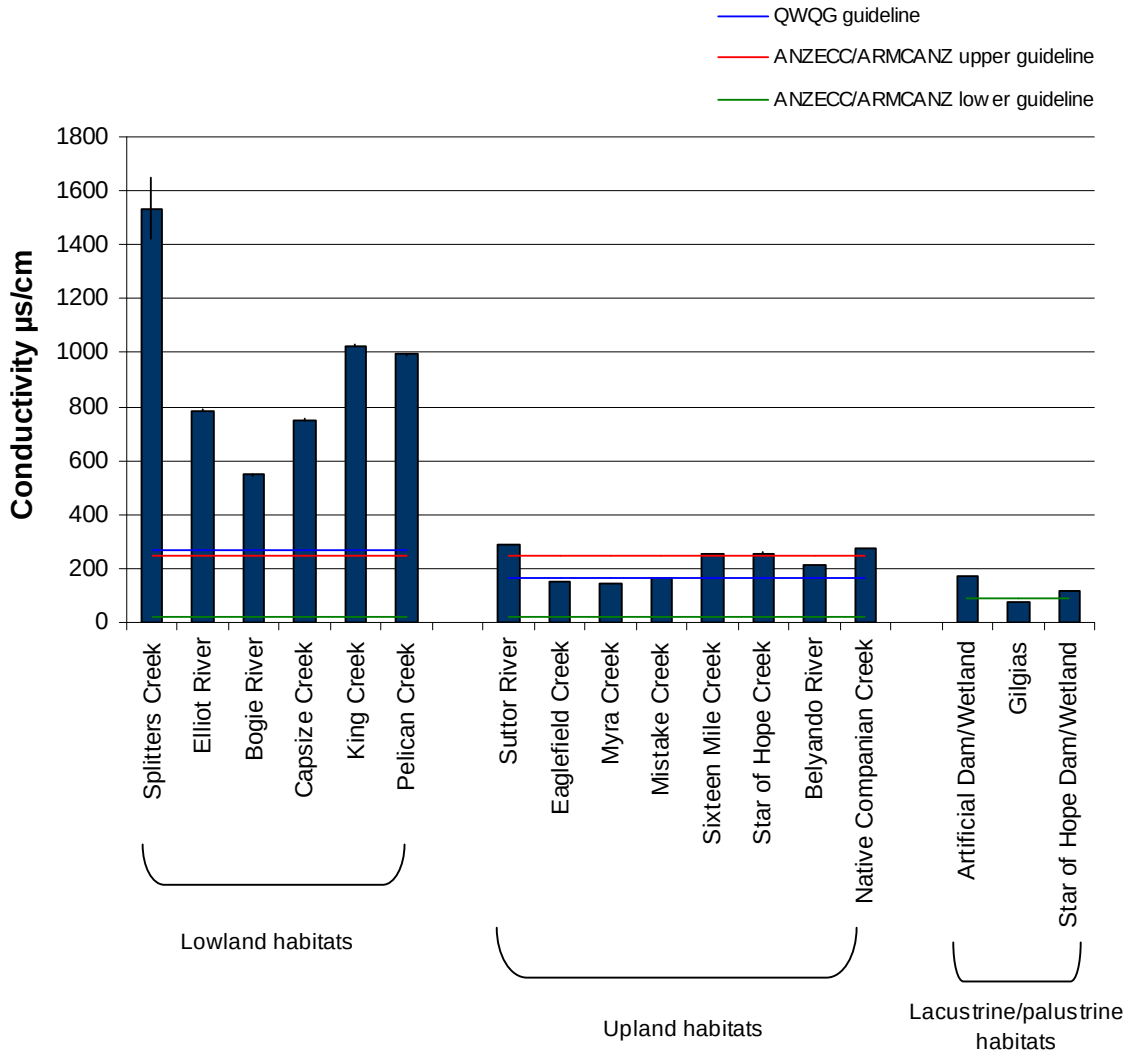
Figure 10-6: Turbidity (NTU) of aquatic habitats in the Project area



10.2.8.6 Conductivity

Conductivity of aquatic habitats within the study area was substantially higher in the lowland habitats than that recorded in the upland and lacustrine/palustrine habitats (refer to Figure 10-7). Conductivity within the lowland habitats ranged from 546.2 ± 0.6 µs/cm in the Bogie River to 1535 ± 114 µs/cm in Splitters Creek. These values are all above the QWQG guideline value for the Burdekin-Bowen (i.e. 271 µs/cm) and the ANZECC/ARMCANZ upper guideline value (i.e. 250 µs/cm). Conductivity within the upland habitats was lower and generally less variable than those in the lowland habitats, however, only three and four of the eight sites were below the QWQG guideline values for the Belyando-Suttor Rivers (i.e. 168 µs/cm) and ANZECC/ARMCANZ upper guideline value (i.e. 250 µs/cm), respectively. Conductivity of the lacustrine/palustrine habitats was generally similar to or slightly lower than that of the upland habitats. The gilgais had the lowest conductivity with a measure of 75.7 ± 0.1 µs/cm. This value was below the ANZECC/ARMCANZ lower guideline value for wetland habitats (i.e. 90 µs/cm) (no upper guideline defined).

Figure 10-7: Conductivity (µs/cm) of aquatic habitats in the Project area



10.2.9 Aquatic Fauna Species

Desktop assessment and field surveys assessed the aquatic ecology values for fish and aquatic reptiles, mammals and macroinvertebrates. Amphibians and waterbirds are further discussed in Volume 6, Appendix F1.

10.2.9.1 Fish

A total of 55 fish species have been previously recorded or are predicted to occur within the study area. These species include two endemic species, the soft-spined catfish (*Neosilurus mollespiculum*) and the small-headed grunter (*Scortum parviceps*); one translocated native species, the golden perch (*Macquaria ambigua*); and four introduced exotic species, Mozambique tilapia (*Oreochromis mossambicus*), spotted tilapia (*Tilapia mariae*), guppy (*Poecilia reticulata*) and mosquitofish (*Gambusia holbrooki*). No listed-threatened species have been previously recorded or are predicted to occur in the study area.

Two additional native species (eel-tailed catfish (*Tandanus tandanus*) and swamp eel (*Ophisternon bengalense*)) and 14 introduced exotic species are known to occur within the broader Burdekin Catchment. These species have a relatively restricted range within the catchment and are not known to occur within the study area.

Fish community structure within the Burdekin Catchment is comprised of diadromous, potamodromous and marine vagrant species. Diadromous fish species migrate between the marine and freshwater environment while potamodromous species migrate wholly within freshwater. Marine vagrant species are primarily marine fish species that occasionally inhabit estuarine and freshwater habitats (Carter and Tait, 2008).

Diadromous fish species can be distinguished between those that live in freshwater and migrate to the marine environment to breed (catadromous species); those that live in the marine environment and migrate to the freshwater to breed (anadromous) and those that migrate between the marine and freshwater environment but not for the purpose of breeding (amphidromous). The community composition of diadromous fish species in the Burdekin Catchment includes six catadromous, one anadromous and seven amphidromous species.

The distribution of diadromous fish species within the Burdekin Catchment is directly influenced by both natural and artificial barriers to fish passage (Pusey *et al*., 1998). The Burdekin Gorge and Falls in the lower Burdekin Catchment is a natural barrier that prevents the colonisation of upstream habitats by diadromous species. Artificial impoundments such as Clare Weir have also effected the distribution of these species. As a result of these barriers, diadromous fish species are primarily restricted to the lower Burdekin Catchment resulting in low fish diversity in the upper reaches (Pusey *et al*., 1998). Within the study area, diadromous fish species are predicted to occur in the aquatic habitats north of Bowen River (e.g. Pelican Creek; Bogie River; Elliot River).

Overall the Burdekin Catchment supports a low diversity of aquatic habitats and microhabitats with the system primarily characterised by open shallow water with a sandy/gravel substrate and little in-stream debris or macrophytes (as observed in this study; Pusey *et al*., 1998). This environment provides habitat for generalist species but supports few resources for specialist species resulting in low species richness. The degradation of aquatic habitats as a result of land use practices (refer to Section 10.2.2 above and 10.2.3 above) has further reduced the availability of habitat resources for fish species throughout the catchment.

A total of 14 marine vagrant species are predicted to occur within the estuarine and lower freshwater reaches in the lower Burdekin Catchment. The estuarine wetland at the Caley Valley and adjacent tidal creeks are likely to provide habitat for these species within the study area. Species confirmed within these habitats during the Abbot Point Multi Cargo Facility EIS (GHD, 2010) included barramundi (*Lates calcarifer*); crested perch (*Terapon jarbua*), spotted scat (*Scatophagus argus*) and banded scat (*Selenotoca multifasciata*).

Barramundi is a key target of the Queensland East Coast Inshore Fin Fish Fishery (Department of Employment, Economic Development and Innovation (DEEDI), 2009). While commercial fishing does not occur within the study area, the individuals that occur within the Caley Valley Wetland are considered a potential component of the commercial fishery. Other commercially-important species occurring/potentially occurring in the northern section of the proposed alignment (i.e. Caley Valley Wetland) include sea mullet (*Mugil cephalus*), mangrove jack (*Lutjanus argentimaculatus*) and long-finned eel (*Anguilla reinhardtii*). Important recreational species include barramundi, mangrove jack, jungle perch (*Kuhlia rupestris*), golden perch (*Macquaria ambigua*), blue catfish (*Arius graeffei*), black catfish (*Neosiluris ater*), sleepy cod (*Oxyeleotris lineolata*), sooty grunter (*Hephaestus fuliginosus*), oxeye herring (*Megalops cyprinoides*), snub-nosed garfish (*Arrhamphus sclerolepis*), pikey black bream (*Acanthopagrus berda*) and seven-spot archerfish (*Toxotes chatereus*).

The fish species that do occur in the Burdekin Catchment are adapted to the highly dynamic and variable nature of the system and this is represented in the specific foraging, breeding and sheltering preferences of the species. Within the study area, the larger rivers such as the Suttor and Bowen Rivers, which contain turbid waters with a higher abundance of in-stream debris, provide habitat for larger-bodied pelagic (e.g. freshwater longtom (*Strongylura krefftii*), golden perch) and benthic (e.g. Rendahl's catfish (*Porochilus rendahli*)) species. In comparison, the shallow, ephemeral creeks are likely to be primarily inhabited by small species that have a preference for sandy substrates (e.g. western carp gudgeon (*Hypseleotris klunzingeri*), eastern rainbowfish (*Melanotaenia splendida splendida*) and spangled perch (*Leiopotherapon unicolor*)). Juvenile spangled perch were observed in high abundance in these habitats during field surveys (refer to Plate 10-11).

Foraging and breeding of the majority of fish species is associated with in-stream microhabitats in the form of fallen logs, undercut banks, root masses, complex substrates (e.g. cobble) and macrophytes. Lacustrine and palustrine habitats generally contain a relatively high diversity of in-stream microhabitats and as a result provide habitat for a range of species including black catfish and purple-spotted gudgeon (*Mogurnda adspersa*). Off-stream water bodies also provide breeding and nursery habitat for fish species (particularly diadromous species) and the breeding season of a number of species (i.e. barramundi, long-finned eel, oxeye herring and empire gudgeon (*Hypseleotris compressa*)) is known to occur during the wet season when flows within the river are increased and the off-stream water bodies are connected to the river system facilitating access to these microhabitat environments (Reynolds, 1983; Pusey *et. al.,* 2004; Stuart and Berghuis, 1997). Water flows are recognised as one of the most important factors influencing the migration of tropical river fish communities (Baran, 2006; Sheaves *et al.*, 2007).

Plate 10-11: Spangled perch (Leipotherapon unicolor) captured from small isolated pool within Sixteen Mile Creek

10.2.9.2 Reptiles

Aquatic reptiles inhabiting the Burdekin Catchment include two crocodile and five freshwater turtle species.

Crocodile species known to inhabit the Burdekin Catchment include the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*). The estuarine crocodile is listed as 'Marine' and 'Migratory' under the EPBC Act and 'Vulnerable' under the *Nature Conservation Act 1992* (NCA). Overall, estuarine crocodile numbers within the Burdekin Catchment are considered low to very low (DERM, 2002). Potentially suitable habitat for the estuarine crocodile within the study area is likely to be limited to the tidal creeks of Caley Valley Wetland and the large permanent pool habitats in the Bowen and Bogie Rivers.

The freshwater crocodile is listed as 'Marine' under the EPBC Act. In Queensland, this species primarily occurs in the northwest highlands, Gulf of Carpentaria, Einasleigh uplands and the Cape York Peninsula (Wilson, 2009). Small populations also occur on the east coast as a result of translocation and introductions from the pet trade. A small breeding population of freshwater crocodiles has established in the Burdekin Catchment as a result of these introductions (DERM, 2010b).

Freshwater turtle species known to occur within the Burdekin Catchment include Cann's long-necked turtle (*Chelodina canni*), Krefft's turtle (*Emydura macquarii krefftii*), Irwin's turtle (*Elseya irwini*), saw-shelled turtle (*Elseya latisternum*) and snaked-necked turtle (*Chelodina longicollis*). The northern long-necked turtle (*Chelodina rugosa*), has also been reported in the catchment (DERM WetlandInfo) however this record has not been verified. Whilst no turtle species within the Burdekin Catchment are listed under the EPBC Act or NCA, the Irwin's turtle is endemic to the Burdekin Catchment and has been listed as high priority for conservation under the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife.

10.2.9.3 Mammals

The platypus (*Ornithorhynchus anatinus*) is known to occur within the Burdekin Catchment and has been previously recorded in the study area (DERM WildNet). This species is listed as 'Special Least Concern' wildlife under the NCA. 'Special Least Concern' wildlife are those species considered as

having inherent value and potential importance for the maintenance of ecosystem processes. 'Special Least Concern' fauna are also considered a source of genetic information integral to an understanding of the evolution of the Australian biota and a genetic resource of potential benefit to society. These species are also considered culturally significant.

Within the study area, suitable habitat for the platypus is likely to be restricted to permanently inundated water bodies that provide habitat throughout the year (e.g. Bowen River, Suttor River). The spatial utilisation of habitat within these water bodies is expected to be restricted to reaches that support necessary resources for burrowing (i.e. earthen banks consolidated by the roots of riparian vegetation, overhanging vegetation, undercut banks (Grant and Temple-Smith, 1998)). Clearing of riparian vegetation and degradation of banks from cattle have reduced platypus habitat suitability in many areas within the study area. Ephemeral rivers and creeks located adjacent to platypus habitat may provide additional foraging resources during the wet season.

10.2.9.4 Macroinvertebrates

Macroinvertebrate diversity and community composition within the Burdekin Catchment is characteristic of river systems with highly variable and unpredictable environmental conditions (PB, 2009). Within these systems, macroinvertebrate diversity is relatively low and communities are dominated by generalist species with few pollution sensitive taxa.

A total of 57 macroinvertebrate taxa were recorded in the lower Burdekin Catchment during Water for Bowen EIS surveys (PB, 2009). Dominant taxa included mayfly nymphs (*Tasmanocoenis sp*), midge larvae (subfamily Chironominae), diving beetles (family Dytiscidae) and freshwater shrimps (family Atyidae). A number of these macroinvertebrates families were found to be widespread and abundant throughout the survey area (PB, 2009). Macroinvertebrate abundance has also been reported to be high in the Burdekin River (Pearson, 1991).

Macroinvertebrate diversity within the upper Burdekin Catchment is relatively unknown, however, predictions may be made based on analysis of similar habitats in the upper Fitzroy Catchment. A study by Duivenvoorden *et al*. (1996) at 11 sites in the Fitzroy Catchment recorded approximately 50 macroinvertebrate families. Dominate taxa included Coleoptera, Diptera, Ephemeroptera, Hemiptera, Odonata, Trichoptera, Bivalvia, Gastropoda, Decapoda and Isopoda.

The Queensland Museum crustacean database identified a total of 41 crustacean species within the Burdekin Catchment. These taxa are dominated by marine and estuarine species with only four species of freshwater crustaceans recorded.

Macroinvertebrate families opportunistically observed during the field assessments include Bivalvia (e.g. freshwater mussels (refer to Plate 10-12)), Coleoptera (e.g. diving beetles), Gastropoda (e.g. snails) and Decapoda (e.g. crabs and prawns (refer to Plate 10-13). Freshwater crabs were the most abundant macroinvertebrate observed within the study area, with relatively large numbers of deceased individuals recorded in dried water bodies (refer to Plate 10-14). Burrows (refer to Plate 10-15) were also abundant along the margins of isolated pools.

Plate 10-12: Freshwater muscle (family Hyriidae) observed at the margin of an artificial dam

Plate 10-13: Freshwater prawn (Macrobrachium sp) observed in Splitters Creek

Plate 10-14: Deceased freshwater crabs observed in a dried gilgai

Plate 10-15: Burrows adjacent to an isolated pool in the Belyando River

10.2.10 Aquatic Flora Species

A total of 55 native aquatic dependent flora species[4] are known to occur within the Burdekin Catchment (Inglis and Howell, 2009). Nine of these species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The priority species include *Ceratopteris thalictroides*, *Eucalyptus coolabah*, *Eucalyptus tereticornis*, *Hydrilla verticillata*, *Hymenachne acutigluma*, *Leersia hexandra*, *Lomandra hystrix*, *Melaleuca leucadendra* and *Vallisneria nana*. All species are listed as 'Least Concern' under the NCA.

The diversity and abundance of macrophytes within the study area was relatively low during field assessments. The majority of the riverine habitats assessed supported little (1-10%) to no macrophytes species. Macrophytes present were generally emergent species from the family Cyperaceae and in particular the genus *Cyperus*. Other species observed included *Persicaria attenuata* (refer to Plate 10-16) and *Typha* spp. (refer to Plate 10-17). Typical of habitats that

[4] Aquatic dependent flora are those species that are adapted to and dependent on living in wet conditions for at least part of their life cycle and found wither within or immediately adjoining a non-riverine or riverine wetland (DERM, 2009).

experience pulses of high flow events followed by extended dry periods, the riverine habitats within the study area supported very few submerged and no floating macrophyte species. The lacustrine and palustrine habitats (i.e. gilgais, Artificial Dam/Wetland and Start of Hope Wetland) supported the highest diversity and abundance of macrophytes (moderate to extensive). Emergent, submerged and floating macrophyte species were all evident in these habitats. Dominant macrophyte species observed included native waterlily (*Nymphaea violacea*) (refer to Plate 10-18), water snowflake (*Nymphoides indica*), water primrose (*Ludwigia peploides* ssp. montevidensis), onagraceae (*Ludwigia peruviana*), monochoria (*Monochoria cyanea*) and caldesia (*Caldesia oligococca*).

Riverine habitats within the study area generally supported little (1-10%) algae in the water column and on the substrate. Algae most commonly occurred in the margins of drying pools (refer to Plate 10-19) and habitats with moderate to extreme cattle degradation (e.g. Capsize Creek) evidence from hoof prints in and around water bodies. The lacustrine and palustrine habitats supported the highest diversity and abundance of algae (i.e. moderate rating) in the study area.

Plate 10-16: Persicaria attenuata observed at Star of Hope Wetland

Plate 10-17: Typha sp observed at Table Mountain Creek

Plate 10-18: Native waterlily (Nymphaea violacea) observed in the Artificial Dam/Wetland habitat

Plate 10-19: Algae recorded at the margin of a stagnant pool

A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment. Cabomba (*Cabomba caroliniana*), hymenachne (*Hymenachne amplexicaulis*) and salvinia (*Salvinia molesta*) are listed as Weeds of National Significance (WONS). Siam weed (*Chromolaena odorata*) is listed as a Class 1 pest plant under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Eight of the aquatic dependent species are listed as Class 2 pest plants while two species are listed as Class 3 pest plants. Only rubber vine (*Cryptostegia grandiflora*) was observed in the study area.

10.2.10.1 Marine Plants

A marine plant is defined in Section 8 of the *Fisheries Act 1994* as a plant that usually grows on or adjacent to tidal land, whether is it is living or dead, or material of that plant, or a plant prescribed to be a marine plant. Marine plants are located in the estuarine habitats of the Caley Valley Wetland. Species present include salt couch (*Sporobolus virginicus*), which is present in narrow fringing meadows in low lying overflow areas beside the tidal creeks and weeping paperbark (*Melaleuca leucadendra*), which is the main riparian species in this area. No other marine plants were observed although large meadows of *Tecticornia australasica* and *Sarcocornia quinqueflora* are known to occur in this area (Louise Johns, Queensland Primary Industries and Fisheries (DEEDI), pers. comm. 20.05. 10).

Marine plants are discussed in more detail in Volume 3, Section 9 of this EIS.

10.2.11 Summary

The existing aquatic environment within the study area is dominated by riverine habitats with smaller areas of estuarine and lacustrine/palustrine habitats. Riverine habitats are primarily ephemeral and characterised by a uniform channel with a sandy/gravel substrate and little in-stream habitat. Due to their ephemeral nature, low abundance of habitat features and degradation from cattle and weeds, these rivers/creeks generally provide low value habitat for aquatic fauna. Riverine habitats that do provide important fauna values are primarily restricted to those that contain permanent pool habitats (e.g. Suttor River, Table Mountain Creek and Mistake Creek). These habitats act as refuge habitats for aquatic species during the dry season and provide important population sources from which the ephemeral habitats can be re-colonised during flow conditions. Of particular habitat importance is the nationally important Bowen River: Birralee - Pelican Creek Aggregation. This river contains a range of unique aquatic habitats that are unavailable in other habitats within the study area.

Estuarine habitats within the study area include mangrove and saltwater wetlands and adjacent tidal creeks. These habitats are located within the nationally important Caley Valley Wetland, at the northern end of the proposed rail alignment. Although only covering a small area of the study area, this habitat provides important spawning, breeding and nursery habitats for many fish species and is particularly important habitat for waterfowl and shorebirds.

Lacustrine and palustrine habitats are scattered throughout the Project footprint and include the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation (located approximately 3.5 km from the Project alignment). These habitats support a high diversity and abundance of in-stream debris and macrophytes species and are known to provide important breeding habitat for many fish species.

Overall aquatic habitats within the study area are dynamic and vary over a temporal scale in association with local and catchment climatic conditions. During periods of high water flow, water

quality is relatively constant throughout the river and the main influences on water quality are associated with sedimentation and the input of nutrients. Water quality during no/low flow conditions is highly variable on a temporal and spatial scale and is largely influenced by local land use. The loss of riparian vegetation as a result of cattle grazing has had a direct impact on water quality as a result of increased channel and bank erosion, increased weed infestation and increased input of nutrients.

Aquatic habitats within the study area provide habitat for a range of generalist fauna and flora species. No listed-threatened species have been previously recorded or are predicted to occur in the study area. The distribution of fish species throughout the study area is primarily influence by the Burdekin Gorge and Falls in the lower Burdekin Catchment.

Aquatic reptiles inhabiting the Burdekin Catchment include two crocodile and five freshwater turtle species. Crocodile species known to inhabit the Burdekin Catchment include the estuarine crocodile) and freshwater crocodile. The estuarine crocodile is listed as 'Marine' and 'Migratory' under the EPBC Act and 'Vulnerable' under the NCA. Potentially suitable habitat for the estuarine crocodile within the study area is likely to be limited to the tidal creeks of Caley Valley Wetland and the large permanent pool habitats in the Bowen and Bogie Rivers and potentially the Elliot River. The freshwater crocodile is listed as 'Marine' under the EPBC Act. Whilst no turtle species within the Burdekin Catchment are listed under the EPBC Act or NCA, the Irwin's turtle is endemic to the Burdekin Catchment and has been listed as high priority for conservation under the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife. This species prefers sandy riverine habitats with an abundance of macrophytes and in-stream debris. Although suitable habitat was identified during the field surveys, the overall low abundance of macrophytes observed suggests that in general the study area provides lower quality habitat for the species.

The platypus (*Ornithorhynchus anatinus*) is listed as 'Special Least Concern' wildlife under the NCA. Within the study area, suitable habitat for the platypus is likely to be restricted to permanently inundated water bodies that provide habitat throughout the year (e.g. Bowen River; Suttor River).

Macroinvertebrate diversity and community composition within the Burdekin Catchment is characteristic of river systems with highly variable and unpredictable environmental condition. Within these systems, macroinvertebrate diversity is relatively low and communities are dominated by generalist species with few pollution sensitive taxa.

A total of 55 native aquatic dependent flora species are known to occur within the Burdekin Catchment and nine of these species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The majority of the riverine habitats observed within the study area supported little (1-10%) to no macrophytes species. Marine plants, protected under the *Fisheries Act 1994*, are located in the estuarine habitats of the Caley Valley Wetland. Species present include salt couch (*Sporobolus virginicus*) and weeping paperbark (*Melaleuca leucadendra*).

A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment and ten of these are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Only rubber vine (*Cryptostegia grandiflora*) was observed in the study area. Similarly, four introduced exotic fish species have been previously recorded or predicted to occur in the study area. An additional 14 introduced exotic fish species are known to occur within the broader Burdekin Catchment though these species have a relatively restricted range within the catchment and are not known to occur within the study area.

10.3 Potential Impacts and Mitigation Measures

10.3.1 Overview

The study area supports a variety of aquatic environmental values ranging from low value habitats and generalist species to high value nationally important wetlands and conservation significant species. The Project has the potential to impact these aquatic environmental values as a result of construction and operational activities. The identification of these potential impacts and the development of targeted mitigation measures aim to reduced the risk of the Project to aquatic environmental values. An impact and risk assessment was undertaken to assess the risk of the Project on the aquatic environmental values. The potential impacts and mitigation measures are summarised in the following sections with further detail provided in Volume 6, Appendix F1 of this EIS.

10.3.2 Construction Phase

10.3.2.1 Overview

Activities associated with the proposed construction of the Project corridor have the potential to cause a number of direct and indirect impacts to aquatic environmental values. These activities include:

- removal of riparian vegetation at aquatic habitat crossings;
- construction within the bed and banks[5];
- movement of vehicles and plant to, from and around the construction site; and
- flow diversion and control.

A Project Construction Environmental Management Plan (CEMP) will be developed and implemented to include measures relevant to minimizing the impact to the aquatic ecosystems within and adjacent to the footprint.

10.3.2.2 Potential Impact – Loss of Aquatic Habitat

The majority of habitats have a relatively low environmental value however those that contain permanent water bodies are considered locally important. The most significant aquatic habitats within the study area are the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation. Clearance of vegetation and works within the bed and banks will result in the loss of aquatic habitats within the Project footprint.

10.3.2.2.1 Estuarine Habitat

The proposed alignment of the rail loop at the Port of Abbot Point will cross estuarine habitat within the Caley Valley Wetland. The rail corridor will be primarily constructed on an embankment with two sections of elevated structures located to maintain wetland flows. At this location the rail loop footprint currently intersects <1 ha of estuarine habitat however the actual area of lost habitat will be reduced somewhat with the installation of the elevated structures. The loss of estuarine habitat at the locations of the elevated structures will be limited to the small areas of the pylon footings. A small amount of additional estuarine habitat may also be temporary lost and/or damaged during the construction

[5] For the purpose of this impact assessment, construction within the bed and banks refers to construction activities within all aquatic habitats including lacustrine and palustrine habitats.

process. Mitigation measures managed through the CEMP such as minimising clearing outside the footprint and clearly identifying areas to be cleared on construction plan will assist in minimising this loss. Following construction these temporary areas will be re-instated.

10.3.2.2.2 Riverine Habitat

Riverine habitats (i.e. creeks and rivers) are the dominant aquatic habitat type within the Project footprint. These habitats are relatively uniform and support a low abundance and diversity of in-streams habitats. The majority of habitats are ephemeral and dry out completely during the dry season. The larger habitats such as the Suttor River, Mistake Creek and Table Mountain Creek, which contain permanent water bodies, provide locally important dry season refuge habitats for many aquatic species.

The extent of aquatic habitat loss at each riverine habitat within the Project footprint is dependent upon the crossing infrastructure incorporated into the design. The design criteria for crossing infrastructure is defined in Volume 3, Section 11 of this EIS. It defines flows that will require bridge crossings and those that will require either major or minor culverts. The direct loss of aquatic habitat at bridge crossing locations will generally be limited to a small area of riparian habitat for the rail footprint and small area of in-stream habitats and at the locations of the pylons. At these crossing the infrastructure will be rail only, i.e. no road crossings. Additional habitat may be temporarily lost/damaged during the construction process however this impact will be restricted to the minimal amount necessary and habitat features (e.g. channel morphology etc) will be restored at the completion of construction. The loss of riparian and in-stream habitat at these locations will result in the permanent loss of aquatic fauna foraging and sheltering habitat though the impact will be localised and is not considered to impact upon species diversity and abundance outside the Project footprint.

Major and minor culverts are proposed for the remainder of the riverine habitat crossings within the Project footprint. Project construction at these locations will result in the loss of all riparian and in-stream habitat within the corridor. The riverine habitats defined to require culvert crossings are considered to be primarily ephemeral, and the overall value of these habitats for aquatic flora and fauna is relatively low compared to permanently inundated habitats. The ecological consequence of this habitat loss will increase where culvert crossings result in the loss of permanent pool habitat. Permanent pool habitat is considered locally important habitat for flora and fauna species and is relatively limited throughout the study area. The ecological consequence of permanent pool habitat loss may include a local reduction in species abundance and diversity within the immediate area. Loss of permanent pool habitat could potentially occur at a small number of crossings (e.g. Mistake Creek) depending upon the location of the final alignment.

The proposed alignment will cross the Bowen River approximately 15 km upstream of the nationally important Bowen River: Birralee - Pelican Creek Aggregation. No loss of this habitat will occur.

10.3.2.2.3 Lacustrine and Palustrine Habitats

Lacustrine and palustrine habitats are scattered throughout the Project footprint and include the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation (located approximately 3.5 km from the proposed alignment). These habitats support a high diversity and abundance of macrophytes species and are known to provide important breeding habitat for many fish species. As discussed above, construction of the Port Loop will transverse the Caley Valley Wetland and will consist of a rail embankment with two sections of elevated structures located to

maintain wetland flows. This rail loop footprint currently intersects 13.5 ha of palustrine habitat however the actual area of lost habitat may be smaller than this with the installation of the elevated structures sections. At these sections the loss habitat will be limited to the small areas of the pylon footings. The CEMP will incorporate measures to avoid unnecessary disturbance to stream bed as well as incorporate a Rehabilitation Plan that includes both riparian and in-stream habitat re-instatement (for example bank revegetation and channel morphology re-instatement) upon completion.

Loss of lacustrine and palustrine habitat will also occur throughout the Project footprint. Given these habitats provide unique resources that are not available within the main riverine habitats, localised impacts to aquatic flora and fauna species would be expected to occur where habitats are lost. The ecological significance of these impacts will be dependent upon the total area of habitat to be lost and the availability of similar habitat within the immediate area. By minimising the crossing of these habitats during the design phase, the total loss of lacustrine and palustrine habitat will be minimised.

The proposed alignment will not result in the loss of lacustrine and palustrine habitat within the nationally important Bowen River: Birralee - Pelican Creek Aggregation.

10.3.2.3 Mitigation Measures

Construction activities will result in the relatively small loss of aquatic habitat within the Project footprint, including <1 ha of estuarine habitat and approximately 13.5 ha of palustrine habitat located within the Caley Valley Wetland. This loss of habitat has the potential to result in a significant ecological consequence as a result of reduced availability in foraging and breeding habitat. Mitigation measures proposed include:

- minimising the loss of aquatic habitat in the design phase by locating the rail corridor in areas that have been previously cleared or degraded by past land use practices;
- minimising the loss of remnant *Acacia harpophylla* (brigalow) forest and woodland which support unique gilgais habitat;
- minimising the loss of nationally important Caley Valley Wetland habitat;
- bridging aquatic habitats as per the design criteria defined in Volume 3, Section 11 of this EIS;
- clearly identifying the extent of vegetation clearing and earthworks on construction plans and in the field. The extent of construction is to be restricted to the minimal amount necessary in all aquatic habitat locations;
- locating any additional construction areas and construction sites, such as site offices, soil stockpiles, machinery/equipment storages and construction camps within existing cleared areas and away from aquatic habitats; and
- when unavoidable clearing of marine plants occurs in the estuarine habitat, offsets will be required. Note: the exact amount of certain vegetation types to be cleared is yet to be confirmed but will be required for the Project .

10.3.2.4 Potential Impact – Fauna Mortality

Aquatic fauna occurring within the study area includes three endemic species and two conservation significant species. Construction of the rail corridor may result in the direct mortality of these species if individuals are present when riparian vegetation is cleared and when construction works occur within

the bed and banks. Construction within isolated pool habitats is likely to have the highest risk of fauna mortality due to the relatively high abundance of fauna species within these habitats and the inability of individuals to move away from the area. Fauna mortality as a result of construction activities has the potential to cause a significant reduction in fauna species abundance within the local area.

Semi-aquatic fauna species such as long-necked turtles (i.e. Cann's long-necked turtle (*Chelodina canni*) and snaked-necked turtle (*Chelodina longicollis*)) may also be at risk of fauna mortality. These species are known to undertaken long-distance overland migration in response to habitat degradation and nesting (Cann, 1998) and as such may venture in active construction zones or across access tracks. A temporary increase in vehicular traffic and plant movement to, from and around the construction area has the potential to increase the incidence of turtle roadkill. Mitigation measures such as enforcing on-site speed limits, erecting temporary bunding around construction areas and engaging fauna spotters will reduce the likelihood of this impact.

10.3.2.5 Mitigation Measures

Construction activities have the potential to result in the mortality of aquatic fauna species within the Project footprint. The ecological consequence of this impact may include a reduction in species abundance within the local area, although it is not expected to reduce diversity if managed appropriately. Mitigation measures proposed include:

- restricting construction within aquatic habitats during the wet season where possible. In the dry season the majority of habitats will be dry or supporting fewer fauna species;
- engaging a fauna spotter to be present on site prior to and during all vegetation removal and initial construction within the bed and banks to identify, capture and relocate fauna within the construction area;
- developing an aquatic fauna species relocation plan that describes relocation methodology for aquatic species;
- erecting temporary bunding around aquatic habitats within the construction zone to exclude aquatic fauna;
- educating employees of environmental responsibilities during inductions including treating all native fauna species as protected;
- enforcing on-site speed limits to restrict the incidence of wildlife road kill; and
- developing a fauna mortality register to determine the location, frequency of mortality, and types of species most susceptible, to enable additional mitigation measures to be implemented where necessary.

10.3.2.6 Potential Impact – Alteration to In Stream and Floodplain Hydrology

Construction of the Project corridor within and adjacent to aquatic habitats within the Project footprint may result in the temporary alteration of in-stream and floodplain hydrology. This alteration has the potential to fragment aquatic habitats and restrict fauna movement. Movement of aquatic fauna between breeding, feeding and refuge habitats is considered a crucial life history component of many aquatic fauna species including fish, crocodiles and freshwater turtles (Marsden and Power, 2007; Walsh and Whitehead, 1993; Tucker, 1999). Movement of aquatic fauna species within the Project footprint may include upstream and downstream movement within riverine habitats, lateral movement between riverine and palustrine habitats, tidal movement within estuarine habitats and movement

between freshwater and saltwater environments. Construction of the rail corridor within and adjacent to aquatic habitats has the potential to temporarily restrict movement of aquatic fauna species as a result of physical habitat fragmentation, flow diversion and control, and habitat disturbance. The potential consequences of temporarily restricting fauna movement may include a temporary loss of habitat and resources and disruption of breeding (Marsden and Power, 2007). As the fauna species within the study area are adapted to the highly dynamic and variable nature of the system, movement behaviours, particularly breeding migrations, are associated with flow events. As a result, minimising construction during the wet season where possible will reduce the likelihood of fauna movement restriction. Construction within aquatic habitats during the dry season may however result in fauna species becoming isolated in ephemeral habitats. Maintaining water flows, including trickle flows, via a flow diversion can reduce the likelihood of this impact.

Alteration of in-stream and flood plain hydrology can also result in the degradation of habitats due to a decrease in water quality (Wheeler *et al*., 2005). Specific impacts may include increased sedimentation and reduced oxygen levels. The ecological consequences of reduced water quality are considered significant due to the potential for reduced habitat values and local species abundance (Bunn and Arthington, 2002).

10.3.2.7 Mitigation Measures

Construction activities have the potential to result in the temporary alteration of in-stream and floodplain hydrology. The ecological consequences of this impact may include a temporary loss of habitat and resources, disruption of breeding and reduction in species abundance within the local area. Mitigation measures proposed include:

- restricting construction within aquatic habitats during the wet season where possible. In the dry season movement of fauna, particularly for breeding, is reduced;
- maintaining in-stream flows via a flow diversion system;
- engaging a fauna spotter/catcher to capture and relocate fauna species trapped in isolated habitats that become increasingly degraded as a result of construction activities; and
- maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.

10.3.2.8 Potential Impact – Increased Sedimentation, Run-off and Dust

The water quality of aquatic habitats within the study area is primarily influenced by cattle grazing. Habitats that are particularly influenced by high levels of sedimentation include Pelican Creek, Bowen River and Burdekin River. Construction of the rail corridor within and adjacent to aquatic habitats could result in a further reduction in water quality as a result of point-source pollution from sedimentation, run-off and dust. Sedimentation of aquatic habitats can result in increased turbidity, decreased oxygen levels, reduced light penetration, change in channel morphology and alteration of substrate composition (Wood and Armitage, 1997; Wheeler *et al*., 2005). These impacts may have a localised effect on aquatic flora and fauna by reducing habitat value (e.g. amount of refuges, microhabitats and food availability) within the immediate downstream area. For example, impacts of sedimentation on aquatic flora species may include reduced photosynthesis and primary production, abrasion of leaves and stems, smothering/suffocation and reduced habitat availability (Wood and Armitage, 1997; Wheeler *et al*., 2005). Impacts to aquatic fauna may include decrease in macroinvertebrate, fish and

bimodally respiring turtle respiration, increase in macroinvertebrate drift, reduced suitability of fish spawning habitat and reduced foraging (Wood and Armitage, 1997; Wheeler *et al*., 2005). These impacts are primarily restricted to the construction footprint and will reduce quickly downstream, particularly in low or no flow conditions. In high flows there is a greater likelihood that sediment will be mobilised, however as existing levels of sedimentation are high as a result of grazing related erosion, impacts of additional sedimentation are likely to be reduced.

Construction activities within and adjacent to aquatic habitats may also increase the levels of dust in the environment. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas primarily as a result of reduced water quality. Excessive dust may also influence riparian vegetation by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias, 2007).

Use of construction machinery in and around aquatic habitats also has the potential to result in the introduction of contaminants, such as fuels and lubricants. In severe cases, chemical pollution of the aquatic environment can result in long-term habitat degradation and widespread mortality of species. The development of a Waste and Hazardous Materials Management Plan will substantially reduce the likelihood of chemical contamination with the Project footprint.

Construction of the rail corridor at aquatic habitat crossings will be restricted where possible during the wetter months (especially in more sensitive areas such as the Caley Valley Wetland) and as such impacts of sedimentation, run-off and dust will be minimised and contained within the immediate area. Habitats particularly sensitive to the impacts of sedimentation, run-off and dust will include dry season refuge pools in riverine habitats (e.g. Suttor River) and non-flowing palustrine habitats such as the Caley Valley Wetland. The implementation of an Erosion and Sedimentation Management Control Plan (ESMCP) will further reduce the likelihood of impact in these areas.

10.3.2.9 Mitigation Measures

Construction activities have the potential to result in the degradation of aquatic habitats as a result of sedimentation, run-off and dust. The ecological consequence of this impact may include a reduction in foraging and breeding habitat and potential reduction in species abundance. Mitigation measures proposed include:

- restricting construction within aquatic habitats during the wet season where possible;
- preparing and implementing an Erosion and Sediment Management and Control Plan (refer to Volume 3, Section 5 of this EIS);
- rehabilitating disturbed ground surfaces as soon as is practical to minimise exposed surface periods;
- incorporating dust suppression techniques into construction activities, e.g. tankers spraying down dirt roads;
- appropriately storing and covering/locating soil stockpiles in areas not susceptible to wind erosion or run-off;
- minimising vegetation clearing and the area of bare ground required for construction to only that which is necessary within and adjacent to aquatic habitats;
- maintaining clean operating conditions in vehicles and machines;

- restricting speed limits and other traffic control mechanisms to minimise the generation of dust;
- developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses; and
- maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.

10.3.2.10 Potential Impact – Noise, Light and Vibration Disturbance

Aquatic habitats within the study area support a range of generalist species and a small number of conservation significant species. Construction activities at aquatic habitat crossings are likely to impact these species as a result of a temporary and localised increase in noise, vibration and light disturbance. During the period of construction, there is expected to be constant (i.e. 24 hour) localised disturbance to aquatic fauna behaviours and dynamics (i.e. foraging, breeding and nesting) adjacent to the construction footprint. For example, impacts to fish species as a result of anthropogenic increases in noise level (e.g. pile driving) are known to include disruption to fish behaviour, reduction in hearing, alteration of physiology and injury and mortality (Popper and Hastings, 2009). Increased lighting may subject aquatic fauna to higher levels of predation and may result in excessive algae growth causing blooms.

10.3.2.11 Mitigation Measures

Construction activities have the potential to result in the degradation of aquatic habitats as a result of noise, vibration and light disturbance. The ecological consequence of this impact may include a temporary reduction a habitat and disruption to breeding. These mitigation measures include a range of standard construction techniques that can be implemented to reduce the likelihood of this risk. Mitigation measures proposed include:

- restricting construction within aquatic habitats during the wet season where possible. In the dry season aquatic fauna species diversity and abundance is lowest and fish breeding is reduced. This is particularly relevant for palustrine habitats, such as the Caley Valley Wetland, which provide breeding habitat for commercially and recreationally important fish species;
- limiting lighting to that which is safe for operation and employing directional lighting with protective guards (particularly when adjacent to permanent pools); and
- appropriately servicing and maintaining all plant and equipment to minimise machinery noise where possible.

10.3.2.12 Potential Impact – Increase in Abundance and Diversity of Introduced Species

Vegetation clearing and soil disturbance as a result of Project construction may result in the introduction and spread of introduced flora and fauna species throughout the Project footprint. A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment and ten of these are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Rubber vine (*Cryptostegia grandiflora*) was observed at a number of aquatic habitats during field surveys. This species initially invades aquatic habitats but spreads rapidly into flood plains, pastures and hillsides. Impacts of rubber vine on freshwater ecosystems include chocking of native riparian vegetation and subsequent reduction in species diversity, reduction in in-stream fauna habitat in the form of root mats and branches, increased risk of

soil erosion and increase in introduced fauna species (DNRM, 2004). During construction, weeds can be spread to the environment by machinery and vehicles or on workers clothing. Studies have found that weed species invade areas of spoil ground where road soil or construction waste is stored more readily than undisturbed areas (Dong *et al*., 2008). Weed introduction can also occur through the use of contaminated materials such as construction fill. The introduction and spread of introduced weed species at aquatic habitats has the potential to facilitate further spread of weeds into the wider region through the dispersal of seeds in downstream flows.

Project construction can also facilitate the introduction and spread of introduced fauna species through the creation of movement corridors along cleared rail corridors and associated tracks. Feral pests can impact on flora and fauna diversity by preying on or out competing native populations for resources and degrading habitats. Feral pigs (*Sus scrofa*) can cause substantial degradation of aquatic habitats through the disturbance of soil and increase risk of erosion, destruction of riparian vegetation, degradation of water quality and predation of freshwater turtle eggs (Department of Primary Industries and Fisheries, 2008). Feral pigs are declared a Class 2 pest under the *Land Protection (Pest and Stock Route Management) Act 2002*. Evidence of feral pig disturbance was observed at Pelican Creek during field surveys.

The ecological consequences of an increase in abundance and diversity of introduced weed and pest species can be major with the potential loss of species and/or communities. The development and implementation of a Weed and Pest Management Plan that includes strict control measures will reduce the likelihood of this impact from almost certain to possible.

10.3.2.13 Mitigation Measures

Construction activities have the potential to result in the increase in abundance and diversity of introduced species. The ecological consequence of this impact is considered major due to the potential for species and/or community loss. Mitigation measures proposed include:

- developing a Weed and Pest Management Plan for implementation throughout the construction phase. Management actions will including:
  - providing vehicle wash down stations along the alignment;
  - regularly monitoring declared pest and weed species; and
  - controlling pest and weed species where necessary.
- all construction machinery and materials brought onto site are to be weed, seed and mud free and have undergone a thorough inspection;
- care is to be taken when disturbing soil in known weed infestation locations to limit seed spread to unaffected areas;
- rehabilitating disturbed ground surfaces as soon as is practical; and
- appropriately dispose of all rubbish and other refuse that may potentially attract introduced animals (i.e. food scraps) in sturdy waste disposal receptacles that are frequently emptied.

10.3.3 Operation Phase

10.3.3.1 Overview

The operation of the Project has the potential to cause a number of direct and indirect impacts on aquatic fauna and flora assemblages through the following aspects:

- train operation; and
- rail line infrastructure.

The potential impacts associated with these operation activities are summarised in and are discussed in Sections 10.3.3.2 to Section 10.3.3.12 below. A Project Operational Environmental Management Plan (OEMP) will be developed to incorporate the management measures relevant to minimizing the impact to the aquatic ecosystems within and adjacent to the footprint.

10.3.3.2 Potential Impact – Fauna Mortality

Direct mortality of aquatic fauna (primarily freshwater turtles) could occur during the operational phase of the Project through train strikes and maintenance vehicle strikes. Risk of turtle mortality is most likely to occur in the vicinity of large palustrine habitats and during rain events, when long-necked species undertake overland migrations. It is considered likely that a small number of turtles will be killed during the operation of the Project though population abundance is unlikely to be affected. The ecological consequence of these mortalities is considered minor.

10.3.3.3 Mitigation Measures

The operation of the Project is likely to result in the mortality of a small number of freshwater turtles. Mitigation measures proposed include:

- monitoring turtle mortality rates at large palustrine habitats (e.g. Caley Valley Wetland); and
- developing and installing turtle exclusion barriers in areas that demonstrate high risk of mortality.

10.3.3.4 Potential Impact – Alteration to In-stream and Floodplain Hydrology

The hydrology of aquatic habitats within the study area has been previously altered as a result of road crossings, impoundments and human made bund walls. The rail line infrastructure required for Project operation has the potential to further alter in-stream and floodplain hydrology resulting in the restriction of fauna movement and the degradation of habitat. Movement of aquatic fauna within and between aquatic habitats is a critical life cycle component of many species and is particularly important for dispersal and breeding (Marsden and Power, 2007; Walsh and Whitehead, 1993; Tucker, 1999). A long-term decrease in dispersal migrations within the river system may cause a reduction in gene flow resulting in the formation of genetically isolated populations. A restriction of dispersal migrations may also result in physically isolated populations becoming threatened with localised extinction due to a lack of immigration from neighbouring areas (Tucker, 1999; Bunn and Arthington, 2002). These impacts are particularly relevant to aquatic fauna such as freshwater turtles and crocodiles that do not have a larval dispersal phase.

Many fish species known to occur within the study undertake obligatory breeding migrations within and between habitats and water flows are recognised as one of the most important factors influencing the migration of these species (Baran, 2006; Sheaves *et al.,* 2007). For example, the breeding season of a number of species (i.e. barramundi; long-finned eel; oxeye herring and empire gudgeon) is known to

occur during the wet season when flows within the river are increased and off-stream breeding and nursery habitats (i.e. palustrine habitats) are connected to the river system facilitating access to these environments (Reynolds, 1983; Pusey *et. al.,* 2004; Stuart and Berghuis, 1997).

The ecological consequence of restricted fauna movement can include declines in species abundance, species distribution truncation, localised extinction and a reduction in species diversity (Marsden and Power, 2007). This is already evident within the study area with the localised extinction of diadromous fish species upstream of the Burdekin Falls Dam (Pusey *et al*., 1998).

The bridging of aquatic habitats will have minimal impacts on in-stream flows and as such will reduce the likelihood of fauna movement restriction in these locations. Restriction of fauna movement at culvert locations is likely to be more prevalent. Water velocities through culverts are often greater than the maximum swimming ability of fish, particular small bodied species, and thus upstream movement can not occur. Other factors potentially limiting fauna movement at culvert locations include sedimentation of the culverts and reduced light availability. The design of any culvert crossings will consider appropriate passage requirements, for example as set out in Fish Habitat Management Operational Policy FHMOP 008 (DEEI 2009) and Fish habitat Guideline 006 Fisheries Guidelines for Fish-Friendly Structures (DEEDI 2006).

Alteration of in-stream and floodplain hydrology may also result in the degradation of aquatic habitats. Alteration of in-stream flows within riverine habitats can result in a reduction in water quality, decrease in the downstream transport of woody debris and change in channel morphology as a result of increased sedimentation and erosion (Wheeler *et al*., 2005; Bunn and Arthington, 2002). Only minor changes in channel morphology is expected to occur at the bridge habitats however larger scale impacts are expected at culvert locations where flows are influenced to a greater extent. As these locations are generally ephemeral the likelihood that these habitats will be impacted by habitat degradation is reduced.

Alteration of floodplain hydrology as a result of the rail line infrastructure has the potential to decrease in the inundation and connectivity of floodplain habitats (i.e. palustrine habitats). Alteration of floodplain hydrology has the potential to result in the degradation of these habitats and may also decrease the input of floodplain resources into the main river channel. The inclusion of culverts at key locations within floodplain habitats will reduce the likelihood of these impacts.

10.3.3.5 Mitigation Measures

The rail line infrastructure required for the operation of the Project has the potential to result in the alteration of in-stream and floodplain hydrology. The ecological consequences of this impact include restriction of fauna movement and habitat degradation. As these impacts have the potential to result in the loss of habitat and the potential localised loss of species, this impacts is considered a Major consequence. Mitigation measures proposed include:

- minimising the impact to estuarine and lacustrine/palustrine hydrology by avoiding the fragmentation of these habitats during the design phase;
- bridging aquatic habitats and providing culverts in accordance with the design criteria defined in Volume 3, Section 11 of this EIS; and
- providing culverts at key areas within floodplain habitats (i.e. including estuarine and lacustrine/palustrine habitats).

10.3.3.6 Potential Impact – Increased Sedimentation, Run-off and Dust

The degradation of water quality as a result of land use practises (i.e. cattle grazing and associated clearing of riparian vegetation) has resulted in a reduction in the environmental value of aquatic habitats within the study area. The operation of the Project has the potential to result in further degradation as a result of increased sedimentation, run-off and dust. The rail corridor and maintenance track are likely to collect small volumes of stormwater and direct increased run-off into aquatic habitats. Potential impacts to aquatic habitats as a result of increased sedimentation and run-off include reduced water quality, increased bank erosion and introduction of contaminants or pollutants (Wood and Armitage, 1997; Wheeler *et al*., 2005). The consequences of these impacts are considered significant due to the potential for a reduction in habitat value (e.g. amount of refuges, microhabitats and food availability) and decrease in species abundance. As increased sedimentation and run-off will occur during rainfall events when riverine habitats are primarily flowing and existing levels of sedimentation are high, the likelihood of sedimentation and run-off impacts as a result of the Project are likely to be reduced. Lacustrine and palustrine habitats such as the Caley Valley Wetland, are likely to be more susceptible to impacts of sedimentation and run-off due to the no/low flow conditions. The establishment of sediment traps and biofilters will reduced the likelihood of impact in these areas.

Project operation 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. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas primarily as a result of reduced water quality. Excessive dust may also influence riparian vegetation by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias, 2007). Due to the low frequency in which access tracks will be utilised, it is considered unlikely that dust deposition impacts will occur.

10.3.3.7 Mitigation Measures

Operation activities have the potential to result in habitat degradation as a result of sedimentation, run-off and dust. The ecological consequence of this impact is considered significant due to the potential reduction in foraging and breeding habitat. Mitigation measures proposed include:

- establishing protective vegetation, sediment traps, silt fencing and biofilters at aquatic habitat locations to protect water bodies from sediment and pollutants;
- cleaning and maintaining trains to minimise the introduction of contaminants such as oil and fuel;
- development of an ESMCP which includes dust suppression techniques to address dust emissions from vehicles during the operational phase;
- establishing a Water Quality Monitoring Plan (adequate baseline information will be required) to monitor the composition and condition of the nationally important Caley Valley Wetland; and
- developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses.

10.3.3.8 Potential Impact – Coal Dust and Exhaust Emission

Operation of the Project has the potential to impact aquatic habitats through the emission of coal dust and diesel exhaust emissions from loaded and unloaded trains. High levels of coal dust emission have the potential to increase dust deposition leading to a decrease in water quality and reduction in the

photosynthetic potential of riparian vegetation. 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 are significant and include an overall reduction in aquatic and riparian habitat value and in extreme cases, potential mortality of fauna species and dieback of riparian vegetation.

Measures of coal dust deposition rates along an existing rail corridor have recorded maximum values of 90 mg/m²/day at approximately 3 m from the tracks. Deposition rates of 30 mg/m²/day were recorded approximately 10 m from the tracks, indicating deposition rates decrease rapidly with increasing distance from tracks (Andrews and Skriskandarajah, 1992). Studies undertaken for the Project indicate dust deposition rates of 0.44 mg/m^2/month (15 mg/m^2/day) at 10m from the rail alignment at peak operation (refer to Volume 3, Section Section 13.3.3 of this EIS).

Values of coal dust deposition recorded along the rail corridor were well below proposed threshold level for adverse impacts on crops and vegetation (i.e. 500 mg/m²/day) (Andrews and Skriskandarajah, 1992). These results suggest that the deposition of coal dust in aquatic habitats as a result of the Project will be low and hence the consequences to environmental values are considered moderate. Mitigation measures are proposed in Section 13.3.3.

10.3.3.9 Mitigation Measures

Operation activities have the potential to result in the degradation of aquatic habitats due to coal dust emission. The ecological consequence of this impact is considered moderate due to the potential for permanent degradation of the aquatic environment. Mitigation measures proposed include:

- utilising wagons that minimise loss of coal particles;
- constructing ballasted bridges over aquatic habitats to reduce direct input of coal dust particles into water bodies;
- train operations are to be conducted in accordance with a Dust Management Plan;
- developing an ESMCP which includes measures to minimise run-off of coal dust into aquatic habitats;
- improving coal loading and unloading procedures to minimise parasitic loads on sills etc.;
- train cleaning is to be undertaken regularly; and
- trains are not to be overloaded.

10.3.3.10 Potential Impact – Noise, Light and Vibration Disturbance

Aquatic habitats that are considered important include the permanent water bodies within riverine and palustrine habitats, the Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation. These habitats provide particular foraging, breeding and sheltering resources that are unavailable in other areas. Light, noise and vibration disturbance as a result of Project operation has the potential to disrupt normal fauna behaviours in these areas resulting in a reduction in habitat value.

The main noise and vibration emissions during the operation phase of the Project will be train movement. The frequency of trains utilising the rail corridor is likely to be seven trains moving along the rail line twice a day. Noise and vibration impacts from passing trains may interfere with communication, disrupt breeding and nesting or startle some fauna species displacing them into

adjacent habitats. Nesting of crocodiles and freshwater turtles along adjacent river banks is likely to be most affected by noise disturbance however this will primarily be restricted to areas where the rail corridor crosses permanent pool habitat (e.g. Suttor River). No important nesting habitat for these species is known to occur within the study area. It is likely that some animals will adapt to the infrequent noise and vibration emissions. The platypus (*Ornithorhynchus anatinus*) is known to be tolerant of disturbed habitats and has been observed in habitats adjacent to major road crossings (Grant and Temple-Smith, 1998).

The impact of operational lighting associated with the rail corridor infrastructure on aquatic fauna is generally considered negligible as minimal operational lighting will be required along much of the alignment. The only source of light disturbance in these areas will be from the high powered lights emitted by the trains travelling at night. Aquatic habitats located at or adjacent to road crossings, passing loops and the port loops are likely to have a higher level of light disturbance due to the additional operation lighting that is required in these locations. This impact has the potential to reduce the value of the habitat affected and species diversity and abundance in the localised area may decrease. The use of directional lighting with protective guards will limit the extent of affected habitat in these areas.

10.3.3.11 Mitigation Measures

Mitigation measures proposed include:

- where possible, operational lights, such as at signalling stations, will not be located within or adjacent to aquatic habitats;
- design appropriate lighting within and adjacent to aquatic habitats to minimise lighting disturbances;
- revegetating habitats disturbed during construction to create an environmental buffer to noise for surrounding habitats;
- appropriately service and maintain trains to minimise machinery noise; and
- restricting speed limits within the Caley Valley Wetland to limit noise disturbance.

10.3.3.12 Potential Impact – Increased Abundance and Diversity of Introduced Species

Operation of the Project has the potential to result in an increase in the abundance and diversity of introduced species within the Project area. The maintenance of cleared land within the rail corridor is likely to facilitate the spread of riparian weed species (e.g. rubber vine) along the corridor. Train operation and movement of vehicles along the maintenance access track may also contribute to the spread of riparian weed species through seed transfer. An increase in the abundance and diversity of weed species within aquatic habitats may result in a reduction in native species diversity, reduction in in-stream fauna habitat in the form of root mats and branches and increased risk of soil erosion. Degradation of aquatic habitats by introduced flora species has been recorded extensively throughout the Project footprint as a result of grazing practices and the potential consequence of further impacts is considered major. Implementation of measures such as vehicle and train wash down may reduce the likelihood of this impact.

Pest species that use the rail easement as a linear pathway for movement may become introduced into previously uncolonised habitats. Competition and predation by feral animals has the potential to reduce the abundance and diversity of local terrestrial and aquatic fauna.

10.3.3.13 Mitigation Measures

Operation activities have the potential to result in an increase in the abundance and diversity of introduced species within the study area. The ecological consequence of this impact is considered major due to the potential for species and/or community loss. Mitigation measures proposed include:

- developing a Weed and Pest Management Plan for implementation throughout the operation phase. Management actions will including:
  - providing vehicle wash down stations along the alignment;
  - regularly cleaning trains to remove weeds, seed and mud;
  - regularly monitoring declared pest and weed species; and
  - controlling pest and weed species where necessary.

10.3.4 Protected Areas and Important Species

10.3.4.1 Matters of National Environmental Significance

Matters of national environmental significance relating to aquatic environmental values that may be impacted by the Project include the estuarine crocodile and freshwater crocodile.

Potential impacts of Project construction and operation on the crocodiles are primarily associated with the degradation of potential habitat as a result of altered in-stream hydrology, increased sedimentation, run-off and dust, coal dust emission and increase noise, light and vibration disturbance. These impacts have been assessed against DSEWPC's Significant Impact Guidelines for Listed Migratory Species (Table 10-2) for the estuarine crocodile and DSEWPC's Significant Impact Guidelines for the Commonwealth Marine Environment (Table 10-2) for the freshwater crocodile (DEWHA, 2009). Due to the extremely low abundance of estuarine crocodiles and potential estuarine crocodile habitat within the study area the impact of Project construction and operation on this matter of national environmental significance is considered low.

Table 10-2: Matters of national environmental significance significant impact criteria assessment – listed migratory species

MNES Significant Impact Criteria	Estuarine Crocodile (*Crocodylus porosus*)
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	No important estuarine crocodile habitat occurs within the Project footprint. A small number of individuals may potentially occur in the Bowen and Bogie Rivers however permanent habitat does not occur at the locations of the rail crossings.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The increase in abundance and diversity of introduced species within the Project footprint as a result of Project construction and operation is considered a Medium risk. An increase in weeds species within the riparian zone has the potential to decrease the suitability of nesting habitat for the estuarine crocodile however as nesting is unlikely to occur within the study area, the

MNES Significant Impact Criteria	Estuarine Crocodile (*Crocodylus porosus*)
	likelihood of impact is low.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Habitat degradation, as a result of altered in-stream hydrology, increased sedimentation, run-off and dust, coal dust emission and noise, light and vibration disturbance, has the potential to disrupt estuarine crocodile behaviour within habitats adjacent to the rail corridor. As these habitats have a low value for the estuarine crocodile and are likely to support only a small number of individuals, the likelihood of impact is considered low.

Table 10-3: Matters of national environmental significance significant impact criteria assessment – Commonwealth marine environment

MNES Significant Impact Criteria	Freshwater Crocodile (*Crocodylus johnstoni*)
Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, and life expectancy) and spatial distribution.	No important freshwater crocodile habitat occurs within the Project footprint. A small number of individuals may potentially occur in the Bowen and Bogie Rivers however these individuals have been introduced to the Catchment and are not an important component of the larger freshwater crocodile population.

10.3.4.2 Nationally Important Wetlands

Nationally important wetlands located within the study area include the Caley Valley Wetland and the Bowen River: Birralee – Pelican Creek Wetland aggregation.

Caley Valley Wetland

The rail loop at the Port of Abbot Point will cross the Caley Valley Wetland near chainage 505 km, resulting in a footprint of <1 ha of estuarine habitat and approximately 13.5 ha of palustrine habitat. Additional potential impacts of Project construction and operation on the Caley Valley Wetland are discussed in detail above. All potential construction phase impacts are considered to have a high risk to the Caley Valley Wetland prior to mitigation. The implementation of proposed mitigation measures will reduce these impacts to medium risk. Potential operation phase impacts considered to have a high risk to the wetland include alteration to in-stream and floodplain hydrology, increased sedimentation, run-off and dust and increase in abundance and diversity of introduced species.

Bowen River: Birralee – Pelican Creek Aggregation

The Bowen River: Birralee - Pelican Creek Aggregation is located approximately 3.5 km away from the proposed railway alignment. The Project construction and operation will not have a direct impact of the Bowen River: Birralee - Pelican Creek Aggregation. Potential indirect impacts may occur as a result of alteration to in-stream and floodplain hydrology and increased sedimentation, run-off and dust. The implementation of mitigation measures identified for these impacts will minimise the impact to these aggregation.

10.3.4.3 Commercially and Recreationally Important Fish Species

Commercial fishing does not occur within the study area however a number of fish species that inhabit the Caley Valley Wetland are considered a potential component of the Queensland East Coast Inshore Fin Fish Fishery (DEEDI, 2009). Section 10.2.9.1 above identifies the fish species.

As the Caley Valley Wetland provides important spawning, breeding and nursery habitat for these species, potential impacts of the Project construction and operation on commercially and recreationally important fish species is primarily associated with impacts to the Caley Valley Wetland (see Section 10.3.4.2 above).

10.3.4.4 Endemic Species

Three fauna species endemic to the Burdekin Catchment occur within the study area. These species are the soft-spined catfish (*Neosilurus mollespiculum*), small-headed grunter (*Scortum parviceps*) and Irwin's turtle (*Elseya irwini*). The Irwin's turtle is also listed as high priority for conservation the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife.

- soft-spined catfish (Neosilurus mollespiculum) - Potential habitat for this species within the Project study area is primarily restricted to those habitats that contain permanent water bodies (i.e. Suttor River and Mistake Creek). Potential impacts of the Project construction and operation on this species are discussed in general in Sections 10.3.1 and 10.3.2 above. As this species has generalist habitat requirements and is tolerant to a range of environmental conditions, the mitigation measures proposed for the Project are considered likely to adequately reduce the risk of impact to low;
- small-headed grunter (*Scortum parviceps*) - Potential habitat for this species within the Project study area is primarily restricted to those river habitats that contain deep permanent water bodies (i.e. Suttor River). Potential impacts of Project construction and operation on this species are discussed in general in Sections 10.3.1 and 10.3.2 above. As potential habitat for this species is relatively limited within the Project footprint, the mitigation measures proposed for the Project are considered likely to adequately reduce the risk of impact to low; and
- Irwin's turtle (*Elseya irwini*) - Suitable habitat for the Irwin's turtle in the study area is primarily restricted to the Bowen and potentially the Bogie River. Tributaries of these rivers, such as Pelican Creek, may provide temporary habitat during the wet season. Due to a reliance on aquatic respiration, this species is likely to be sensitive to changes in environmental conditions including dissolved oxygen levels, temperature and turbidity. Potential impacts of Project construction and operation on this species are discussed in general in Sections 10.3.1 and 10.3.2 above. As potential habitat for this species is relatively limited within the Project footprint, the mitigation measures proposed for the Project are considered likely to adequately reduce the risk of impact to low.

10.3.4.5 Marine Plants

Marine plants protected under the *Fisheries Act 1994*, are located in the estuarine habitats of the Caley Valley Wetland. Offsets will be required to compensate for the clearance of these marine plants.

Marine plants are discussed in more detail in Volume 3, Section 9 of this EIS, however in general clearing of all marine plants will be minimised where possible. Areas to be removed will be clearly marked to avoid unnecessary clearing.

An offsets package for the Project will be developed in consultation with DERM, DEEDI and DSEWPC giving consideration to relevant State and Commonwealth policies relating to offsets.

10.4 Conclusions

The existing aquatic environment within the study area primarily supports a range of low value aquatic habitats and generalist flora and fauna species. Habitats considered locally important are restricted to those such as the Suttor River, Mistake Creek and the Star of Hope Wetland which support permanent riverine and palustrine water bodies. Nationally important aquatic habitats within the study area include the Caley Valley Wetland and Bowen River: Birralee - Pelican Creek Aggregation. The Caley Valley Wetland provides a range of habitats for aquatic flora and fauna species and provide high value habitat for commercially and recreationally important fish species.

Locally important fauna species potentially occurring within the study area included the endemic soft-spined catfish, small-headed grunter, and Irwin's turtle. Irwin's turtles is also listed as high priority for conservation under the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife. Conservation significant fauna species protected under the EPBC Act and/or NCA include the estuarine crocodile and freshwater crocodile. A small number of individual animals potentially occur in the tidal creeks of Caley Valley Wetland (estuarine crocodile only) and the large permanent pool habitats in the Bowen and Bogie Rivers.

No conservation significant aquatic flora species are known to occur within the study area however nine species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The saltcouch and weeping paperbark that occur in the estuarine habitats are protected as marine plants under the *Fisheries Act 1994*. A total of ten flora species are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Only rubber vine was observed in the study area.

The potential construction related impacts of the Project aquatic environmental values include:

- loss of aquatic habitat;
- fauna mortality;
- alteration to in-stream and floodplain hydrology;
- increased sedimentation, run-off and dust;
- light, noise and vibration disturbance; and
- increase in abundance and diversity of introduced species.

The potential operation related impacts of Project aquatic environmental values include:

- fauna mortality;
- alteration to in-stream and floodplain hydrology;
- increased sedimentation, run-off and dust;
- coal dust emission;
- light, noise and vibration disturbance; and
- increase in abundance, diversity and distribution of introduced species.

These impacts can be effectively mitigated by restricting construction during the wet season where possible, bridging aquatic habitats and providing culverts suitable for fish passage at other aquatic habitats in accordance with the design criteria, maintaining water quality, and managing introduced species. Specific mitigation measures have been identified and will be included in the construction and environmental management plan for the Project to realise these measures.