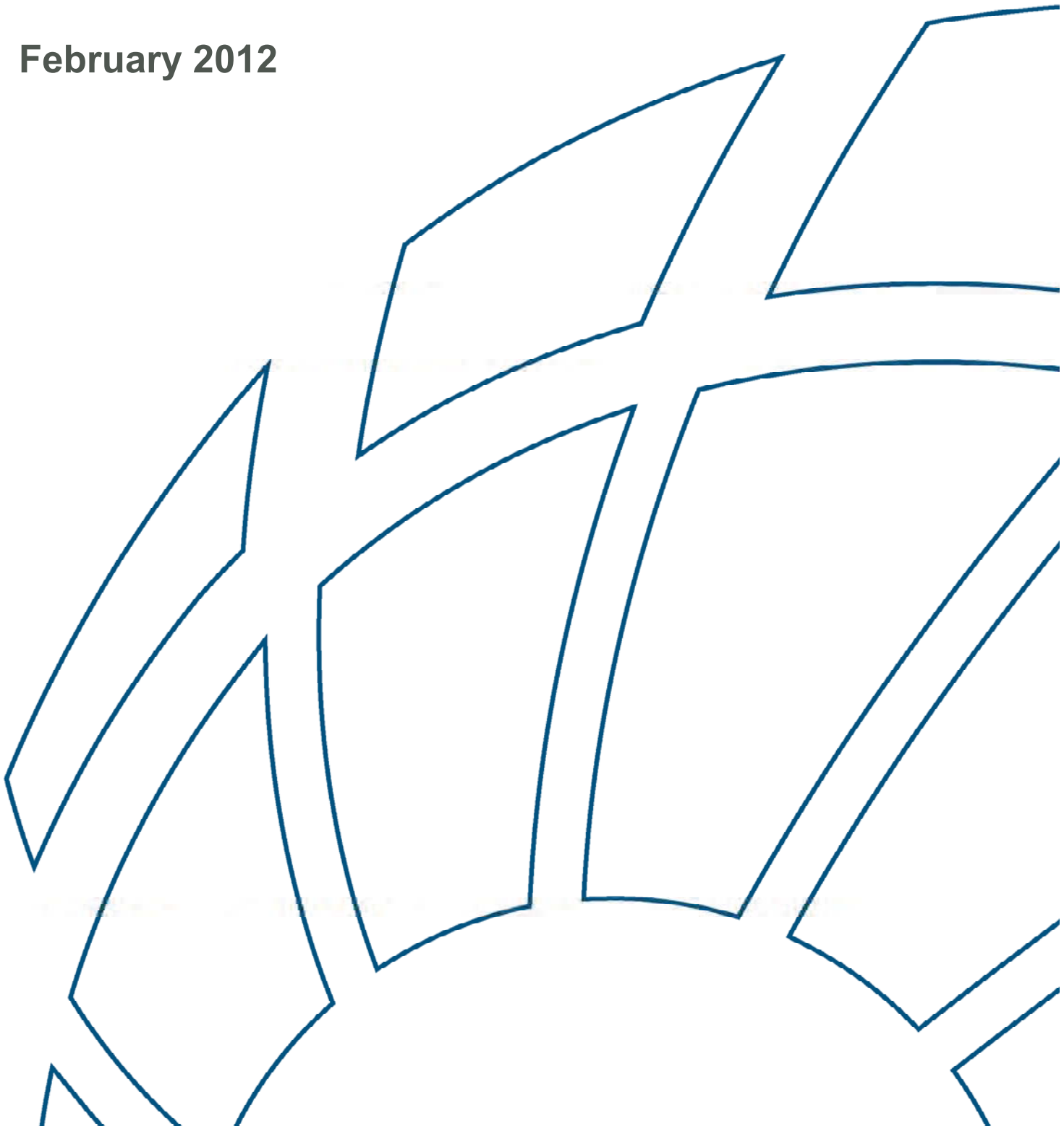


Kaili (Caley) Valley Wetlands Baseline Report

February 2012



Kaili (Caley) Valley Wetlands Baseline Report

Prepared For: Office of the Coordinator-General, Department of State
Development, Infrastructure and Planning

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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EXECUTIVE SUMMARY

Background

The Kaili (Caley) Valley Wetlands (the Wetlands) is a large coastal wetland system located on the central Queensland coast approximately 21 kilometres (km) northwest of Bowen (refer Figure 1-1). The Wetlands cover an area of approximately 5,154 hectares (ha) and are listed under the Directory of Important Wetlands in Australia (DIWA). The Wetlands represent one of the largest intact wetland systems between Townsville and Bowen.

This baseline report was commissioned by the State Development Areas Division (SDAD), Office of the Coordinator-General (OCG), to provide a description of the environmental values of the Wetlands and the threats to these values. This report describes the environmental values of the Wetlands and adjacent areas, focusing on the Abbot Point State Development Area (APSDA), based on information available at the time of preparation (mid 2011).

Given the focus on the APSDA, the baseline report refers to the Wetlands project area, which includes:

- all areas of the Wetlands that are situated within the APSDA; and
- creeks, riparian and terrestrial areas within the APSDA that adjoin or otherwise contribute to maintaining the environmental values of the Wetlands, as defined in Figure 1-2.

Functional Zones

The Wetlands is composed of diverse coastal and inland wetland types. Six broad functional zones have been identified in the Wetlands.

Coastal Zone

The Wetlands contains a small section of open coast between Mount Stewart Creek and Branch Creek, located on the western side of the Wetlands. This zone contains coastal open waters, sandy beaches and spits, and coastal dune vegetation communities. Sparse seagrass beds occur offshore, and are of an ephemeral nature. This zone is not represented in the APSDA.

Western Estuarine Zone

The tidal creeks located on the western side of the Wetlands contain large areas of estuarine vegetation. A mosaic of mangrove forests, saltmarsh, saltpan, and Casuarina dominated wetland types occur within this zone. The spatial distribution and structure of these vegetation communities is largely controlled by the interaction between tidal hydraulics, soil and benthic ecosystem processes. Only a small portion of this zone (at Branch Creek) is represented in the APSDA.

Hypersaline Zone

The area between the western (outer) and causeway (inner) bund contains extensive salt pans and ponded hypersaline waters. This zone is located mostly within the APSDA. The environmental character of this zone can be described as follows:

- The impounded hypersaline waters upslope of the western (outer) bund had high salinity levels and areas of anoxic sediment.
- The saltpan areas are typically dry but contain sparse coverage of salt tolerant saltmarsh species. When the Wetlands are inundated by flood waters, this zone can become estuarine to brackish in character, allowing the temporary development of saltmarsh communities.

Since the construction of the western (outer) bund in the 1980's, approximately 46 ha of mangrove forest have been lost as a result of alterations to tidal hydraulics. *Wetland Basin Zone*

This zone is located east of the hypersaline – saltpan zone to the east of the causeway (inner) bund. This zone contains palustrine (marshes) and lacustrine (lakes) areas that are of near-marine to freshwater character (varying depending on rainfall and salinity conditions). The palustrine wetland represents the largest wetland type in the Wetlands. It is thought that surface water runoff and marine water intrusion interact to control water quality conditions in this zone. To date, no studies have considered these processes in detail, nor are changes in wetland vegetation structure and water quality well understood. The dominant vegetation in this area is discrete sedge patches almost entirely consisting of one species, Mangrove Clubrush (*Schoenoplectus litoralis*).

Saltwater Creek Zone

The Saltwater Creek zone encompasses the portion of Saltwater Creek and adjoining riparian and wetland environments within the boundaries of the Wetlands. Saltwater Creek has a brackish to freshwater character, with riparian vegetation communities comprised of mangroves, melaleuca and a range of other riparian species, and in-stream communities dominated by floating macrophytes (water lilies). The creek forms a permanent aquatic refuge and has high habitat values for waterbirds and fish.

Terrestrial Zone

The terrestrial zone contains a range of small low order streams that are ephemeral in nature. Riparian vegetation along these streams is fragmented and typically narrow, but still retains values (albeit degraded) as fauna movement corridors. The adjacent terrestrial vegetation has been heavily disturbed by clearing, although patches of remnant and high quality regrowth occur in places.

Fauna

A fauna movement corridor extends in an east–west direction across the Wetlands. This corridor represents a wildlife corridor of State significance, connecting the Wetlands to Mount Aberdeen National Park 40 kilometres southwest of Bowen. However, there is generally poor north – south connectivity between the coastal plains and the ranges due to extensive clearing for grazing. This loss of connectivity is likely to impact many species groups.

The Wetlands have high values for waterbirds. The coastal and estuarine habitats, together with the salt pans, represent feeding and roosting areas for a range of migratory and resident shorebird species. The more estuarine/brackish and freshwater sections of the Wetlands represent important waterfowl feeding, roosting and breeding areas. Waterfowl can be extremely abundant east of the causeway (inner) bund in the wet season, with hundreds of individuals recorded. The Wetlands provide one of Queensland's largest and most northerly coastal nesting areas for Black Swans

(*Cygnus atratus*). The more permanent waterbodies in the Wetlands represent important dry season refugia, although specific dry season values have not been examined in detail.

Surveys to date have recorded 25 fish species in the Wetlands, including estuarine and freshwater representatives. The bunds are thought to represent a barrier to fish movements between the sea and the Wetlands, as well as within the Wetlands. This greatly limits the fisheries habitat values of the Wetlands particularly to species that migrate between freshwaters and marine waters as part of their life-cycle (e.g. barramundi). Most fish species known to occur in the Wetlands have an obligate marine phase or are estuarine species, suggesting some connectivity is being maintained at present.

A range of threatened and near-threatened species are known to occur in the Wetlands and immediate surrounds, including:

- Waterbird species, including the migratory shorebird Little Tern *Sterna albifrons*, and the resident waterbirds Black-necked Stork *Ephippiorhynchus asiaticus*, Beach Stone-curlew *Esacus magnirostris* and Freckled Duck *Stictonetta naevosa*.
- Saltwater Crocodile *Crocodylus porosus*, a non-avian wetland-dependent species.
- A range of other terrestrial fauna species could potentially utilise the Wetlands, such as Squatter Pigeon *Geophaps scripta scripta*. Consultation with the Department of Environment and Natural Resources identified several other threatened species as potentially occurring in the study area (including the Wetlands), including Northern Quoll (*Dasyurus hallucatus*), Coastal Sheath-tail Bat (*Tapozous australis*) and Water Mouse (*Xeromys myoides*). Patterns in usage of the Wetlands by these species would need to be assessed through further surveys.

The Wetlands are also thought to provide an important habitat for many terrestrial fauna species by providing a relatively intact habitat in an otherwise disturbed landscape.

Environmental Values

On the basis of a review of existing information and the DIWA nomination criteria that the Wetlands currently meets, the following Environmental Values (EVs) are considered to be supported by the portion of the Wetlands within the APSDA:

The Wetlands supports the following EVs:
EV1. Diverse estuarine, brackish and freshwater wetland types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity
EV2. Important foraging and roost habitat for resident and migratory shorebird species, including the threatened Little Tern
EV3. Important dry season refugia for aquatic fauna, resident shorebirds and terrestrial fauna
EV4. Important nesting areas for shorebirds, most notably Black Swan
EV5. Important habitat for fish and other aquatic species, including species of fisheries significance
The Wetlands project area and Wetlands together support the following additional EVs:
EV6. The Wetlands project area and the Wetlands is part of a significant fauna movement corridor for aquatic and terrestrial species, including the threatened species.

Threats to EVs

There are numerous existing and potential threatening processes that could potentially lead to further changes to the ecological character of the Wetlands. In particular, the following key risks were identified:

- Habitat modifications due to sea level rise - which is relevant to wetland environments within the study area.
- Restricted fish movements and associated loss of habitat values for species of fisheries significance (particularly Barramundi) due to ongoing operation of the western (outer) bund and the causeway (inner) bund. This is relevant to wetland environments within the study area.
- Potential altered hydrological regimes and water quality in creeks and the Wetland due to catchment development. This is relevant to wetland environments within the study area.
- Disturbance of Little Tern nesting activities due to uncontrolled human access on beaches. This is relevant mostly to beach environments within the Wetlands but outside the Wetlands project area.

Information Gaps

Detailed baseline information is required to inform planning of future development projects within the APSDA and establish a baseline for ongoing monitoring activities. Key further investigations include:

- Characterisation of baseline water quality and sediment quality conditions. Water quality can show marked variation over time in response to changes in rainfall and tidal processes. It is important to understand these patterns and underlying processes in order to determine controls on wetland ecosystem functioning, and to provide baseline water quality (and water depth) data for any future development of a receiving environment water quality model (RWQM). This information also provides a basis for establishing local water quality management targets/objectives.
- Patterns in Vegetation Community Structure. Wetland vegetation communities can also show great variation over time in response to a range of factors, particularly hydrological conditions (wetting and drying cycles, flows) and associated changes in water quality conditions. There is no available empirical data describing temporal patterns in vegetation community structure within the Wetlands, and the key drivers of such changes. This represents an important information gap in the context of: (i) establishing a baseline to assess the effectiveness of future management strategies; and (ii) assessing impacts of existing pressures on wetland vegetation that may require management intervention (e.g. impacts of the causeway (inner) bund on salinity and vegetation community structure).
- Fauna Distribution and Habitat Usage. Most fauna studies to date either have a narrow spatial coverage (i.e. sampling within the vicinity of the footprint of a proposed development activity) or represent a snap-shot with limited temporal coverage. Further information is required to more accurately define patterns in habitat usage by wetland and terrestrial fauna, and key habitats/areas for these species.

Recommendations are provided on key priority studies and timing of such studies.

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1 INTRODUCTION

1.1 Background

The Kaili (Caley¹) Valley Wetlands (the Wetlands²) are a nationally important wetland system that is listed under the Directory of Important Wetlands in Australia (DIWA). The Wetlands are located approximately 21 kilometres northwest of Bowen, central Queensland (refer Figure 1-1). The Wetlands are partly located within the boundaries of the Abbot Point State Development Area (APSDA), and adjoins the Port of Abbot Point (Port) (Figure 1-1)). The Wetlands cover an area of approximately 5,154 ha, and represent one of the largest intact wetland systems between Townsville and Bowen.

The Wetlands supports a wide range of habitats that are in varying states of condition, including from freshwater streams and marshes to estuarine wetlands and hypersaline saltpan areas. Although the Wetlands contain degraded areas, it supports outstanding values for a wide range of wetland associated species.

This baseline report was commissioned by the SDAD, OCG, to provide a description of the environmental values of the Wetlands and adjoining areas (the study area) and the threats to these values. It has been based on information available at the time of preparation (mid 2011). The specific objectives of this baseline report are to:

- Describe the distribution, extent and condition of wetland types within the study area;
- Identify patterns in the key flora and fauna species, populations and communities within the study area, including usage of each habitat type;
- Describe the key threats and risks to the environmental values of the study area;
- Identify additional information that would assist with defining baseline patterns in natural variability in Environmental Values (EVs) and threats to values; and
- Support the formation of management objectives and actions.

The intent of the APSDA is to accommodate large scale industrial development, including current and planned expansions at the Port, and Galilee and Bowen Basin coal export proposals. Any proposed development within the APSDA will undergo the relevant regulatory processes which will include the identification of potential impacts to the EVs of the Wetlands and proposed mitigation strategies.

1.2 Area to which the Baseline Report Applies and Terminology

The Wetlands are spatially defined by the DIWA (DEWHA 2010b) for the area known as "Abbot Point - Caley Valley Wetland QLD 001" as shown in Figure 1-2. Summary details for the Wetlands (which underpin DIWA designation) are provided in Table 1-1.

¹ The Wetlands are referred to by their traditional spelling Kaili. Place names such as Caley Homestead and Lake Caley are also used.

² The *Wetlands* is a place term that refers to the Kaili (Caley) Valley Wetlands. The terms *wetland* or *wetlands* refers to wetland ecosystem features (e.g. wetland plants, animals).

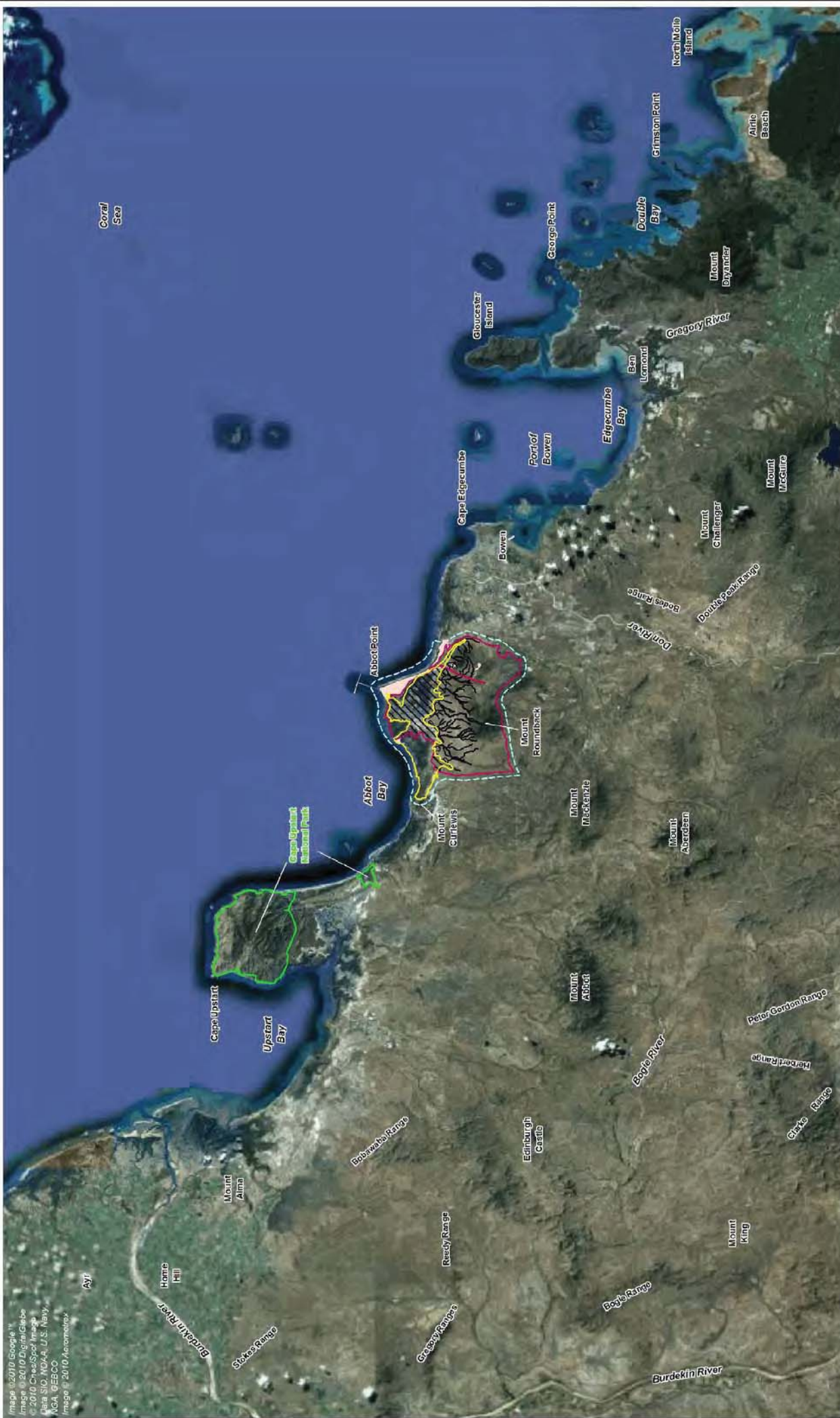


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<p>Figure: 1-2</p> <p>Rev: E</p>		<p>Title: Kaili Valley Wetlands as Identified by the Directory of Important Wetlands in Australia Listing (DEWHA 2010b)</p>	
<p>BMT WBM endeavours to ensure that the information provided in this document is accurate and reliable. However, BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		<p>LEGEND</p> <ul style="list-style-type: none"> Kaili Valley Wetland Boundary as Defined through DIWA Listing APSDA Boundary Road Railway Regrowth Watercourse (DERM) 	
<p>Wetlands Project Area</p> <ul style="list-style-type: none"> Causeway (Inner) Bund Western (Outer) Bund Homestead 		<p>Scale</p> <p>0km 1 2</p> <p>Approx. Scale</p>	
<p>BMT WBM</p> <p>www.bmtwbm.com.au</p>		<p>BMT WBM</p> <p>www.bmtwbm.com.au</p>	

Table 1-1 Summary Details for the Wetlands (primary source: DEH³ 2006)

Attribute	Details
General	
Centre point coordinates	19° 55' 22" S, 148° 02' 25" E
Drainage Division	Northeast Coast
River Basin	Don River Basin (noting that study area streams do not feed into Don River)
IBRA Region	Brigalow Belt North
IMCRA Region	Northeast Province (Lucinda-Mackay Coast meso-scale bioregion)
Regulatory authorities	<p>The Coordinator-General on behalf of the Queensland Government is the assessment manager for material change of use development applications within the APSDA.</p> <p>In 2011, the Abbot Point Coal Terminal was acquired by Adani Abbot Point Terminal Pty Ltd on a 99 year lease from NQBP. It is operated and maintained by Abbot Point Bulkcoal Pty Ltd, as part of Xstrata Coal Queensland. NQBP is the regulatory authority for development and activities occurring on strategic port land.</p> <p>Whitsunday Regional Council is the assessment manager for all assessable development under the <i>Sustainable Planning Act 2009</i> for the part of the Wetlands outside the APSDA and for assessable development other than material change of use in the APSDA.</p>
DIWA information	
Name	Abbot Point – Caley Valley Wetlands
Old Reference No.	BBN001QL
New Reference No.	QLD001
Area (ha)	5,154
Wetland types	A1,5,6,8,9,10,11,C1
Criteria for Inclusion in the DIWA	1,2,3, 5

The majority of the Wetlands is owned by the Coordinator-General. The marine (and some estuarine) sections of the Wetlands are located outside the APSDA. The previous dominant land use within the part of the Wetlands owned by the Coordinator-General was grazing lands for cattle.

The terms *wetland* or *wetlands* refers to wetland ecosystem features (e.g. waterbodies or otherwise areas with wetland-dependant plants and/or animals).

The study area (refer Figure 1-1) includes the Wetlands as defined above, together with marine, coastal and terrestrial habitats adjacent to the Wetlands as defined in Figure 1-2.

The Wetlands project area, which is specific to the APSDA, is shown in Figure 1-2 and includes:

³ Excepting source references, DEH should be interpreted as SEWPAC.

- All areas of the Wetlands that are situated within the APSDA; and
- Creeks, riparian and terrestrial areas within the APSDA that adjoin or otherwise contribute to maintaining the EVs of the Wetlands, as defined in Figure 1-2.

1.3 Study Approach

Wetland and other flora and fauna species, communities and habitats that adjoin or otherwise contribute to the Wetland habitats within the study area have been defined through a review of existing vegetation and habitat mapping, searches of on-line databases, a review of previous studies and field-based investigations.

A range of other Geographical Information System (GIS) datasets were examined and mapped as part of this study and are fully referenced in the report. Public access databases were also searched to identify endangered, vulnerable and rare and other flora and fauna known to occur, or potentially occurring, in the study area, namely:

- Wildlife Online (DERM 2010) database. This is a Queensland Department of Environmental Resource Management (DERM⁴) internet based database that stores records of plant collections and fauna sightings for a search area defined by the user.
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Report (SEWPac 2010a). This is a Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC), formerly the Department of Environment, Water, Heritage and the Arts (DEWHA)) internet-based database, and its associated search tool, enables the user to generate a report that will assist with determining whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area of interest.
- Environmental Reporting Tool (SEWPAC 2010b). This is a SEWPAC internet-based database, and its associated search tool, enables the user to identify:
 - Matters of national environmental significance or other matters protected by the EPBC Act;
 - Invasive species; and
 - Wetlands listed on the DIWA.

Searches were done in public domain databases by specifying coordinates (defining a rectangle) that contained the study area. It should be noted these information sources have restricted locational precision, therefore, are considered to be indicative only. As such, flora and fauna information from these sources are assessed in the context of habitat conditions present within the Wetlands and adjacent terrestrial areas, and the potential for these habitats to support listed species and communities. Flora and fauna species which were unlikely to utilise habitats within the study area or from literature sources where the locations were unclear are not described or considered in this report.

⁴ The change of government in March 2012 saw functions of DERM transfer into a number of separate agencies including the Department of Environment and Heritage (DEHP) and Department of Natural Resources and Mines (DNRM). Future references to DERM within this report (excepting source references) should be interpreted as either DEHP or DNRM.

Following an initial information review, several important knowledge gaps that limit an understanding of the values and functions of the Wetlands were identified. The gap analysis identified the following key information gaps:

- Data describing changes in water quality characteristics of the Wetlands over a tidal cycle;
- Information on the fish assemblages within the major wetland types supported by the Wetlands; and
- Information on potentially important areas for waterbirds within the Wetlands.

Field surveys were therefore undertaken during October-November 2010 to fill some of these information gaps. Sampling methodologies are described in Appendix A (water quality), B (fish) and C (birds).

EVs supported by the Wetlands and adjoining areas were identified on the basis of existing information and field data. The approach used to identify EVs is outlined in Section 5.1 of this report.

2 ENVIRONMENTAL SETTING

2.1 General Context

The Wetlands (refer Photo 2-1) is located within the Don River Basin, which forms part of the Brigalow Belt Bioregion (DERM 2009). The regional landscape of the Wetlands and immediate surrounds generally consists of plains of Quaternary estuarine and marine deposits subject to periodic inundation by saline or brackish marine waters and corresponds to land zone one⁵ (DERM 2003). The adjoining terrestrial areas are traversed by numerous Quaternary alluvial (creek-associated) systems (refer Section 2.2.2). A mountain range of Mesozoic to Proterozoic igneous rocks (mainly granitic) (land zone 12) occurs approximately six kilometres south of the Wetlands, and Quaternary coastal dunes and beach ridges occur along much of the coastline within and adjacent to the Wetlands. Further details about the geology are provided in Section 2.2.4.



Photo 2-1 Kaili Valley Wetlands Facing East from Mount Luce

The study area south of the Wetlands represents a mosaic of remnant forest and cleared grazing lands. Most of the lowland areas have been cleared and were previously used for cattle grazing (grass) lands. Steeper areas (e.g. Mount Roundback) are covered in remnant vegetation, and patches of scattered trees occur along the banks of the numerous small creeks that drain into the Wetlands. The fringing coastal vegetation between Mount Curlewis and Mount Little is largely intact, the exception being around the Abbot Point Coal Terminal (APCT), which is located outside of the APSDA.

This remnant vegetation provides a valuable habitat and wildlife corridor for a range of flora and fauna species. A large portion of the Wetlands and the remnant vegetation along Branch Creek south of the Wetlands is mapped as State Significant Corridor Vegetation (refer Figure 2-1). The largely intact coastal vegetation also provides relatively good habitat connectivity between the Wetlands and Cape Upstart National Park. However, there is poor connectivity in a direct line (north to south) between the Wetlands and the ranges.

⁵ Land zones which represent a significant difference in geology and associated landforms, soils and physical processes that gave rise to distinctive landforms or continue to shape them (Sattler and Williams 1999).

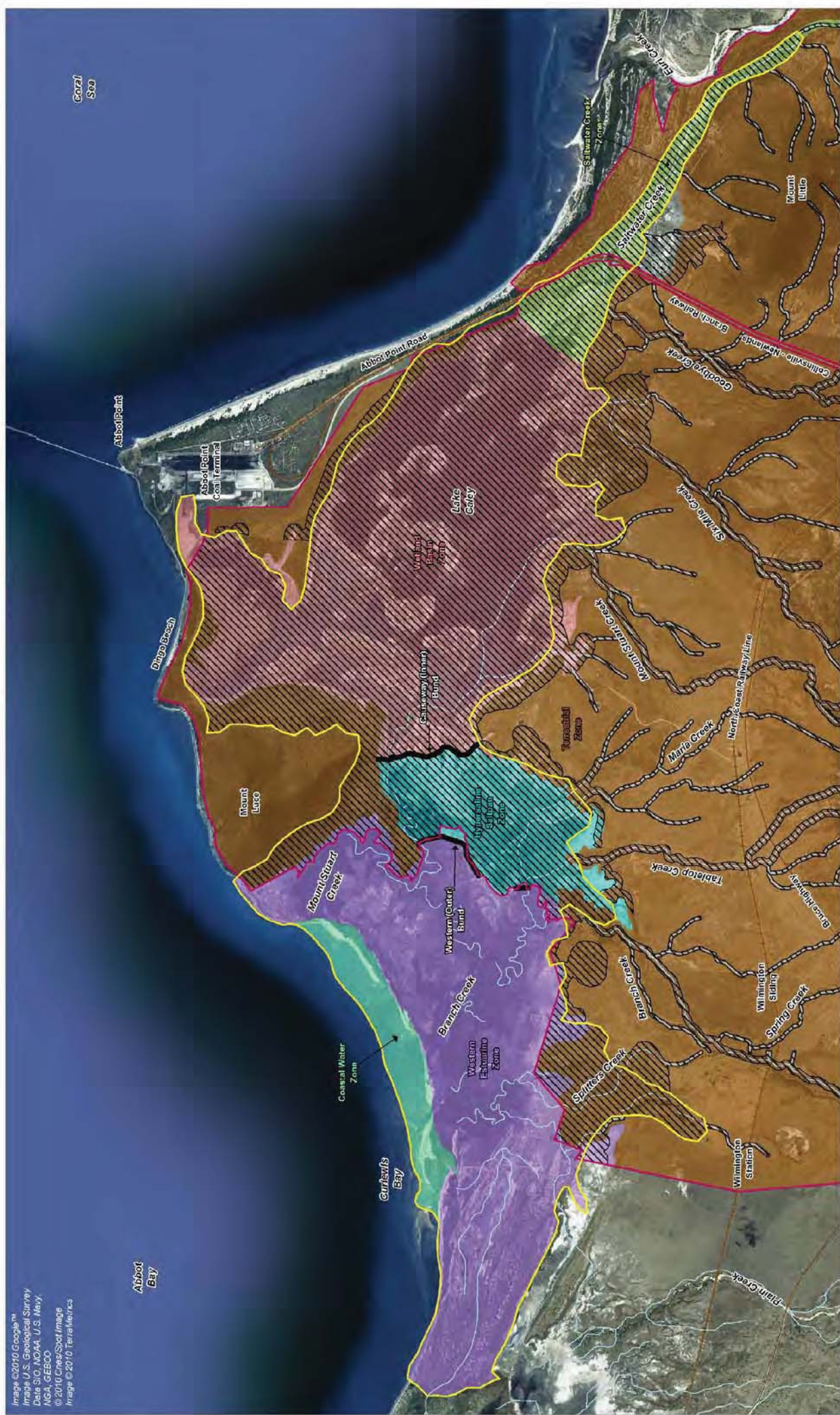


<p>LEGEND</p> <ul style="list-style-type: none"> Kail Valley Wetland Boundary as Defined through DIWA Listing APSDA Boundary Road Railway Regrowth Watercourse (DERM) 		<p>Wetlands Project Area</p> <p>State Significant Corridor Vegetation (DERM)</p>		<p>Title: State Significant Corridor Vegetation</p>	<p>Figure: 2-1</p>	<p>Rev: E</p>
<p>Image ©2010 Google™ Data SIO, NOAA, U.S. Navy, NGA, GEBCO © 2010 Cnes/Spot Image Image © 2010 DigitalGlobe</p>		<p>BMT WBM endeavours to ensure that the information provided in this document is correct to the best of its knowledge. BMT WBM does not warrant, guarantee or make representations regarding the accuracy and reliability of information contained in this map.</p>		<p>BMT WBM www.bmtwbm.com.au</p>		

On the basis of landform types, salinity characteristics (refer Section 2.2.5) and vegetation communities (refer Section 3.1) present, the study area has been split into six broad functional zones (refer Figure 2-2). Each functional zone may include a number of wetland types (as described in Section 3.2):

- Coastal Zone, which is located on the western side of the Wetlands and is comprised of marine habitat types. This zone is not represented in the Wetlands project area, but is well represented in adjacent wetland areas.
- Western Estuarine Zone, which is located down-slope of the western (outer) bund and is comprised of estuarine vegetation, tidal flats and creeks. Only a small area of this zone is located within the Wetlands project area, but is well represented within the Wetlands outside APSDA.
- Hypersaline Zone, which is located between the western (outer) and causeway (inner) bund, and contains a mosaic of natural saltpan and degraded wetland habitat. This zone is largely confined to the Wetlands project area.
- Wetland Basin Zone forms the majority of the Wetlands and is comprised of a shallow lagoon with fringing saltmarsh vegetation. This zone is largely confined to the Wetlands project area.
- Saltwater Creek Zone, which contains permanent freshwaters and riparian vegetation (including some mangroves). This zone is largely confined to the Wetlands project area; although Saltwater Creek does extent upstream of Wetlands project area.
- Terrestrial Zone, which contains small ephemeral streams as well as terrestrial ecosystems (i.e. woodlands and grasslands - refer Section 3.1).

These zones form the basis for describing the biological and physio-chemical features of the Wetlands and adjoining areas influencing the Wetlands.



<p>Figure 2-2</p>	<p>Rev. E</p>	<p>BMT WBM www.bmtwbm.com.au</p>
<p>Title: Location of Wetland Zones</p>		<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representation as to the currency and accuracy of information contained in this map.</p>
<p>LEGEND</p> <ul style="list-style-type: none"> Kaiti Valley Wetland Boundary as Defined through DIWA Listing APSDA Boundary Road Railway Regrowth Watercourse (DERM) <p>Wetlands Project Area</p>		<p>Scale 0 1 2 km Approx. Scale</p>

2.2 Physical and Physio-chemical Patterns and Processes

This section provides an overview of the key physical and chemical patterns and processes that are important to the natural functioning of the Wetlands. This considers processes operating across broad regional spatial scales (i.e. extending well beyond the boundaries of the APSDA), such as climate and geology, and processes operating at local scales within the Wetlands (i.e. water quality and local-scale tidal hydraulics).

2.2.1 Climate and Weather Patterns

Important climatic patterns and processes in the broad region include:

- The region has a tropical monsoon climate with distinct wet and dry seasons (refer Figure 2-3);
- The annual average rainfall at Bowen Post Office is 1096 millimetres (mm) (118 years of data, Bureau of Meteorology 2010);
- The months of December to March tend to be the warmest and wettest. Tropical cyclones occasionally traverse the coast during these summer months. Such events can cause substantial damage to coastal vegetation and flooding within the Wetlands;
- The driest months occur in August and September;
- During summer, winds are frequently from the east to northeast, but southeast trade winds can persist throughout the year. These southeast trade winds are stronger in the winter and create wind-driven currents of up to 0.1 metres per second which partially drive a net movement of offshore sands to the west–northwest (WBM 2006).

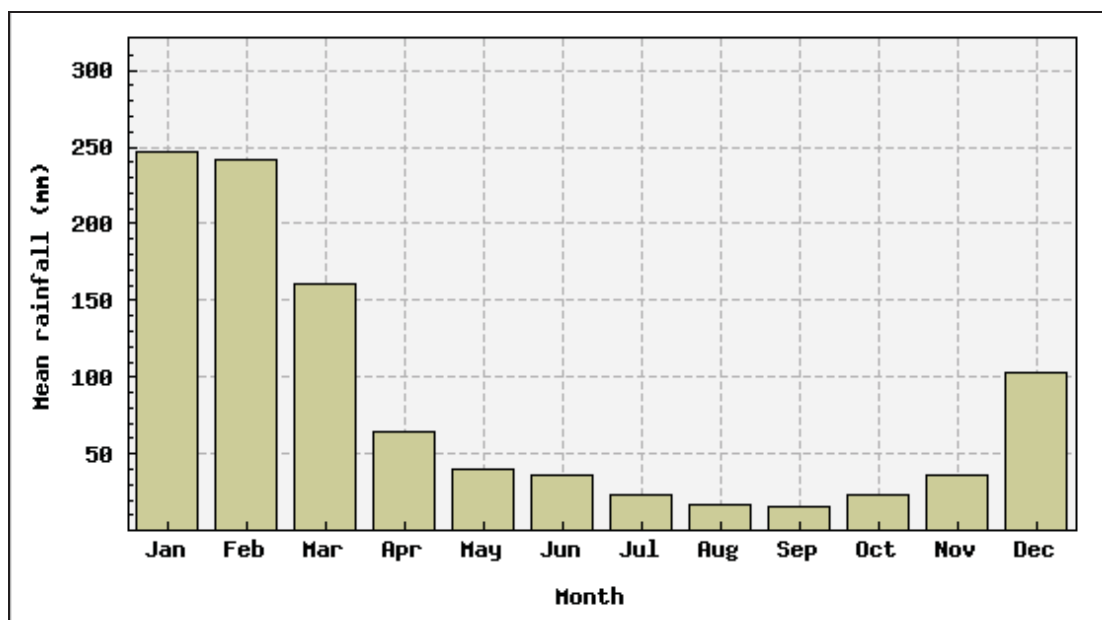


Figure 2-3 Mean Monthly Rainfall Data for Bowen Post Office - Station 033007 (BOM 2010)

In the period leading up to the preparation of this report, the study area and broader bioregion experienced one of the most severe droughts on record (2001–2006), followed by four consecutive

years of above average rainfall (Bureau of Meteorology unpublished data). There are anecdotal reports that this high rainfall resulted in flooding of the Wetlands. This high degree of inter-annual and seasonal variability in rainfall patterns results in significant changes to wetland habitats, communities and species, as discussed in the following sections of this report.

2.2.2 Regional Geology and Geomorphology

Patterns in regional geology and geomorphological processes underpin the ecological character of the Wetlands. A review of the regional geology using the Ayr and Bowen 1:250,000 Queensland Geological Mapping (Department of Mines and Energy 1968 and 1971) was undertaken. The geological mapping is reproduced in Figure 2-4 and depicts the location of the Wetlands and adjacent terrestrial areas.

The oldest rocks within this area were formed during the Upper Carboniferous and Lower Permian Age during the Paleozoic era some 230 to 345 million years ago. The coastal inselbergs of up to 286 metres (m) Australian Height Datum (AHD) outcrop at Abbot Point, Dingo Beach and at Mount Luce. These exist as steep sided hills and ridgelines with high relief and represent the highest ground in the area. The outcrops are composed of diorite, quartz diorite, tonalite, gabbro, norite, minor granodiorite, adamellite and granite while on the eastern side of Mount Luce there is a small area of outwash and talus (rock fragments lying at the base of the mountain) of Quaternary origin.

Mount Roundback and Mount Little bound the Wetlands to the south and southeast and represent Paleozoic intrusives. Mount Roundback is largely composed of adamellite, granite, some granodiorite with minor fine-grained variants while Mount Little is similar to the outcropping rocks at Abbot Point.

The Wetlands appear to have been formed by deposition of fluvial sediments and beach sands from Euri Creek and the Don River (DEWHA 2010b). During the last interglacial period, the sea level is thought to have been slightly higher than it is presently and Mount Luce and some of the surrounding rock outcrops were probably separated from the mainland as islands. Then as beach sands and sediments from the Don River and Euri Creek were transported to the northwest by the southeast trade winds, they accreted around Mount Luce and the rocks at Abbot Point. Eventually, accretion was sufficient to join these islands to the mainland (DEWHA 2010b). Freshwater delivered via the Don River system was then trapped within an embayment, creating the Wetlands.

The Wetlands are underlain by unconsolidated coastal mud flats. The coastal dunes located along Dingo Beach and running south of Abbot Point are up to approximately 2.5m AHD, and border the Wetlands to the north and east respectively. These dunes are composed of sand with some interbedded silt. The higher ground south of the Wetlands and between the outcropping Paleozoic intrusives are generally composed of alluvial and deltaic deposits consisting of sand, silt mud, gravel which is semi-consolidated in places.

Acid sulfate soils (ASS) are present over most of the coastal mudflat area of the region, including the Wetlands. The distribution of ASS within the Wetlands is closely related to the distribution of Quaternary coastal mudflats within the Wetlands (GHD 2009 ASS) and surrounding the APCT (Aurecon Hatch 2009).

2.2.3 Fluvial Hydrology

The fluvial hydrology of the Wetlands is dominated by local runoff from the Salisbury Plain and the slopes of Mount Roundback and Mount Little, located to the south and south east of the Wetlands respectively. The Wetlands are fed by both overland flow and numerous creek systems, which include: (from west to east) Plain, Splitters, Spring, Branch, Tabletop, Maria, Mount Stuart, Six Mile, Goodbye and Saltwater creeks (Figure 2-4). Saltwater Creek is the largest creek system draining into the Wetlands, and is connected to the upgradient Euri Creek and Don River systems to the east of the Wetlands. The remaining creeks that flow into the Wetlands are ephemeral drainages, most of which are expected to dry or contain small pools during dry periods.

The hydrology of the Wetlands undergoes dramatic seasonal and inter-annual variability. In the wet season, the Wetlands can be 18 km long and 6 km wide, and cover an area of approximately 5,000 ha (GHD 2009). Under such conditions, water is thought to flow in a predominantly east–west direction. During the dry season, tidal processes tend to dominate in wetland areas west of the mouth of Saltwater Creek. Under prolonged drought conditions, waters within the Wetland Basin Zone can contract into the area known as Lake Caley. There are no reports of Saltwater Creek completely drying.

2.2.4 Tidal Hydraulics

The maximum tidal range for Abbot Point is 2.4 m (GHD 2009) however storm surges resulting from low atmospheric pressure and onshore winds can raise maximum tidal heights. Tidal regimes in the Great Barrier Reef (GBR) lagoon and lower reaches of the Wetlands are semi-diurnal. The mean tidal range in Curlewis Bay is 3.6 m (DEWHA 2010b). During the dry season, the effect of tides is more pronounced due to there being a smaller volume of freshwater entering the Wetlands in conjunction with a much reduced overall water volume.

There are two bunds located in the western sections of the Wetlands which have an influence on tidal hydraulics and therefore ecosystem functioning within the Wetlands (refer Figure 2-2 for bund locations). The causeway (inner) bund was originally constructed in the 1950s and refurbished in the early 1980s to provide access for construction equipment to the APCT (GHD 2010) and is located entirely within the Wetlands project area. Tidal water movements cross under this structure via a small (300 mm diameter) pipe located on the southern end of the causeway (inner) bund. It is also possible that tidal waters may overtop the causeway (inner) bund via a low-lying depression located on the northern end of the causeway (inner) bund. The causeway (inner) bund would be overtopped during high flood events combined with strong southerly winds.

The western (outer) bund, located on Mount Stewart Creek, was constructed in the early 1980s. This feature is located within and adjacent to the western boundary to the Wetlands project area. The western (outer) bund restricts tidal movements into the Wetlands within the Wetlands project area⁶, particularly within the northern section of the Wetlands between the two bunds. As a result, approximately 46 ha of mangroves (GHD 2010) have been replaced by saltpan and ponded hypersaline waters upslope of the western (outer) bund. Furthermore, the western (outer) bund represents an aquatic fauna movement barrier, reducing fish habitat value of the Wetlands.

⁶ While tidal exchange within the Wetlands (i.e. in the area upslope of the Western Bund) occurs via Branch Creek during large spring tides, this is insufficient to flush the Wetlands.

During spring tides, tidal waters propagate along Branch Creek and onto the saltpan of the Hypersaline Zone. It is also expected that tidal waters would intrude into this zone through the outer (outer) bund wall. During dry periods, marine waters become impounded upslope of the Western Estuarine Zone outer bund, despite the apparent 'leaky' nature of this structure, and salinity increases as water levels decline in response to evaporation (refer Section 2.2.5).

The tidal hydraulics of Saltwater Creek is not well understood. This creek system has a freshwater to slightly brackish water character (refer Section 3.2.4). A small channel connects Saltwater Creek to mangrove forests to the east. Field measurements undertaken during a spring tide cycle over October to November 2010 did not identify any tidal water movement through this channel and into Saltwater Creek (Appendix A). Marine waters could potentially intrude into Saltwater Creek from the east during large spring tide events or as a result of storm surges. A fluvial delta occurs at the mouth of Saltwater Creek, and appears to limit tidal water movement into the Saltwater Creek Zone.

2.2.5 Water Quality

Surface water quality of the Wetlands is largely driven by the fluvial hydrology, groundwater and tidal influences described above in Sections 2.2.2 and 2.2.3. Other water sources which may influence the water quality of the Wetlands include treated surface water runoff from the Port of Abbot Point located to the north of the Wetlands, and runoff from the elevated dunes and ridges within the APCT which enter the Wetlands from the east (GHD 2009). Patterns in water quality within the Wetlands are summarised below based on the data sources shown in Table 2-1. Figure 2-4 shows the location of sampling sites referred to in the text.

Table 2-1 Water Quality Data Considered in this Baseline Assessment

Data source	Description	Spatial coverage	Temporal coverage	Parameters
Peter Hollingsworth and Associates (1979 and 1981)	Addendum to the Abbot Point Coal Terminal EIS, undertaken prior to APCT construction	Four sites within the Wetlands	One off - 1981	Salinity
APCT (unpublished data) in WBM (2006)	Routine monitoring data compiled by Ecovise Environmental on behalf of APCT.	Two sites – one site in the NE extremity of the Wetlands; one site downstream of the secondary settlement pond (refer Figure 2-4).	1997 to 2004	Salinity/EC, pH, occasional dissolved oxygen
Wetlands Database (DEWHA 2010b)	Snap shot survey only.	Several sites around the lake	September 1999	Salinity
WBM (2006)	Data collected for APCT Stage 3 Expansion EIS. Data collected following catchment rainfall.	Six sites throughout the Wetlands (refer Figure 2-4).	Two sample events: April & June 2005.	In situ physio-chemical parameters, ions, trace metals, nutrients
GHD (2009)	Data collected for APCT X110 Expansion – Infrastructure Development Project Voluntary Environmental Assessment	Three sites within and adjacent to APCT.	Monthly sampling Jan 08 to Jan 09	Salinity/EC, nutrients, pH
GHD (2010)	Monitoring data collected on behalf of NQBP	14 sites throughout Wetlands	Monthly sampling, Feb to July	Salinity

Data source	Description	Spatial coverage	Temporal coverage	Parameters
			10	
BMT WBM (BMT WBM October 2010 – November 2010 study)	Data collected to inform information gaps identified in the BMT WBM October 2010 – November 2010 study.	Nine sites within the Wetlands	Oct to Nov 10 (EC, depth) Snap-shot for most other parameters	Continuous measurements of EC and depth over a one month period. Snap-shot survey of trace metals, nutrients and chlorophyll a.

GEOLOGICAL UNIT

Quaternary

- Qr - Clay, silt, sand, gravel and soil; colluvial and residual deposits
- Qa - Alluvium, coastal mud flats, minor evaporites, colluvium and soil
- Qs - Residual and colluvial soil, sand, gravel and rubble;
some semi-consolidated material

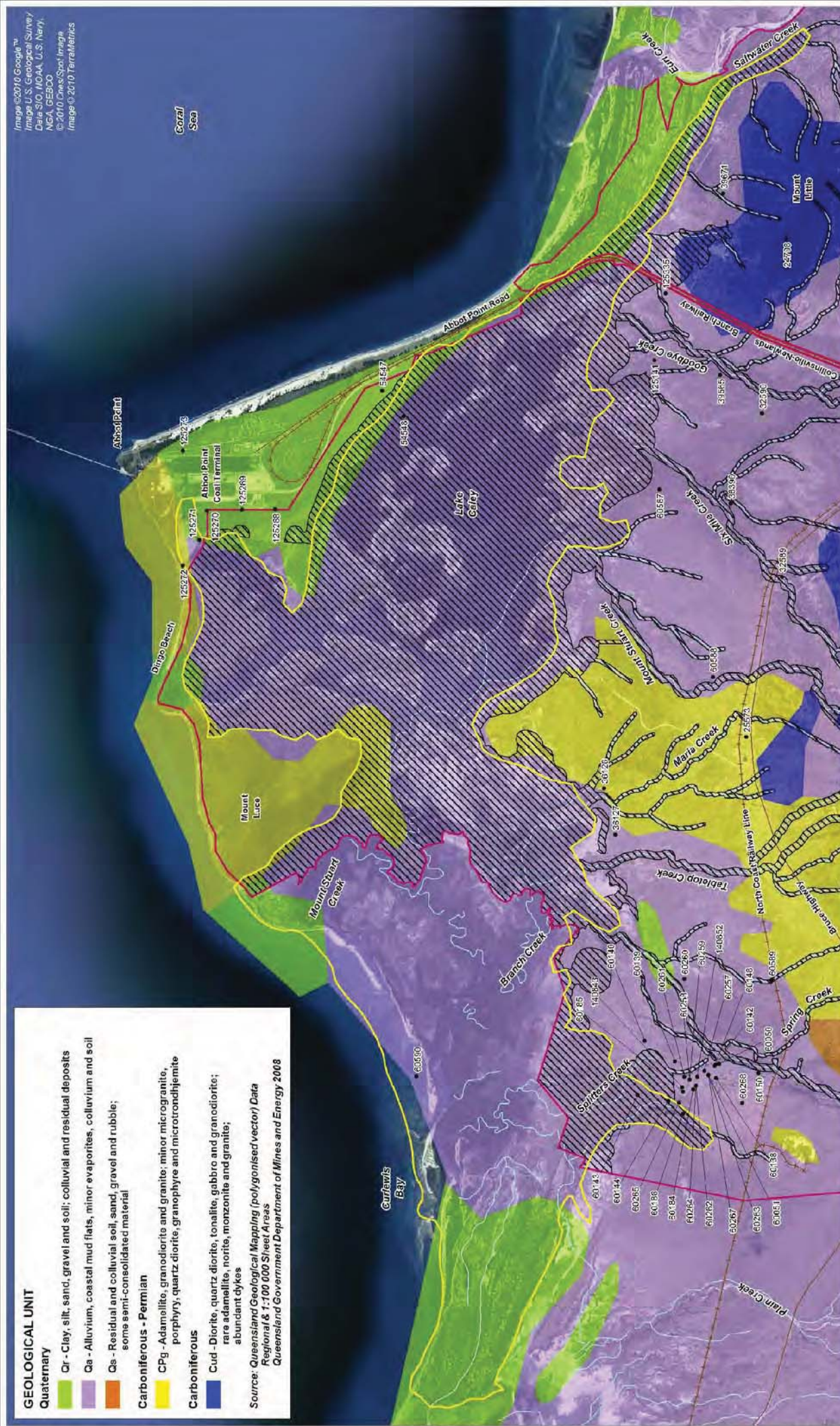
Carboniferous - Permian

- CPg - Adamellite, granodiorite and granite; minor microgranite,
porphyry, quartz diorite, granophyre and microtrondhjemite

Carboniferous

- Cud - Diorite, quartz diorite, tonalite, gabbro and granodiorite;
rare adamellite, norite, monzonite and granite;
abundant dykes

Source: Queensland Geological Mapping (polygonised vector) Data
 Regional & 1:100 000 Sheet Areas
 Queensland Government Department of Mines and Energy 2008



LEGEND



Kaili Valley Wetland Boundary
 as Defined through DIWA Listing

APSDA Boundary

Road

Railway

Regrowth Watercourse (DERM)



Wetlands Project Area

Bore (Labelled with RN Number)

Figure

2-4

Rev:

E

Title: Geology and Boreholes Within the Kaili Valley Wetlands and Surrounding Areas

BMT WBM endeavours to ensure that the information provided in this map is accurate and reliable. BMT WBM does not accept any liability for any errors or omissions, or for any loss or damage, arising from the use of this map. BMT WBM does not guarantee or make representations regarding the currency and accuracy of information contained in this map.



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 Approx. Scale



BMT WBM
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Coral
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Abbot
 Bay

Abbot Point

Diago Beach

Abbot Point
 Coal Terminal

Mount
 Luce

Mount
 Luce

Curlew's
 Bay

Lake
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Salinity

Salinity data, together with patterns in vegetation community structure, reveal that a salinity gradient exists within the Wetlands, resulting in the creation of marine, hypersaline, brackish and freshwater waterbodies along this gradient (refer Figure 2-6). Patterns in salinity within each functional zone are summarised below.

Coastal Zone

The coastal zone, which is outside the Wetlands project area, is dominated by marine waters, except during major floods which are expected to result in short term reductions in salinity. There are no salinity data for the coastal zone within the Wetlands, although some data are available for adjacent Port waters (refer WBM 2006).

Western Estuarine Zone

Monthly monitoring data collected by GHD (2010) at a site down-slope of the western (outer) bund shows that while salinity is typically within the range of marine conditions during non-flow periods, but declines following rainfall. Measurements by BMT WBM in October to November 2010 also showed that the estuarine channels in the western sections of the Wetlands (the lower reaches of Branch Creek and Mount Stewart Creek) are typically marine to slightly hypersaline in character during dry periods (~35 g/L to 45 g/L). The slightly hypersaline conditions have been recorded in the upper reaches of Mount Stewart Creek immediately down slope of the western (outer) bund (WBM 2006; BMT WBM October 2010 – November 2010 study). Salinity measurements undertaken by BMT WBM indicate that highest salinities occur during low tides, suggesting some leakage of ponded hypersaline waters through the western (outer) bund wall.

Salinity can show marked declines following rain events. For example, a 100 mm rainfall event on the 18th November 2010 resulted in salinities declining to 24,000 $\mu\text{S}/\text{cm}$ (~15 g/L, or one third seawater) in the upper reaches of the Mount Stewart Creek, and 353 $\mu\text{S}/\text{cm}$ (freshwater) in the upper estuary of Branch Creek.

Hypersaline Zone

This zone broadly occurs between the causeway (inner) and western (outer) bunds. Salinity regimes in this zone vary over time in response to catchment rainfall patterns, varying from freshwater conditions during floods, to hypersaline during dry periods (GHD 2010).

During spring tides, tidal waters propagate along Branch Creek and onto the saltpan. It is also likely that tidal waters would intrude into this zone through the western (outer) bund. During dry periods, marine waters become impounded upslope of the western (outer) bund, despite the apparent 'leaky' nature of this structure, and salinity increases as water levels decline in response to evaporation. Waters within this zone can have very high salinities (>100 g/L; refer WBM 2006 and Figure 2-5), and a thick crust of salt and algae can form during dry condition.

As water depth increases in response to catchment runoff, salt concentrations are reduced through dilution, and can approach brackish water conditions (DEWHA 2010b). Sampling undertaken in October and November 2010 indicate that salinity was generally >60 g/L (hypersaline), but declined

to 21.6 g/L (approximately 60% seawater) following catchment rainfall in mid to late November. This can result in major shifts in vegetation community structure, with a range of brackish water macrophytes establishing in this zone during prolonged wet periods (DEWHA 2010b).

Wetland Basin Zone

This zone occurs in wetland areas upslope of the causeway (inner) bund and down-slope of Saltwater Creek. A weak east-west salinity gradient exists within this zone during non-flood periods, varying in response to rainfall conditions. During non-flow periods, large areas of the Wetland Basin Zone experience salinities approaching marine conditions (GHD 2010; refer also Appendix A), which is reflected in the largely estuarine character of vegetation in this zone.

While estuarine conditions persist following rainfall events (GHD 2010), salinity can show rapid and marked declines following catchment rainfall (Appendix A). Logger measurements by BMT WBM indicated that during non-rainfall periods (27/10/10 to 1/11/10), salinity ranged from 27,979 $\mu\text{S/cm}$ (~16 g/L salinity, or 46% seawater) in the eastern part of the Wetland Basin Zone (site 3), to 48,804 $\mu\text{S/cm}$ (~29 g/L, or 82% seawater) in the western part of the Wetland Basin Zone and 70,153 $\mu\text{S/cm}$ (42 g/L, hypersaline) immediately upslope of the causeway (inner) bund. Salinity showed little variation over time for most of the subsequent measurement period at site 3 (eastern part of the Wetland Basin Zone), but did decline to ~10,000 $\mu\text{S/cm}$ (6 g/L, or 17% seawater) following >150 mm of rainfall between the 18th and 23rd November. At the two sites located in the western sections of the Wetland Basin Zone, salinity showed marked declines in response to rainfall events, most notably between 18th and 23rd November when salinities declined to ~10,000 to 13,000 $\mu\text{S/cm}$ (6-8 g/L, or 17% to 22% seawater).

The variable salinity is a distinct feature of the Wetland Basin Zone (GHD 2010). For example, APCT monitoring data for a site located in the north of the Wetland Basin Zone immediately downstream of the APCT settlements ponds shows that equivalent salinity ranged from approximately 1 g/L (freshwater) to 10 g/L (~28% seawater). Salinity regimes here are driven by rainfall, with cumulative three month rainfall explaining approximately 80% of the variation in electrical conductivity (Figure 2-5). Similar fluctuations in salinity were observed by GHD (2010) at sampling sites throughout the Wetland Basin Zone.

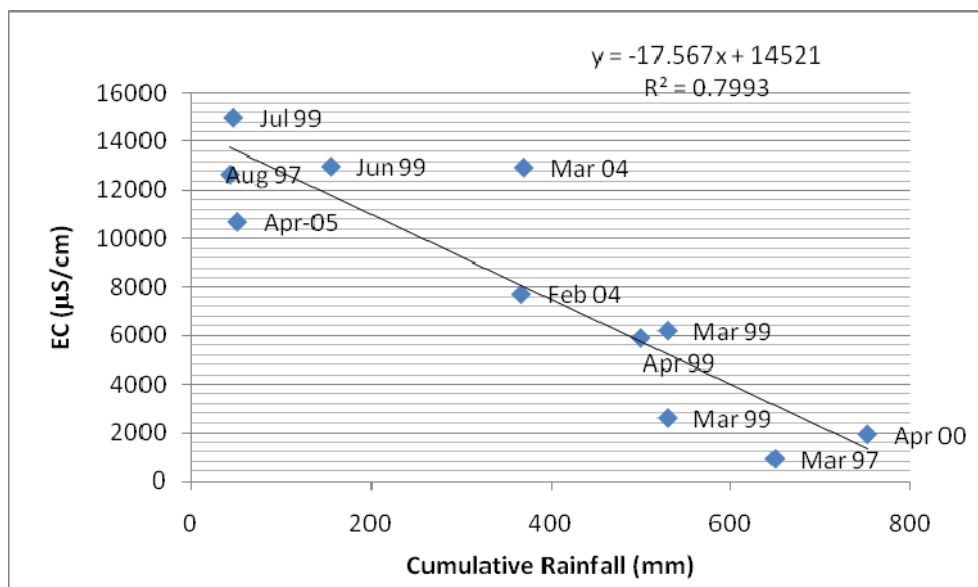


Figure 2-6 Electrical Conductivity (µS/cm) and Cumulative Three Month Rainfall at the “Caley Valley Wetlands Site” (i.e. site 5 of WBM 2006) near APCT (Source: APCT in WBM 2006)

Saltwater Creek Zone

The reach of Saltwater Creek within the Wetlands project area has a freshwater to slightly brackish character (GHD 2010; refer also Appendix A). Monthly monitoring undertaken by GHD (2010) at two sites in Saltwater Creek revealed a slight increase in salinity over time, approaching 2,000 µS/cm during dry periods. Similarly, measurements undertaken by BMT WBM during a dry period in October 2010 indicate that the downstream sections of the creek (site 2) typically had salinities <1,600 µS/cm (freshwater), whereas further upstream (site 1) slightly brackish conditions were recorded (3,800 µS/cm, 2.2 g/L or 6% of seawater).

Salinity can show marked short-term variability in response to rainfall in the catchment. Logger data (Appendix A) shows that a rainfall event in late November 2010 resulted in an increase in salinity in the downstream sections of the creek (3,343 µS/cm), suggesting that the slightly brackish waters upstream were being pushed downstream by the stream flow. However, upstream at site 1, there was little change in measured salinity during this rainfall event.

These complex salinity patterns appear to be partly a function of seawater intrusion into the creek from the east. A small channel, which connects Saltwater Creek to the sea, remained dry throughout the measurement period, suggesting that any connection occurs intermittently. No correlation between water levels at either sites in Saltwater Creek and tidal height were observed during the measurement period, again suggesting that any intrusion of seawater via tidal processes, if present, would only occur intermittently. It is notable that riparian vegetation along Saltwater Creek does include mangroves, suggesting that the creek maintains some connectivity to the sea. Further work is required to characterise the hydraulics of this creek system in order to determine the risk of saltwater intrusion due to any changes in wetland hydraulics or sea level rise.

Terrestrial Zone

There are no data describing the water quality of smaller creeks that enter the Wetlands. This is considered to represent a major gap, particularly in the context of determining appropriate water quality objectives for these waterways.

Nutrients and Trace Metals

Nutrient and trace metal data are available from snapshot surveys undertaken by WBM (2006) and BMT WBM (Appendix A).

WBM (2006) sampled a site within the Hypersaline Zone (site C) and two sites⁷ within the Wetland Basin Zone. At the time of the survey, site C (Hypersaline Zone) had lower nitrogen but higher phosphorus concentrations than the two sites located in the Wetland Basin Zone (sites 5 and E). Organic nitrogen was the dominant nitrogen species at all sites, and site C also had higher concentrations of nitrogen oxides (NO_x) and ammonia than the other sites.

The BMT WBM October 2010 – November 2010 study assessed nutrient concentrations at nine sites throughout the Wetlands in November 2010 (Appendix A). Total nitrogen ranged from 0.9 (site 9, Wetland Basin Zone) to 1.9 mg/L (site 2, Saltwater Creek Zone), with exceedances of default regional guideline values outlined in DERM 2009) at most sites. Organic nitrogen dominated, although concentrations of ammonia exceeded guideline values at most sites. Total phosphorus concentrations also exceeded the regional guideline value at all sites, however filterable reactive phosphorus, which is bio-available and therefore able to exert a major influence on algae growth, was recorded in low concentrations.

Large mats of algae were observed in shallow waters within the Hypersaline Zone and the Wetland Basin Zone. DEWHA (2010b) suggests that the nutrient enriched sediments in these areas represent an important source of nutrients for the wetland ecosystem.

WBM (2006) found that concentrations of most trace metals were highest at the site in the Hypersaline Zone (site C) than the two sites in the Wetland Basin Zone. By contrast, the BMT WBM October 2010 – November 2010 study found that sites in the Hypersaline Zone had lower trace metal concentrations than other parts of the Wetlands. In the BMT WBM October 2010 – November 2010 study, the Saltwater Creek Zone and the Western Estuarine Zone had the highest concentrations of most trace metals.

Trace metal concentrations were compared with ANZECC/ARMCANZ (2000) toxicant trigger values (95% species protection level). In summary:

- WBM (2006) found that trace metal concentrations were below *marine* trigger values at all sites (which are applicable given the saline nature of waters at the time of sampling).
- In the October-November 2010 study, the Saltwater Creek Zone had concentrations of aluminium, chromium, copper and zinc which exceeded respective *freshwater* trigger levels (which are applicable given the conditions at the time of sampling).

⁷ One site located the northeast corner of the Wetlands immediately downstream of APCT (site 5) and the Wetlands at the homestead (site E).

- The October-November 2010 study also found that the following trace metals had concentrations above ANZECC/ARMCANZ (2000) trigger values for *marine* waters: copper (all sites except the Hypersaline Zone), chromium (Western Estuarine Zone) and zinc (Western Estuarine Zone, and one site in the Wetland Basin Zone).

There are many factors which influence spatial and temporal patterns in concentrations of trace metals and other pollutants. In particular, rainfall can exert a major influence on trace metals concentrations. It is noted that the November 2010 sampling was undertaken immediately following a rainfall event at the end of the dry season. Such 'first flush' events can flush large quantities of soil and other pollutants from the surrounding catchment into receiving waters, resulting in a temporary spike in pollutant concentrations. The WBM (2006) study may be more representative of background conditions.

Sampling across a range of sites across a range of time periods is required to adequately characterise background water quality conditions (DERM 2009), and the drivers leading to changes in water quality conditions. This is critical to establishing local water quality objectives for the Wetlands prior to industry and infrastructure development occurring in the APSDA.

Other Water Quality Parameters

The 1981 sampling indicated that the two sites immediately upslope of the causeway (inner) bund within the Hypersaline Zone were alkaline, pH ranging from 8.5 – 9.8. The northeast corner of the Wetland Basin Zone (immediately downstream of the APCT) has a variable pH, with either mildly acidic or mildly alkaline conditions occurring. These variations would be associated with upstream inputs of low pH waters from APCT. Measurements of pH in 1999 (DEWHA 2010b) ranged from 7.8 on the flat south east of Mount Luce to 8.9 on the eastern side of the northern end of the causeway (inner) bund. Sampling from 2005 indicated that pH throughout other parts of the Wetland Basin Zone ranged between 8.65 and 9.24 (Figure 2-6). During the period 2005-2008, the pH in Lake Caley proper was highly variable ranging from approximately 6 to 9.5 (GHD 2009).

Dissolved oxygen concentrations can show great spatial variability throughout the Wetlands. For example, sampling by DEWHA (2010) in 1999 recorded dissolved oxygen concentrations ranging from 50 percent saturation (4.5 mg/L) in the northern section of the Wetland Basin (taken at 9:30 am) to 267 percent (20.4 mg/L) south of Lake Caley (time of sampling not documented). Sampling by WBM (2005) suggested that most sites were well oxygenated, with slightly depressed concentrations recorded in the Western Estuarine Zone immediately downstream of the western (outer) bund (Figure 2-6). Dissolved oxygen concentrations tend to vary greatly in time in response to changes in algae and microbial production (which varies seasonally and in the case of algae between day and night) and wetland hydrology. There are presently too few data to determine temporal trends in dissolved oxygen.

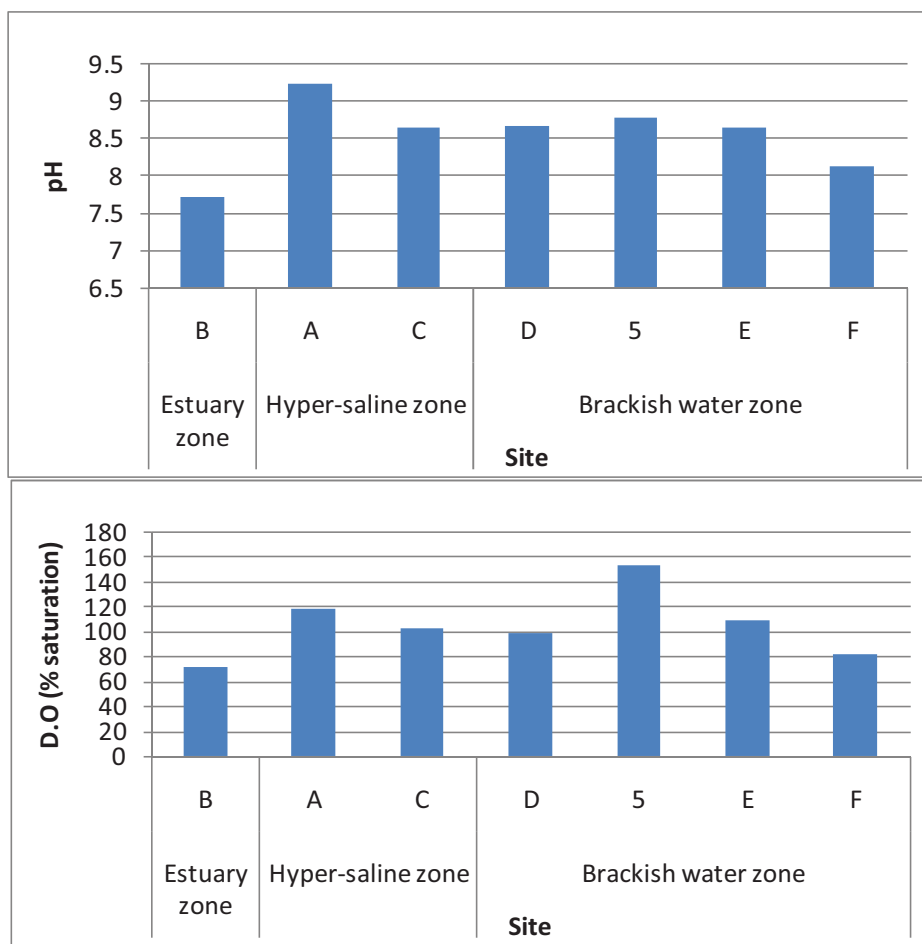


Figure 2-7 Measurements of pH and Dissolved Oxygen in the Wetlands – 20th April 2005 (WBM 2006)

2.2.6 Ground Water Quality

PB (2009) notes the following in relation to groundwater conditions in the study area:

- The Wetlands are likely to be prone to shallow groundwater levels;
- There is a high correlation between surface elevation and groundwater levels, with groundwater levels predicted to range between 0-2 m below the ground surface;
- The close proximity to the coast means that groundwater is likely to be at the freshwater/saltwater interface; and
- The combination of a density difference at the freshwater/saltwater interface and shallow gradients are the dominant hydraulic features controlling groundwater movement and water levels.

The holistic surface/groundwater water balance including the interaction with the Wetlands has not been quantified to date.

Figure 2-4 shows the location of licensed bores within the vicinity of the Wetlands. Of the data available to date, groundwater quality exceedances have previously been recorded at DERM registered groundwater bores on land adjacent to the northeast corner of the Wetlands (WBM 2006).

The analytes that exceeded the relevant water quality guidelines were total arsenic, aluminium, cadmium, chromium, copper, lead, manganese, nickel and zinc. Iron and sulphate concentrations were also considered elevated and it has been suggested by GHD (2009) that the elevated concentrations of iron and sulphate may be associated with either infiltration of runoff contaminated from the coal stockpiles, leakage of the APCT settlement ponds into groundwater and/or a natural occurrence related with acid sulphate soils or marine sediments.

2.3 Key Human Uses

2.3.1 Land Use

The previous dominant land use within the study area was grazing for cattle. DEH (2006) suggests that the security of this international port facility is partly dependent on maintenance of uninhabited wetland areas around its perimeter. The other main use is the port facility at Abbot Point, located north of the study area.

Several dwellings occur within and directly adjacent to the study area, most of which are dwellings of local graziers. The APCT does not contain any on-site accommodation; however it does contain ancillary office facilities.

2.3.2 Recreation and Tourism

Recreation and tourism are not recognised as values supported by the Wetlands. The Wetlands are not promoted on the Tourism Bowen website as an area of interest for tourists. Although the Wetlands serve as important roosting and foraging ground for a wide range of bird species, it is not known to represent a key bird watching area. Similarly, while several charter fishing boats operate out of Bowen, the Wetlands are not known to represent an important fishing area for these operators.

As part of the Wetlands within the Wetlands project area is privately owned, access constraints limit the recreation and tourism opportunities associated with the Wetlands in the Wetlands project area.

The desired management intent of the Port and future industrial activities within the APSDA is to maintain the security and integrity of land and facilities and the safety of staff and visitors. Uncontrolled access to the Wetlands in the Wetlands project area could conflict with this management intent.

2.3.3 Fisheries Resource Values

The Wetlands themselves are not known to represent an important fishing area for commercial fishers. However, the Wetlands provides a large area of potential breeding and nursery habitat for a number of important commercial species, most notably Barramundi (*Lates calcarifer*).

The Wetlands occur immediately adjacent to a range of marine habitats (seagrass meadows, reefs, soft sediments) of potential fisheries significance (refer Section 4.2 for fisheries habitat values). Commercial catch data for the region was extracted from CFISH database, through the Fisheries Queensland (FQ) Coastal Habitat Resource Information System (CHRIS). Commercial catch data were extracted from grid M22, which covers the entire Abbot Point area. For the period 1998-2003 (WBM 2006), finfish catches were numerically dominated by mackerel species, which together

represented 49% of the total catch. Of the mackerel catch, 49% were spotted mackerel, followed by Spanish Mackerel (29% of catch), unspecified (20% of catch) and Grey Mackerel (6% of catch). The shark fishery represented ~ 41 % of the total finfish catch, whereas cod (predominantly Coral Trout) represented 3% of the total catch. All other finfish species represented <2% of the total finfish catch. WBM (2006) states that shellfish catches were more evenly distributed among species than finfish. In terms of prawns, Tiger Prawns represented the highest proportion (~41%) of the total shellfish catch, followed by King Prawns (15%), Endeavour Prawns (4%) and Banana Prawns (3%). Mud Scallops represented 22% of the total shellfish catch, while bugs (11%) and saucer scallops (3%) represented smaller proportions of the total catch.

3 WETLAND HABITATS AND CONDITION

3.1 Representative Wetland Types

The Wetlands are composed of a diverse range of coastal and inland wetland types. Wetland types present range from intertidal forested wetlands and mudflats, to seasonal freshwater marshes and permanent freshwater pools. The DIWA wetland classification system (DEH 2006) has been adopted in this report. Several existing data sources describe the distribution of different wetland types that are analogous to those used in the DIWA classification scheme, namely:

- Wetland mapping undertaken by the DERM as part of the State-wide Queensland Wetlands Program. Refer to Section 3.1.1.
- Queensland DERM Regional Ecosystem (RE) mapping, including pre-clearing vegetation extent. Refer to Section 3.1.2⁸.

These data sources, together with site inspections and review of aerial photography, provide a basis for describing the distribution of DIWA wetland types within the Wetlands (refer Section 3.2).

3.1.1 DERM Wetland Mapping

The DERM mapping method uses a combination of RE mapping (refer Section 3.1.2) and waterbody mapping (interpreted from satellite imagery) in order to classify wetlands into the broad categories of marine, estuarine, riverine, lacustrine and palustrine types. The DERM and DIWA classification systems are partly analogous, however the DIWA classification scheme adopts a finer-scale classification scheme (e.g. DERM Marine includes at least five DIWA wetland types; DERM Estuarine includes six DIWA wetland types).

DERM wetland mapping for the Wetlands is shown in Figure 3-1, and includes the following wetland types:

- Marine Waterbodies (WB);
- Lacustrine Waterbodies;
- Estuarine Waterbodies and Estuarine REs;
- Palustrine Waterbodies and Palustrine REs; and
- Riverine waterbodies and Riverine REs.

It should be noted that the DERM wetland mapping was undertaken based on a review of existing information and limited ground-truthing. For this reason, this mapping does contain some inaccuracies. For example, while the DERM mapping does identify some small areas of lacustrine waterbodies, it fails to identify a large proportion of the Wetland Basin Zone (including Lake Caley), which is considered to fall into this category. In addition the APCT settlement ponds, which are artificial waterbodies, are mapped as an Estuarine Waterbody. Similarly, Saltwater Creek is mapped as an Estuarine RE, but field surveys suggest it has a more freshwater to slightly brackish character. Due to these anomalies, this mapping should be used with caution.

⁸ DERM have also mapped important GBR wetlands. Refer to Appendix G for a description of this mapping.

WETLAND TYPE

- Estuarine Regional Ecosystem
- Estuarine Water Body
- Lacustrine Water Body
- Marine Water Body
- Palustrine Regional Ecosystem
- Palustrine Water Body
- Riverine Regional Ecosystem
- Riverine Water Body

Coral Sea

Abbot Point

Dingo Beach

Mount Largo

Mount Stuart Creek

Branch Creek

Gulf Lewis Bay

Lake Carey

Abbot Point Road

Abbot Point Coal Terminal

Shiners Creek

Branch Creek

Tabletop Creek

Marjo Creek

Wilmington Sliding

Spring Creek

Wilmington Station

Plain Creek

Blue Mtns

Goodby Creek

Collinsville-Newlands

Branch Railway

North Coast Railway Line

Emu Creek

Saltwater Creek

Mount Duff

LEGEND



- Kaill Valley Wetland Boundary as Defined through DIWA Listing
- APSDA Boundary
- Road
- Railway
- Regrowth Watercourse (DERM)



Wetlands Project Area

RE Boundary (DERM)

Title: **Present-day Wetland Types Mapped by DERM (Unpublished)**

Figure: **3-1**

Rev: **E**

BUT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BUT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



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3.1.2 Regional Ecosystems and Threatened Vegetation

RE mapping has been undertaken by the Queensland Herbarium throughout the broader region, including the study area. REs are vegetation communities that are consistently associated with a particular combination of landform, soil and geology, and are unique to individual biogeographic regions. Some of these REs are analogous to DIWA wetland types (refer Table 3-1). Pre-clearing and present-day REs as currently mapped by DERM for the Wetlands are shown in Figure 3-2 and Figure 3-3, respectively. Figure 3-3 includes changes proposed to existing mapping by GHD (2009) following ground surveys. It should be noted that such changes to RE mapping have no legal status until they are formally remapped by DERM. The pre-clearing regional ecosystems are determined from the survey of remnant vegetation, aerial photographs, geology, ecological and historical knowledge (DERM 2010d).

A total of 24 REs have been mapped within the study area (Appendix E). These REs encompass coastal dunes, estuarine vegetation, palustrine wetlands and terrestrial vegetation. There is generally good agreement between pre-clearing and existing RE mapping for areas within the Wetlands. It should be noted that RE mapping did not identify changes in wetland vegetation that have been documented in other studies (Section 3.2.2), hence caution is advised when interpreting these maps. By contrast, RE mapping shows there have been extensive changes to the vegetation in adjoining terrestrial areas and beyond.

One RE is equivalent to a threatened ecological community (TEC) listed under the Commonwealth EPBC Act, namely RE 11.2.3 - Microphyll vine forest ("beach scrub") on sandy beach ridges and dune swales. This TEC is listed as endangered under the EPBC Act, and as Of Concern RE under the Queensland *Vegetation Management Act 1999* (VM Act). There are three mapped patches of this RE in the study area (Figure 3-3), with one patch located near the mouth of Saltwater Creek and partly within the Wetlands project area, a second patch within the APSDA and Port lands but largely outside the Wetlands, and a third patch near APCT is located entirely outside the Wetlands and the APSDA.

Mixed polygons indicate areas containing separate, different REs, which have not been mapped separately at the scale of the map (DERM 2009). Ground surveys would be required to map the exact locations of the different REs present within each of the mixed polygons.

One rare or threatened vegetation species is known to occur within the study area. Black Ironbox (*Eucalyptus raveretiana*) listed as Vulnerable under the EPBC Act and the NC Act was located in the vicinity of Saltwater Creek, though its exact location was not given (PB 2009). Threatened species were identified within the broader search area using the EPBC Act protected matters search tool but were not located within the Wetlands though they may occur on Mount Luce. Further discussion on threatened species is provided in Appendix D.

PRE-CLEARING RE (DERM)

11.1.1	11.3.25b
11.1.2	11.3.25f
11.1.2/11.2/11.1.4 (75/20/5%)	11.3.27x1c
11.1.2a	11.3.27x1c/11.1.2b (60/40%)
11.1.2b	11.3.29x1/11.3.35 (50/50%)
11.1.2b/11.3.27x1c (70/30%)	11.3.31
11.1.4	11.3.31/11.3.7/11.3.13 (75/15/10%)
11.1.4	11.3.32/11.3.30/11.3.33 (70/25/5%)
11.2.1	11.3.32/11.3.30/11.3.33 (70/25/5%)
11.2.2	11.12.1
11.2.3	11.12.1/11.3.10/11.3.30/11.3.32 (40/40/15/5%)
11.2.5	11.12.1/11.3.30/11.3.32/11.3.33 (50/25/15/10%)
11.2.5/11.2.3 (85/15%)	11.12.1/11.12.4 (95/5%)
11.2.5/11.2.3/11.2.2 (75/20/5%)	11.12.1/11.12.4/11.12.10 (65/20/10/5%)
11.2.5/11.3.1/11.3.12/11.3.13 (50/25/20/5%)	11.12.4
11.3.7/11.3.9 (50/50%)	11.12.7
11.3.9	11.12.13
11.3.9/11.3.7/11.3.10/11.3.25 (45/45/5/5%)	11.12.13/11.12.4 (50/50%)
11.3.10/11.3.30 (60/40%)	11.12.16
11.3.12/11.3.32/11.3.34/11.3.13 (35/30/25/10%)	11.12.16x1
11.3.25	

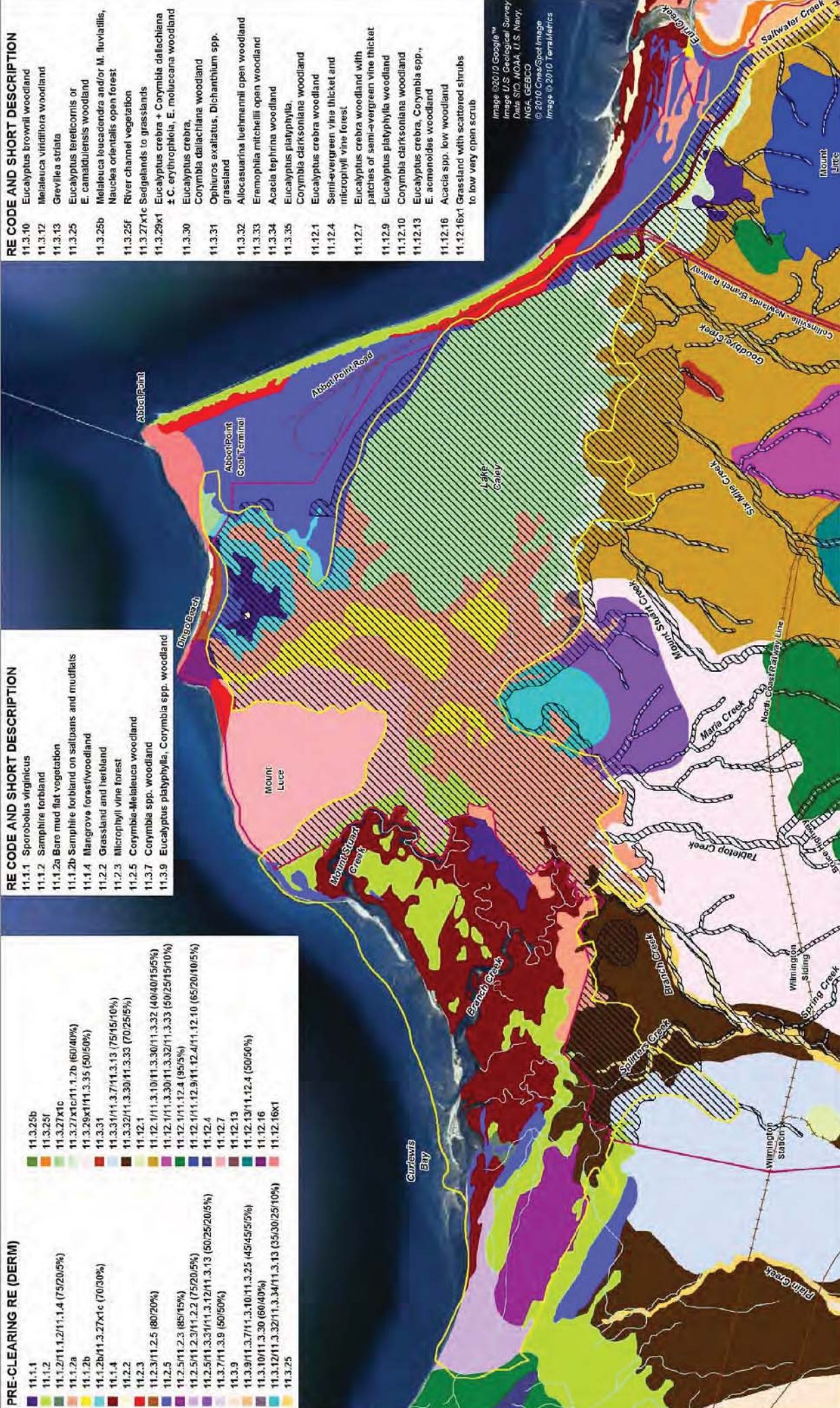
RE CODE AND SHORT DESCRIPTION

11.1.1	Sporobolus virginicus
11.1.2	Samphire forland
11.1.2a	Bare mud flat vegetation
11.1.2b	Samphire forland on salt pans and mudflats
11.1.4	Mangrove forest/woodland
11.2.2	Grassland and herbland
11.2.3	Microphyll vine forest
11.2.5	Corymbia-Melaleuca woodland
11.3.7	Corymbia spp. woodland
11.3.9	Eucalyptus platyphylla, Corymbia spp. woodland

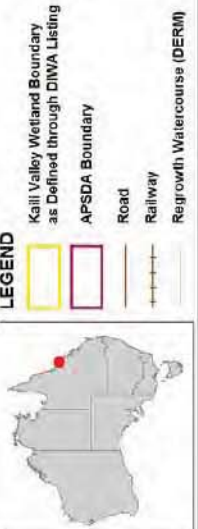
RE CODE AND SHORT DESCRIPTION

11.3.10	Eucalyptus brownii woodland
11.3.12	Melaleuca viridiflora woodland
11.3.13	Grevillea striata
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland
11.3.25b	Melaleuca leucadendra and/or M. fluviatilis, Nauclea orientalis open forest
11.3.25f	River channel vegetation
11.3.27x1c	Sedgeland to grasslands
11.3.29x1	Eucalyptus crebra + Corymbia dalachiana ± C. erythrophloia, E. moluccana woodland
11.3.30	Eucalyptus crebra, Corymbia dalachiana woodland
11.3.31	Ophirox exaltatus, Dichanthium spp. grassland
11.3.32	Allocasuarina luehmii open woodland
11.3.33	Eremophila mitchellii open woodland
11.3.34	Acacia tephrosia woodland
11.3.35	Eucalyptus platyphylla, Corymbia clarksoniana woodland
11.12.1	Eucalyptus crebra woodland
11.12.4	Semi-evergreen vine thicket and microphyll vine forest
11.12.7	Eucalyptus crebra woodland with patches of semi-evergreen vine thicket
11.12.9	Eucalyptus platyphylla woodland
11.12.10	Corymbia clarksoniana woodland
11.12.13	Eucalyptus crebra, Corymbia spp., E. acmenoides woodland
11.12.16	Acacia spp. low woodland
11.12.16x1	Grassland with scattered shrubs to low very open scrub

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NGA, GEBCO
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LEGEND

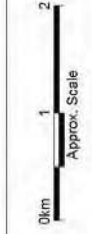


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Title: Pre-clearing Regional Ecosystems

Figure: 3-2

Rev: E



RE (DERM)

11.1.1	11.3.25
11.1.2	11.3.25f
11.1.2/11.1.2/11.1.4 (75/20/5%)	11.3.27x1c
11.1.2a	11.3.28a/11.3.35 (50/50%)
11.1.2b	11.3.31/11.3.7/11.3.13 (75/15/10%)
11.1.2b/11.3.27x1c (70/30%)	11.3.32/11.3.30/11.3.33 (70/25/5%)
11.1.4	11.12.1/11.3.30/11.3.32/11.3.33 (50/25/15/10%)
11.2.2	11.12.1/11.12.4 (95/5%)
11.2.3*	11.12.1/11.12.9/11.12.4/11.12.10 (65/20/10/5%)
11.2.5	11.12.4
11.2.5/11.2.3 (85/15%)	11.12.4a
11.2.5/11.2.3/11.2.2 (75/20/5%)	11.12.7
11.3.7/11.3.9 (50/50%)	11.12.13/11.12.4 (50/50%)
11.3.9	11.12.16x1
11.3.9/11.3.7/11.3.10/11.3.25 (45/45/5/5%)	

* Threatened Ecological Community, EPBC Act

Note: Terrestrial areas not covered with coloured polygons are non-remnant.

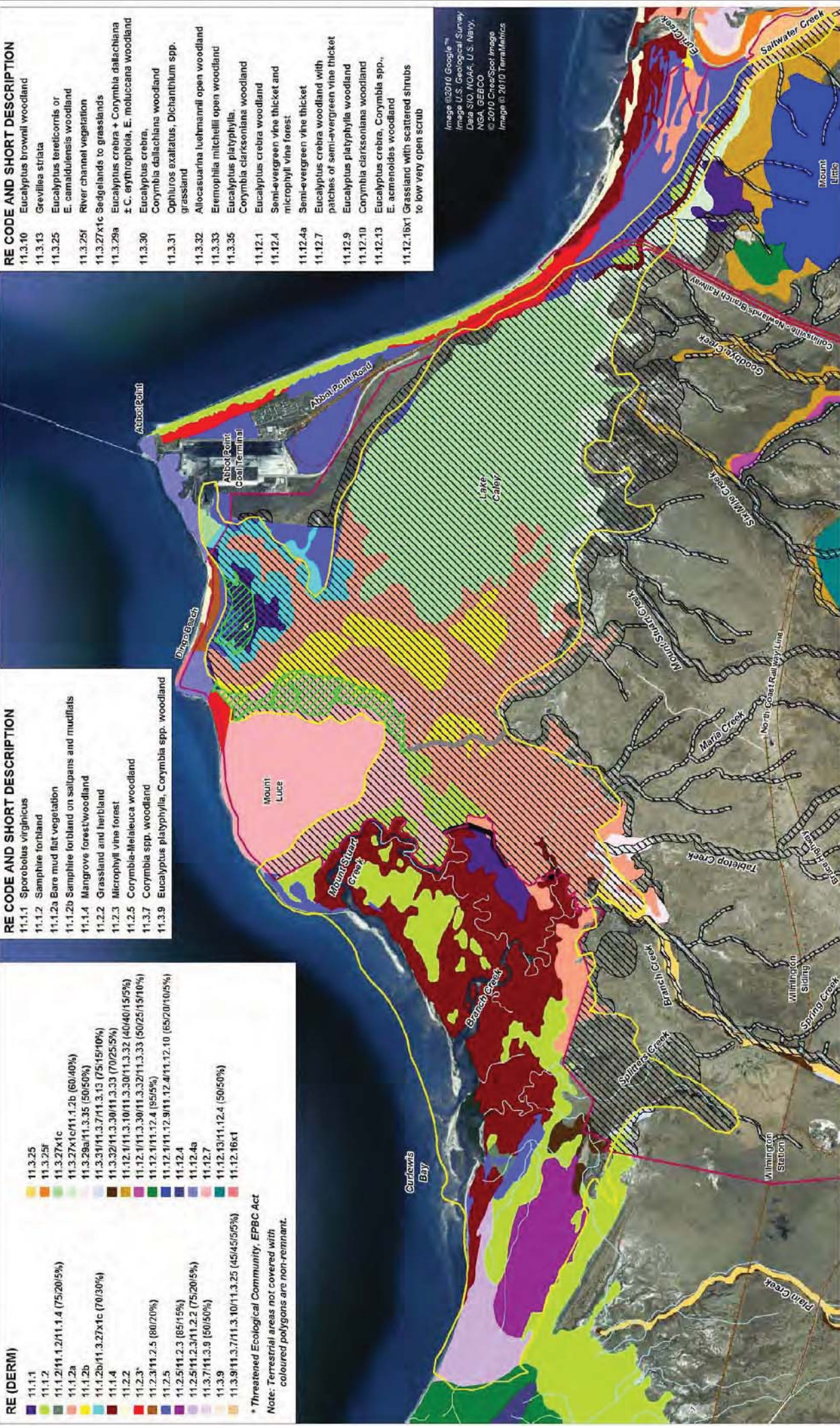
RE CODE AND SHORT DESCRIPTION

11.1.1	Sporebites virginicus
11.1.2	Samphire forbland
11.1.2a	Bare mud flat vegetation
11.1.2b	Samphire forbland on salpans and mudflats
11.1.4	Mangrove forest/woodland
11.2.2	Grassland and herbland
11.2.3	Microphyll vine forest
11.2.5	Corymbia-Melaleuca woodland
11.3.7	Corymbia spp. woodland
11.3.9	Eucalyptus platyphylla, Corymbia spp. woodland

RE CODE AND SHORT DESCRIPTION

11.3.10	Eucalyptus brownii woodland
11.3.13	Grevillea striata
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland
11.3.25f	River channel vegetation
11.3.27x1c	Sedgelands to grasslands
11.3.28a	Eucalyptus crebra + Corymbia dalachiana ± C. erythrophloia, E. moluccana woodland
11.3.30	Eucalyptus crebra, Corymbia dalachiana woodland
11.3.31	Ophirox exaltatus, Dichanthium spp. grassland
11.3.32	Allocasuarina luehmanni open woodland
11.3.33	Eremophila mitchelli open woodland
11.3.35	Eucalyptus platyphylla, Corymbia clarksoniana woodland
11.12.1	Eucalyptus crebra woodland
11.12.4	Semi-evergreen vine thicket and microphyll vine forest
11.12.4a	Semi-evergreen vine thicket
11.12.7	Eucalyptus crebra woodland with patches of semi-evergreen vine thicket
11.12.9	Eucalyptus platyphylla woodland
11.12.10	Corymbia clarksoniana woodland
11.12.13	Eucalyptus crebra, Corymbia spp., E. acmenoides woodland
11.12.16x1	Grassland with scattered shrubs to low very open scrub

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Data SIO NOAA, U.S. Navy,
NGA, GEBCO
© 2010 CeresGeo Image
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LEGEND

- Kaill Valley Wetland Boundary as Defined through DWA Listing
- APSDA Boundary
- Road
- Railway
- Regrowth Watercourse (DERM)

- Wetlands Project Area
- Proposed RE Changes (GHD 2009)
- Causeway (Inner) Bund
- Western (Outer) Bund

Title: Existing Regional Ecosystems

Figure: 3-3
Rev: E

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3.1.3 Collated Wetland Types

DIWA wetland types and their associated codes (e.g. A1, A2 etc.) that have been recorded in the Wetlands are listed in Table 3-1. These wetland types have been identified on the basis of RE mapping, the Regional Ecosystem Description Database (REDD), DERM wetland mapping, and field observations by BMT WBM⁹. In summary:

- Seven of the 12 DIWA marine/coastal wetland types are represented in the Wetlands project area;
- Eight of the 12 DIWA marine/coastal wetland types are represented in the Wetlands outside the Wetlands project area;
- Two inland wetland types that do not have marine/coastal equivalents are represented in the Wetlands project area;
- One inland wetland type is represented in the Wetlands outside the Wetlands project area;
- Two human-made wetland types are represented in the Wetlands project area; and
- One human-made wetland type is located in the Wetlands outside the Wetlands project area.

Note that only natural wetland types are considered to have EVs for the Wetlands.

In addition to the wetland types listed by DEWHA (2010b) for the Wetlands, an additional five wetland types were recorded in the Wetlands in the BMT WBM October 2010 – November 2010 study. It is uncertain why these additional wetland types were not listed by DEWHA (2010b).

For discussion purposes, wetland types have been broadly grouped into the following categories:

- Coastal wetlands - which are represented by (A1) Marine waters and (A5) Sandy beach wetland types. These wetlands are not represented in the Wetlands project area, but occur within the Wetlands outside the APSDA.
- Estuarine wetlands - represented by (A6) Estuarine waters, (A7) Intertidal flats, (A8) Intertidal marshes, (A9) Intertidal forested wetlands, and (C1) Impounded waters. These wetlands are found throughout the Western Estuarine Zone (which is located primarily outside the Wetlands project area but within the Wetlands outside the APSDA) and the Hypersaline Zone (which is contained almost exclusively within the Wetlands project area).
- Palustrine/lacustrine wetlands - represented by (A10) Brackish lagoons/marshes. These wetlands are mostly located within the Wetland Basin Zone (which is contained almost exclusively within the Wetlands project area).
- Freshwater and brackish water creek habitats and wetlands - represented mainly by (B1) Permanent rivers and streams, small areas of (A11) Freshwater marshes, (A12) Non-tidal freshwater forested wetlands and (B2) Seasonal and irregular rivers and streams. These habitats are represented mainly in the Saltwater Creek Zone (Wetlands project area) and the portions of the Wetlands project area within the Terrestrial Zone.

⁹ No definitive map of the distribution and extent of DIWA wetland types has been developed to date.

Table 3-1 DIWA Wetland Types within Kaili Valley Wetlands Listed by DEH (2006) and Other Sources

Wetland Type	Equivalent RE	Listed by DEWHA (2010)	Examples in the Wetlands project area	Examples in the Wetland outside the Wetlands project area	Wetland Zone best represented
A. Marine and coastal zone wetlands					
A1. Marine waters - permanent shallow waters <6m deep at low tide; includes sea bays, straits.	NA	Yes	None known	Abbot Bay adjacent to Mount Stuart Ck mouth	Coastal Zone
A2. Subtidal aquatic beds; includes kelp beds, seagrass.	NA	No	None known - <i>Ruppia</i> recorded in the hypersaline zone but is not considered a true seagrass species	None known - Seagrass located offshore but not in the Wetlands	
A3. Coral reefs.	NA	No	None known	None known	
A4. Rocky marine shores; includes rocky offshore islands, sea cliffs.	NA	No	None known	None known	
A5. Sand, shingle or pebble beaches; inc. sand bars, spits, sandy islets.	11.2.2	Yes	None known - unvegetated sandy banks within the wetland basin are considered to be salt pans, lagoons and marshes (refer below)	Sandy beaches adjacent to Mount Stuart Ck mouth, well represented elsewhere nearby	Coastal Zone
A6. Estuarine waters; permanent waters of estuaries and estuarine systems of deltas.	NA	Yes	Small area of Branch Creek, and mouth of Saltwater Creek (note - estuarine areas within the wetland basin are considered more analogous to lagoon/marsh wetland types)	Western reaches of Mount Stuart and Branch Creeks	Western Estuarine Zone
A7. Intertidal mud, sand or salt flats.	11.1.2a,b	No	Salt pans present upslope of the western reaches of Mount Stuart and Branch Creeks	Salt pans present upslope of the western reaches of Mount Stuart and Branch Creeks	Western Estuarine Zone (also Hypersaline Zone and Wetland Basin Zone)
A8. Intertidal marshes; includes salt-marshes, salt meadows, raised salt marshes, tidal brackish and freshwater marshes.	11.1.1; 11.1.2; 11.1.3	Yes	Well developed saltmarsh and brackish marshes present throughout wetland basin and the hypersaline zone	Saltmarsh present adjacent to the western reaches of Mount Stuart and Branch Creeks	Western Estuarine Zone (also Hypersaline Zone and Wetland Basin Zone)
A9. Intertidal forested wetlands; includes mangrove swamps, nipa swamps, tidal freshwater swamp forests.	11.1.4	Yes	Small areas present adjacent to the western reaches of Mount Stuart and Branch Creeks	Extensive mangrove systems and Melaleuca forests located adjacent to the western reaches of Mount Stuart and Branch Creeks	Western Estuarine Zone
A10. Brackish to saline lagoons and marshes with one or more relatively narrow connections with the sea.	11.1.1; 11.1.2; 11.1.3; 11.3.27x1 _c	Yes	Brackish/saline marshes and lagoon well represented upslope of the western reaches of Mount Stuart and Branch Creeks and the wetland basin	Present in the western sections of the Wetlands	Wetland Basin Zone (also Western Zone and Hypersaline Zone)

Wetland Type	Equivalent RE	Listed by DEWHA (2010)	Examples in the Wetlands project area	Examples in the Wetland project area	Wetland Zone best represented
A11. Freshwater lagoons and marshes in the coastal zone.	11.3.27x1 _c	Yes	Brackish lagoon/marsh may revert to a freshwater lagoon/marsh during the wet season. Small areas of 'true' freshwater marsh present around Saltwater Creek	None known	Saltwater Creek Zone (and Wetland Basin Zone during wet season)
A12. Non-tidal freshwater forested wetlands.	11.3.25; 11.3.25b	No	Riparian vegetation, Melaleuca and Casuarina forest present adjacent to Saltwater Creek	Areas of Melaleuca and Casuarina adjacent to estuarine reaches of Mount Stuart and Branch Creeks	Saltwater Creek Zone
B. Inland wetlands	Numerous inland wetland types are present but are analogous to the coastal wetlands described above. The following additional wetlands do not have analogues under (A) Marine/Coastal				
B1. Permanent rivers and streams; includes waterfalls.	11.3.25; 11.3.25b	No	Saltwater Creek appears to be a permanent waterbody, but not perennial	None known	Saltwater Creek Zone
B2. Seasonal and irregular rivers and streams.	11.3.25; 11.3.25b	No	Numerous low order ephemeral streams present	Numerous low order ephemeral streams present.	Terrestrial Zone
C. Human-made wetlands					
C1. Water storage areas: reservoirs, barrages, hydro-electric dams, impoundments (generally >8 ha).	NA	Yes	No water storages >8ha are known for the Wetlands project area however the waters impounded by the western (outer) bund falls into this category (i.e. an impoundment)	None known	Hypersaline Zone
C2. Ponds, including farm ponds, stock ponds, small tanks. (generally <8 ha).	NA	No	Small dams present within the Wetlands project area	Settlement ponds within APCT	Terrestrial Zone
C3 to C9. Other artificial waterways and wetlands	NA	No	None known	None known	

Grey shading – no representative example known

3.2 Habitat Description and Condition

3.2.1 Coastal Habitats

Description

Neither (A1) Marine waters and (A5) Sandy beach wetland types are represented in the Wetlands project area, but both occur in the Wetlands outside the Wetlands project area between Mount Stewart Creek to the mouth of Splitters Creek.

There is little data describing the nature of sandy shore habitats within the Wetlands. Broad-scale shoreline mapping by Geosciences Australia (2010) shows that exposed coastal shorelines between Mount Stewart Creek and Branch Creek are mainly comprised of sandy sediments. The Geosciences Australia mapping data has a coarse spatial resolution and is based on limited ground-truthing. Site assessments are required to refine and validate this mapping (refer Section 7).

Coastal habitats also include a range of coastal dune-associated communities, although there is no direct DIWA wetland type equivalent for these vegetation communities. These regional ecosystems are represented along the coastal foreshore of the adjoining wetlands.

Patterns in Variability and Key Underpinning Processes

No studies have examined spatial and temporal patterns in the extent of these wetland types. It would be expected that the extent and configuration of sand spits and beaches will vary over time in response to storm-induced disturbance and seasonal changes in beach accretion/erosion. Similarly, there are no available data describing water and sediment quality within these habitats.

Condition and Key Threats

The above two wetland types appear to be in a largely undisturbed condition. There is some use of the sandy beaches by four-wheel drive vehicles, which may lead to disturbance of shorebirds and their nests. Loss of habitat as a result of sea level rise is a threat to sandy beach wetland type in the long term.

3.2.2 Estuarine Habitats

Description

Estuarine wetland types include the following:

(A6) Permanent waters of estuaries and estuarine systems of deltas

Determining the extent and distribution of estuarine waters is to a large extent dependent on the definition of an estuary. For the purposes of this study, estuarine waters are considered to include the freshwater/marine interface area within creeks and rivers. It is represented within the Wetlands by the western reaches of Mount Stewart Creek and Branch Creek. Both creeks are located in the Wetlands project area and adjoining wetland areas to the west.

(A7) Intertidal flats, (A8) Intertidal marshes, (A9) Intertidal forests

Remnant mangrove communities (RE 11.1.4) are represented:

- On the well flushed estuarine creeks systems within the Western Estuarine Zone (i.e. Splitters, Branch and Mount Stuart creeks). A small area of mangrove forest was recorded within the Wetlands project area on Branch Creek, however most mangroves occurred in adjacent wetland areas down-slope of the western (outer) bund.
- Within the Saltwater Creek Zone. Field observations indicate that mangroves had a sparse and patchy distribution throughout the section of the Saltwater Creek Zone within the Wetlands project area.

The distribution of different mangrove species varied among locations. Milky Mangrove (*Excoecaria agallocha*) was the dominant mangrove species in the portion of Saltwater Creek Zone within the Wetlands project area, reflecting this species preference for low salinity waters (Bunt 1982 in Hutchings and Saenger 1987). By contrast, species such as Red Mangrove (*Rhizophora stylosa*) and Yellow Mangrove (*Ceriops tagal*), which co-dominate in the Western Estuarine Zone, were generally confined to areas with salinities near full marine conditions. Grey Mangrove (*Avicennia marina*), which has a wide salt tolerance, was recorded in both the Western Estuarine Zone and Saltwater Creek Zone.

Saltmarsh and saltpan areas occur landward of mangrove forests, and together represent a dominant estuarine habitat type within the Wetlands project area and adjacent wetland areas. Saltpans and saltmarsh were particularly well developed in the Hypersaline Zone, and also occurred in the Western Estuarine Zone landward of mangroves, and fringing the Wetland Basin Zone.

Saltpans typically have very low cover of vascular plants (trees, shrubs, grasses), although salt tolerant benthic algae can form a crust. DEH (2006) indicates that periodic disturbance of these algae mats during, for example, storms and tides, can provide a source of nutrients to the Wetlands. DEH (2006) also recorded halophytic scrub-shrub species (saltmarsh) on the landward margins of these saltpans, including *Halosarcia halocnemoides*, *H. indica*, *H. pergranulata*, *Suaeda arbusculoides*, *Tecticornia australasica*, *Sarcocornia quinqueflora* and *Sporobolus virginicus*. Areas of salt couch (*Sporobolus virginicus*) grassland also occur within the Wetlands. DEH (2006) noted that during extended periods of inundation by runoff, some saltpan areas may become temporarily inundated with brackish water and support emergent or aquatic macrophyte beds.

From a regional perspective, the estuarine habitats and communities are representative of those found in the wider region. The Wetlands contains a small proportion (<1%) of the total available area of each of the marine vegetation classes in Brigalow Belt North bioregion. At a more local scale, DEEDI mapping shows that there are numerous estuarine channels along the coast between Townsville to just around Gloucester Island (south of Bowen), and these creeks are typically dominated by saltpan and a smaller proportion of mangroves. Duke (2006) suggested that saltmarsh tends to proliferate in areas where average annual rainfall is <1500 mm, as occurs in the area between Townsville to Gloucester Island (including the Wetlands).

(C1) Impounded Hypersaline Waters (and Saltpan)

This is an artificial wetland type that was restricted to the area between the causeway (inner) and western (outer) bunds within the Hypersaline Zone (largely within the Wetlands project area). This wetland type has formed as a result of saline waters being impounded by the western (outer) bund (refer below), and presently occupies an area formerly comprised of mangrove forest and saltmarsh/saltpan.

Patterns in Variability and Key Underpinning Processes

Trends in estuarine vegetation distribution, extent and structure over time were assessed by comparing 'pre-clearing' and present-day regional ecosystem mapping (refer to Figure 3-2 and Figure 3-3). This mapping erroneously shows that there have been no major changes in the extent of estuarine vegetation REs within the Wetlands and broader study area.

GHD (2010) mapped changes in the extent of mangroves and other fringing vegetation within the Hypersaline Zone on three occasions: 1971, 1986 and 2009. Over this time period, estuarine vegetation extent declined by approximately 46 hectares, and was replaced by saltpan habitat. The die-back appears to be a result of altered tidal hydraulics associated with the operation of the western (outer) bund.

Saltpan vegetation can show great variation in vegetation community structure over time in response to rainfall and inundation patterns. There is no available empirical data describing temporal patterns in saltmarsh vegetation community structure, such as the extent, duration and frequency of brackish versus hypersaline conditions within saltpan areas, which represents an important information gap.



Photo 3-1 Halophytes Re-sprouting along the Southern Shoreline of the Wetland Basin Zone

Key Processes

The key underpinning processes in the context of estuarine wetlands include:

- Tidal flushing - this is important in maintaining suitable water quality for estuarine flora and fauna as it provides oxygen enriched water and removes potential contaminants that would otherwise accumulate. Without tidal flushing sufficient oxygen and nutrients may not be made available to

mangrove roots and toxic sulphates may not be removed from the soil (Hutchings and Saenger 1987).

- Fluvial flows - fluvial (river) flows contribute fresh water and sediments, and transport nutrients and particulate organic material to estuaries such as Saltwater Creek. These freshwater inputs influence the salinity cycle of rivers and creeks over time, which in turn influences the presence/absence of flora and fauna and their distribution (i.e. upstream and/or downstream extent of distribution) (Hutchings and Saenger 1987). Such effects are evident in the distribution of mangroves as described above.

Condition and Key Threats

Available data suggests the following key trends in habitat condition:

- Estuarine habitats and vegetation communities in the Western Estuarine Zone appear to be in a largely undisturbed state. An exception to this is the presence of a small area of mangrove die-back immediately to the west (down-slope) of the western (outer) bund. Salinity measurements undertaken in the BMT WBM October 2010 – November 2010 study indicate that waters immediately down-slope of the western (outer) bund wall were greater than seawater, suggesting that there is some leakage of ponded hypersaline waters into this area. It is unknown whether the localised mangrove die-back observed in this area is a response to water quality degradation or other processes.
- Alterations to tidal hydraulics by the western (outer) bund has:
 - Resulted in the loss of 49 hectares of mangrove and other estuarine vegetation within the Hypersaline Zone (Wetlands project area);
 - Likely altered salinity patterns within existing salt pan habitats throughout the Hypersaline Zone, leading to changes to a range of ecosystem processes. The extent of degraded saltpan habitat within the Hypersaline Zone has not been mapped to date; and
 - Created a 'lagoon' habitat that is in a severely degraded condition (i.e. hypersaline waters, highly anoxic sediment, and limited connectivity to natural waterway areas).

The western (outer) bund also represents a significant barrier to aquatic fauna movements within the Wetlands. As discussed in Section 4.1, although in significantly modified condition, the Hypersaline Zone contains areas of salt pan habitat that represent feeding areas for a variety of shorebird species.

Key potential existing and future threats include:

- Ongoing degradation and fragmentation of habitats within the Hypersaline Zone as a result of the western (outer) bund; and
- Potential indirect (e.g. changes to hydrology and water quality) impacts associated with future development activities within the APSDA.

3.2.3 Palustrine and Lacustrine Wetlands

Description

RE mapping indicates that the dominant palustrine wetland vegetation community in the Wetlands is RE 11.3.27 x1c Palustrine wetland - Sedgeland to grasslands on Quaternary deposits. This was the dominant regional ecosystem within the Wetland Basin Zone (this zone is located entirely within the Wetlands project area) (Figure 3-3). Field observations in the BMT WBM October 2010 – November 2010 study suggest that Mangrove Clubrush (*Schoenoplectus littoralis*) (refer Photo 3-2) represented the dominant macrophyte species within standing waters.



Photo 3-2 Islands of Mangrove Clubrush in the Wetland Basin Zone

DERM wetland mapping does not identify lacustrine (lakes) within the Wetlands (Figure 3-1). There are however, large areas of the Wetland Basin Zone are lacustrine in nature, most notably Lake Caley (otherwise known as the Lake). Anecdotal reports suggested that Lake Caley is approximately 10 m deep (Blackman *et al.* 1999), however based on the BMT WBM October 2010 – November 2010 studies, this figure appears to be in error. In this regard, the maximum recorded water depth of the Lake was approximately 0.6 to 0.9 m and much of the waterbody was less than 0.2 m deep at the time of the survey. Although water depths would increase during the wet season, it is unlikely to reach a depth much above 1 m except in extreme flood events.

Patterns in Variability and Key Underpinning Processes

Comparison of pre-clearing and present-day RE mapping suggests that there has been no long term change in the extent of palustrine wetland regional ecosystems since European settlement. It is likely however, vegetation communities within the Wetland Basin Zone vary greatly across a range of temporal scales in responses to cyclic changes in wetland inundation and salinity.

As discussed in Section 2.2.5, water levels and salinity in the Wetland Basin Zone can vary spatially and over a range of temporal scales (seasonal, inter-annual etc.). During extended dry periods, tidal processes dominate, and the Basin can have marine or near marine conditions (and hypersaline in places - refer below). During wet periods, the Wetland Basin Zone can revert to freshwater or brackish water conditions, varying from east to west. It is likely that vegetation communities and a wide range of ecosystem processes will vary in response to these changes in these processes, although this has not been studied to date.

Condition and Key Threats

Like other wetland habitats within the study area, it is likely that the conversion of the catchment to grazing lands has increased pollutant (i.e. sediment, nutrients) loads entering the Wetland Basin Zone. No modelling has been undertaken to date to quantify changes in pollutant loads and its effect on aquatic ecosystems. The loss of catchment vegetation and associated loss of connectivity between wetland and terrestrial habitats is also expected to have greatly impacted populations of wetland fauna species (refer Section 4).

The two bund structures are the most obvious anthropogenic pressures affecting the ecology of the Wetlands. DEWHA (2008) suggests that the causeway (inner) bund has altered tidal hydraulics within the Wetlands resulting in a reduction in salinity upslope of the bund. There is at least one (and possibly more) culvert within the causeway (inner) bund that allows some tidal water exchange between the Wetland Basin Zone and Hypersaline Zones. During a spring (high) tide in October 2010, tidal waters were observed to propagate up Branch Creek and into the Hypersaline Zone, and then flowed into the Wetland Basin via a culvert pipe located at the southern end of the causeway (inner) bund (southern culvert pipe). At the time of sampling, the upper reach of Branch Creek immediately upslope and down-slope of the causeway (inner) bund had a hypersaline character. No studies have quantified the extent to which salinity and vegetation communities have been altered by the causeway (inner) bund, which represents an information gap (refer Section 7).

The two bunds also represent a significant barrier to aquatic fauna movements. The southern culvert pipe has a small diameter (300 mm) and is not expected to be regularly used by fish. The western (outer) bund represents an almost complete barrier to fish movements. Overtopping of the causeway (inner) bund during flood events is expected to represent the main means by which fish and other aquatic fauna to move between the Wetland Basin Zone and the Western Estuarine Zone and the Coastal Water Zone. As discussed in Section 4.2, it is expected that fish community structure and fisheries habitat values of the Wetlands are therefore in a highly modified condition.

In addition to these existing (ongoing) threats, future potential effects include direct (e.g. clearing) and indirect (e.g. changes to hydrology and water quality) impacts associated with future development activities within the APSDA.

3.2.4 Rivers and Streams

Description

The main freshwater/brackish stream in the Wetlands is Saltwater Creek. All of the reach of Saltwater Creek within the Wetlands is located in the Wetlands project area.

Several REs have been mapped in the DERM RE mapping along this creek within the Wetlands project area. RE 11.3.27x1c – Palustrine wetland (e.g. vegetated swamp) sedgeland to grasslands on Quaternary deposits co-dominated along the southern embankment of Saltwater Creek within the Wetlands project area (Figure 3-3). RE 11.1.4 – Mangrove forest/woodland on marine clay with patches of RE 11.1.2 Samphire forbland on marine clay plains also occur along the length of the creek within the Wetlands project area. Mixed polygons of eucalypt woodland on alluvial plains and RE 11.3.25 – *Eucalyptus tereticornis* or *E. camaldulensis* were mapped along drainage lines.

However during the BMT WBM October 2010 – November 2010 studies, Saltwater Creek was observed to have relatively homogenous vegetation along much of its length which was dominated by a mix of Weeping Teatree (*Melaleuca leucadendra*), Milky Mangrove (*Excoecaria agallocha*) and White-flowered Black Mangrove (*Lumnitzera racemosa*) (refer Photo 3-3). There are also scattered Forest Red Gum (*Eucalyptus tereticornis*). Introduced species of tree, shrub and vine weeds occurred in the mid-storey, with Prickly Acacia (*Acacia nilotica*), Rubber Vine (*Cryptostegia grandiflora*) and Parkinsonia (*Parkinsonia aculeata*) representing the most abundant mid-storey species.



Photo 3-3 Riparian Forest along Saltwater Creek

The ground storey of the riparian zone along Saltwater Creek was quite sparse due to shading by the canopy trees and shrubs. Groundcover species included a variety of herbaceous weeds and grasses, with dense stands of the samphire, *Tecticornia australis* and Marine Couch in low lying areas along the banks.

Thickets of reeds and sedges, particularly Mangrove Clubrush and Water Chestnut (*Eleocharis dulcis*), dominated the littoral zone of Saltwater Creek. The submerged aquatic Water Thyme (*Hydrilla verticillata*) formed dense masses, with the introduced Curly Pondweed (*Potamogeton crispus*) sub-dominant. Giant Water Lily (*Nymphaea gigantea*) was widespread throughout Saltwater Creek and Swamp Lily (*Ottelia ovalifolia*) was moderately abundant (refer Photo 3-4).

The species composition of vegetation communities within Saltwater Creek was indicative of a freshwater to brackish water system. The presence of mangroves indicates that the reach of Saltwater Creek within the Wetlands project area experiences some saline influence. While aquatic macrophyte communities were dominated by 'freshwater' species, many of these species are tolerant of slightly brackish water conditions. For example, the dominant aquatic macrophyte *Hydrilla verticillata* can tolerate salinity up to 2 g/L (7% salinity of seawater; Twilley and Barko 1990). The other abundant aquatic macrophyte species observed here are also known to be tolerant of slightly brackish water conditions (Sainty 2003).



Photo 3-4 Saltwater Creek with Giant Waterlily and Other Aquatic Macrophytes

The mouths of numerous small freshwater streams occur within the southern section of Wetlands project area, and discharge directly into the Wetland Basin (e.g. Mount Stewart, Six Mile and Goodbye Creeks) or Hypersaline Zones (Maria, Tabletop, Branch and Splitters Creeks). Vegetation communities on these creeks within the Wetlands project area are generally indicative of an estuarine character. The main reaches of these creeks are predominantly situated in the Wetlands project area, but outside the Wetlands. These creeks are of an ephemeral nature and have limited riparian vegetation. Prior to clearing, REs along these creeks were comprised of eucalypt woodland and alluvial plains with sections of eucalypt woodland on igneous rocks.

Patterns in Variability and Key Underpinning Processes

Comparison of pre-clearing and present-day RE mapping suggests that there has been no long term change in the extent of riparian regional ecosystems along Saltwater Creek since European settlement. Like other wetland communities elsewhere in the Wetlands project area, it is expected that vegetation communities within Saltwater Creek will vary in response to cyclic changes in hydrology, inundation and salinity.

Fluvial flows, rainfall patterns and groundwater both contribute to the volume and distribution of freshwater in a particular creek system and this influences the distribution of plant species and communities. Saltwater Creek appears to retain surface water in all but exceptionally dry periods whereas the upper reaches of many other of the feeder creeks on the southern side of the Wetlands project area appear to be dry for more extensive periods of time.

Geology and soils also profoundly influence the distribution of plant species and communities and is the basis of RE classification (refer Section 3.2). The RE map shows that a variety of soil types are represented along Saltwater Creek.

Condition and Key Threats

Weeds represent a key pressure on vegetation communities within the Saltwater Creek Zone. Both riparian and in-stream vegetation communities contained weed infestations, and in places, weed

species were the dominant vegetation species. Further discussion on weeds is provided in Section 6.1.3.

Land clearing and subsequent cattle grazing has greatly altered vegetation communities within the ephemeral creeks that occur in the study area. There are two REs (identified in the pre-clearing RE map; refer Figure 3-2) that are no longer represented along the creek systems within the Wetlands project area.

Table 3-2 Pre-clearing Regional Ecosystems in the Wetlands and Adjoining Creeks that are not Currently Existing REs

RE code	Short description	VM Act status	Comments
11.3.12	<i>Melaleuca viridiflora</i> , <i>M. argentea</i> +/- <i>M. dealbata</i> woodland on alluvial plains	Least concern	Occurred as a minor RE in a mixed polygon with REs 11.2.5, 11.3.31 and 11.3.13 through which a section of Maria Creek flowed and the dominant RE in a mixed polygon with REs 11.3.32, 11.3.34 and 11.3.13 along part of the southern boundary of the Wetlands within the Wetlands project area
11.3.34	<i>Acacia tephрина</i> woodland on alluvial plains	Of concern	Occurred as a minor RE in a mixed polygon with REs 11.3.12, 11.3.32 and 11.3.13 along part of the southern boundary of the Wetlands within the Wetlands project area

Analysis of Figure 3-2 also indicates that:

- Goodbye Creek and Six Mile Creek flowed through a mixed polygon containing REs 11.12.1/11.3.10/11.3.30/11.3.32 and that narrow strips of this polygon are still present along significant sections of these creeks (though in a degraded state);
- Breakfast Creek for most of its length, particularly where it flows into Six Mile Creek and some of the eastern anabranches of Six Mile Creek flowed through RE 11.3.25, which only presently exist as small patches;
- The lower reaches of Mount Stuart Creek also flowed through a mixed polygon containing REs 11.12.1/11.3.10/11.3.30/11.3.32, however, most of this has been cleared or highly modified;
- Much of Mount Stuart Creek, Tabletop Creek and sections of Spring Creek occur in a mixed polygon of REs 11.3.29/11.3.35 most of which has been cleared or highly modified;
- The upper reaches of Mount Stuart Creek, Maria Creek, Tabletop Creek and Spring Creek flowed through a mixed polygon containing REs 11.12.1/11.12.4 most of which has been cleared or highly modified; and
- Splitters Creek, the upper/middle reaches of Branch Creek, and Plain Creek flowed through RE 11.3.25. Most of this vegetation has been cleared along Splitters Creek and now occurs as a mostly continuous narrow strip along Branch Creek and as disjointed strips along Plain Creek.

The pre-clearing REs provide a useful guide to any future riparian revegetation works.

4 WETLAND DEPENDENT FAUNA

4.1 Migratory and Resident Waterbirds

Description

Shorebirds in Australia fall into three groups:

- Migratory species that migrate from their breeding areas, which are generally in north east Asia, to their feeding grounds in Australia and New Zealand for the southern hemisphere summer. There are more than 30 migratory shorebirds that regularly visit Australia;
- Resident species that remain in Australia all year; and
- Vagrant species that occasionally visit Australia.

The Wetlands supports significant populations of both migratory and resident shorebirds, as discussed below.

Migratory Shorebirds

Twenty two listed migratory wetland and migratory marine bird species under the EPBC Act have been recorded inhabiting the Wetlands (refer Table F-1). Of those:

- 20 are migratory wetland species;
- Two are migratory marine;
- One species is listed as endangered under the NC Act (Little Tern *Sterna albifrons*); and
- Two species are considered near threatened under the NC Act (Australian Cotton Pygmy-goose, *Nettapus coromendalius albipennis* and Eastern Curlew, *Numenius madagascariensis*).

Most migratory shorebird species utilise a range of habitats within the Wetlands for feeding and roosting. Surveys undertaken by BMT WBM in October and November 2010¹⁰ recorded high numbers of migratory shorebirds within the Hypersaline Zone, including the endangered Little Tern (refer below for separate discussion) and the near threatened Eastern Curlew (Figure 4-1). The degraded sections of the Hypersaline Zone also supported a range of migratory shorebird species, but not in numbers found in the near-natural sections of the Hypersaline Zone. Migratory shorebirds were also recorded in low to moderate abundance throughout the entire Wetland Basin Zone and the mouth of Saltwater Creek, but were not recorded within upstream reaches of Saltwater Creek.

Based on surveys undertaken in the Wetlands to this point in time, Little Tern *Sterna albifrons* is the only migratory wader species that has been recorded in internationally significant numbers within the study area to date (refer Appendix F and discussion below for Little Tern). Few broad scale bird surveys have been undertaken across the entire study area thus far, hence there is inadequate data to determine quantitative patterns in natural variability in waterbird abundance at this scale.

¹⁰ This survey was undertaken to determine patterns in habitat usage of the Wetlands by waterbirds, including migratory waders (which arrive in Australia around September each year). This study represents a snap-shot at one time only, and does not consider values during droughts or following prolonged periods of rainfall (refer Appendix C).

Little Tern (*Sterna albigrons*)

This species is listed as migratory under the EPBC Act and endangered under the NC Act. This species has been recorded in several studies carried out in the study area, and was targeted in field surveys undertaken by BMT WBM in October and November 2010. This species was observed throughout the Wetlands (Figure 4-1), but was recorded in high abundance at the following locations:

- The southern section of the Hypersaline Zone along Branch Creek. An aggregation of approximately 300 birds was observed feeding on small fish within the creek. This area maintains some tidal connection and is in a relatively undisturbed condition, unlike northern sections of the Hypersaline Zone. This site is located within the Wetlands project area.
- A sand spit at the mouth of Mount Stewart Creek. This area contained approximately 50 adults, numerous nests and three chicks (refer Photo 4-1 and Photo 4-2). This site is located outside the APSDA but is within the Wetlands.

While large numbers of birds were recorded along the lower reaches of Branch Creek in the BMT WBM October 2010 – November 2010 study, most of the Wetlands project area, would provide suitable feeding areas for this species. It would be expected that patterns in habitat usage will vary over time in response to changes in prey abundance (fish, crustaceans, insects etc.) and changes in wetland hydrology.

The Wetlands may represent an internationally significant location for this species. A wetland can be considered for declaration as a wetland of international importance (i.e. Ramsar site) if (among other factors) it regularly supports 1% of the total population of a species (SEWPaC 2009). The current estimate for the number of breeding birds in Australia is 3,000 (DEWHA 2007 Bamford *et al.* 2008). The population of approximately 350 within the study area can therefore be considered a significant population and would partially fulfil Criteria 6 (1% population threshold) for Ramsar declaration. However, in order to meet this criterion, internationally significant numbers would need to be recorded three out of any five year period. There is insufficient data to confirm whether this criterion is met by the Wetlands.



Photo 4-1 Little Tern Nesting Area Facing Mount Luce



Photo 4-2 Little Tern Chick in Nest

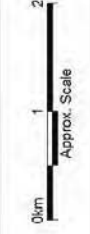
Corral
 Sea



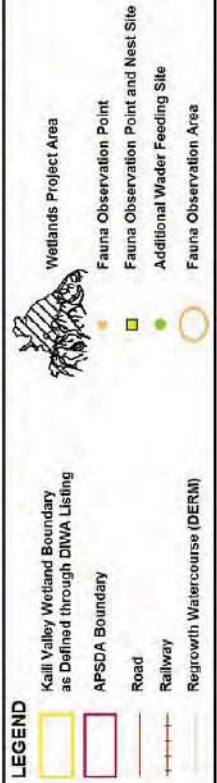
Title: **Migratory Waterbird Count Data**
 (October - November 2010)

Figure: **4-1**

Rev: **E**



BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



Resident Shorebirds

In addition to the migratory species, numerous species of resident waterbirds have been recorded within the Wetlands. The results of previous surveys and the BMT WBM October 2010 - November 2010 survey indicates the following:

- The Wetlands provide one of Queensland's largest and most northerly coastal nesting areas for Black Swans (*Cygnus atratus*). A wet season survey by GHD (2010) recorded 444 individuals within the Wetlands east of the causeway (inner) bund (within the Wetland Basin Zone), several of which were breeding. The BMT WBM November 2010 survey noted an aggregation of approximately 100 individuals west of Lake Caley (Wetland Basin Zone) with a further 400 or more birds within Lake Caley (refer Photo 4-3). These results suggest that Lake Caley and surrounding sections of the Wetland Basin Zone contain large numbers of Black Swan, albeit at numbers below the 1% threshold of 1,000 birds.



Photo 4-3 Black Swan and Australian Pelican Aggregation in Lake Caley

- The Wetland Basin Zone supports a range of ducks and other waterfowl species. Surveys by GHD (2010) within the Wetland Basin Zone east of the causeway (inner) bund recorded large aggregations of Grey Teal *Anas gracillis* (270 individuals); Pacific Black Duck *Anas superciliosa* (314 individuals); Magpie Goose *Anseranus semipalmata* (135 individuals); and Wandering Whistling-duck *Dendrocygna acuata* (163 individuals, including breeding pairs). BMT WBM also recorded during October 2010 to November 2010 moderate numbers of a range of resident waterfowl species, particularly within Lake Caley (refer Figure 4-2). None of these species had counts approaching the 1% population criterion (refer Table F-2).
- Saltwater Creek Zone also represents an important habitat for ducks and other waterfowl species. Surveys by BMT WBM in October-November 2010 recorded a flock of approximately 60 Wandering Whistling-duck, along with Grey Teal (refer Photo 4-4), Pacific Black Duck and Plumed Whistling-duck (*Dendrocygna eytoni*). A small number of Magpie Goose was also observed. Other waterbirds present included Dusky Moorhen (*Gallinula tenebrosa*) and Purple Swamphen (*Porphyrio porphyrio*).



Photo 4-4 Flock of Wandering Whistling-duck in Saltwater Creek

- The Wetland Basin Zone and Saltwater Creek Zone also represent important breeding and nesting sites for non-migratory shorebirds. Numerous resident waterbird species build their nests in the reeds and other littoral vegetation and forage in the Wetlands and adjoining terrestrial areas during the wet season (December to April). During the BMT WBM survey in November 2010, Australian White Ibis (*Threskiornis molucca*) nests (and one Black Swan nest) were found in the Wetlands in the vicinity of Lake Caley (refer Photo 4-6). Numerous nests and young of Darter (*Anhinga melanogaster*) and Cormorants (probably Little Black Cormorants) were located in trees overhanging Saltwater Creek (refer Photo 4-5). Waterbirds are likely to disperse to other wetlands when the Wetlands dry out.



Photo 4-5 Darter Chicks in Nest along Saltwater Creek



Photo 4-6 Australian White Ibis Nest with Egg and Chick near Lake Caley in the Wetlands

- The saline flats within the Hypersaline Zone supports a wide range of non-migratory shorebird species. Wet season surveys by GHD (2010) in this zone identified a number of (non-migratory; Least concern NC Act) shorebird aggregations, with particularly large numbers of Red-capped Plover *Charadrius ruficapillus* (191 individuals). This species was recorded by BMT WBM in high numbers on the intertidal flats and the southern shoreline of the Hypersaline Zone in November 2010 (Photo 4-7). An aggregation of approximately 100 Australian Pelicans (*Pelecanus conspicillatus*) was observed roosting on small sand islands in the hypersaline area east of the causeway (inner) bund.



Photo 4-7 Red-capped Plover is Very Common within the Kaili Valley Wetlands

In terms of threatened and near-threatened species, the following resident waterbird species have been recorded or potentially occur within the Wetlands:

- Black-necked Stork *Ephippiorhynchus asiaticus* - listed as near threatened under the NC Act. This species was recorded during dry and wet seasons within the Wetland Basin Zone by GHD (2010); within Saltwater Creek (WBM 2005); and adults and juveniles were recorded at a variety of locations within the Wetlands project area and adjacent areas outside the APSDA in the BMT WBM October 2010 – November 2010 study (refer Figure 4-2). There is an additional eight records of this species for the study area in the Wildlife Online database (DERM 2010).
- Beach Stone-curlew *Esacus magnirostris* - listed as vulnerable under the NC Act. There are two records of this species in the study area (locality unknown) in the Wildlife database (DERM 2010). No other studies have recorded this species in the study area to date. This species feeds on tidal flats and beaches, and roosts in fringing vegetation (including mangroves). Suitable feeding habitats for this species occur in the Hypersaline Zone and Wetland Basin Zone as well as the coastal beaches in the study area and adjacent areas.
- Freckled Duck *Stictonetta naevosa* - listed as near threatened under the NC Act. This species was reported to potentially occur within the Wetlands by WBM (2005). WBM (2005) suggested that the Wetlands support potential drought refugia and breeding habitat for this species. Saltwater Creek Zone and the Wetland Basin Zone would be expected to provide such values.

Numerous other waterbird species, listed as least concern under the NC Act, have been recorded within and adjacent to the Wetlands (refer to Table F-2). The Wetlands also supports potentially suitable habitat for other threatened waterbird species that have not been recorded in the study area to date (e.g. Australian Painted Snipe *Rostratula australis*, Australasian bittern *Botaurus poiciloptilus*).

Patterns in Variability and Key Underpinning Processes

Most migratory wetland species breed in northern China, Mongolia, Siberia and Alaska during June and July and then migrate to Australia, a distance of up to 25,000 km for the non-breeding season (DERM 2006). During their non-breeding phase they inhabit the southern hemisphere in flocks, arriving in Australia in October and feeding mainly on intertidal invertebrates at low tide. In April, these birds fly from their Australian feeding grounds to breed in the tundra areas of the northern hemisphere.

There are a number of factors that together maintain the values of the study area as a habitat for both migratory and non-migratory shorebirds. These include:

- **Habitat diversity and connectivity.** The Wetlands supports a mosaic of wetland habitats that provide feeding, roosting and breeding areas for shorebirds. This diversity, together with the interconnectivity and close proximity to different habitats, are fundamental to maintaining the values of the Wetlands as shorebird habitat. In particular, the continuum of coastal foreshore, estuarine vegetation, salt pans and brackish/freshwater creeks are especially important in this context.
- **Habitat condition.** With some notable exceptions, the wetland habitats within the study area are generally in good condition from a shorebird habitat perspective. The most notable exception to this is are:
 - The lack of fringing vegetation (i.e. roost habitat) on the southern shoreline of the Wetland Basin Zone and Hypersaline Zone.
 - Habitat degradation within the Hypersaline Zone. The degraded wetland area within the Hypersaline Zone presently supports some shorebird habitat values (i.e. feeding area for some birds). However, the saltpan habitats along Branch Creek, which are in a comparatively undisturbed state, appear to support particularly outstanding values as a shorebird feeding area.
- **Tidal processes.** Most shorebirds feed on tidal flats during low tide. Water level measurements undertaken during the BMT WBM October 2010 – November 2010 study (Appendix A) suggests that there is relatively little tidal height variation within the Wetland Basin Zone and Saltwater Creek. By contrast, the Western Estuarine Zone is well flushed, and the saltpan habitats in the Hypersaline Zone experience some tidal inundation during spring high tides.
- **Lack of human activities.** Most shorebird species are sensitive to human disturbance, and will typically flee when approached. The present low levels of human usage allow breeding, feeding and roosting activities to be undertaken undisturbed. This is especially important for migratory species, which must eat and rest to restore their body weight when they first arrive in Australia and again prior to the return journey (Birds Queensland 2010b). Critical periods in this context are September-November (arrival) and February-March (depart).
- **Hydrology.** Elsewhere, it has been demonstrated that patterns in waterbird abundance (particularly resident species) are primarily linked to the seasonality of rainfall and the annual wetting and drying cycle of tropical wetlands. Rainfall is highly seasonal, such that the Wetlands are typically flooded during the wet season (December to March), and then dry during an extended dry season (April to November). For waterbirds (excluding migratory shorebirds), this pattern of abundance is generally characterised by higher numbers during the wet season,

decreasing in sections of the Wetlands that completely dry out. It is possible that the Wetlands may experience peaks in the late dry season as birds become concentrated in the remaining sources of water. To date, little empirical bird count data have been collected for the site to determine spatial and temporal trends in waterbird numbers within and adjacent to the Wetlands. There are no major water extractions within the catchment of the study area.

Condition and Key Threats

Habitat destruction, particularly in Asia, has led to dramatic reductions in migratory shorebird abundance. In the last 25 years alone, migratory shorebird abundance has declined by 50-80% for several species.

Potential threats to these values and underpinning processes include:

- Disturbance by traffic or pedestrians as a result of future development activities;
- Loss of habitat and catchment hydrology as a result of future development activities; and
- Loss of intertidal habitat as a result of sea level rise (Saintilan and Rogers in Howe et al. 2010).

4.2 Fish Communities

Description

A wet season survey was undertaken in 2009 (GHD 2010) using baited box and opera traps set at 17 locations, which included most of the non-coastal wetland types represented within the Wetlands. A total of eight species were reported by GHD (2010)¹¹.

In the BMT WBM October 2010 – November 2010 study, eight sites were sampled in October 2010 using seine, gill and fyke netting, and box trapping (refer to Appendix B). This survey was undertaken to provide additional information on patterns in fish biodiversity and community structure within different parts of the Wetlands. A total of 23 fish species were recorded during this survey.

Twenty-five fish species have been recorded within the Wetlands to date based on surveys undertaken by GHD (2010) and BMT WBM (October 2010 – November 2010) (Table 4-1). An additional four fish species are known from the wider Don River basin (Pusey *et al.* 2004, Hogan and Vallance 1998, from Wildlife Online records) and are expected to occur in the Wetlands.

No fish species recorded within the Wetlands or the wider Don River basin is listed as threatened under Commonwealth (EPBC Act) or State (NC Act) legislation. Furthermore, none of these fish species are considered to be threatened or near threatened at an international level, as defined under International Union for Conservation of Nature (IUCN) Red List.

One introduced species has been recorded within the study area, namely the Eastern Gambusia (*Gambusia holbrooki*). The Eastern Gambusia is declared a pest species under the *Fisheries Act 1994* and *Fisheries Regulation 1995*. This species aggressively competes with other fish species for habitat and food resources, and has been implicated in population declines of various small bodied fish species (Arthington 1996).

¹¹ GHD (2010) contains a photo of Oxeye Herring *Megalops cyprinoides*, which may represent an additional fish species record for the Wetlands.

Many fish species found within the Wetlands, such as Barramundi (*Lates calcarifer*), Oxeye Herring (*Megalops cyprinoides*) and Longfin Eel (*Anguilla reinhardtii*), utilise both fresh and saltwater habitats to complete their life cycles. Many of these species are catadromous, spawning in marine environments and spending the rest of their life-cycle in estuarine and freshwater environments (refer Table 4-1). Species such as Moses Perch (*Lutjanus russelli*) spends the majority of their adult life as a reef-associated species, whereas juveniles utilise coastal wetlands as nurseries.

Patterns in Variability and Key Underpinning Processes

Figure 4- shows the total number of fish species (i.e. species richness) recorded at each sampling site by BMT WBM in November 2010 (refer to Figure B1). Species richness ranged from one to 11 species, with highest species richness recorded in Saltwater Creek, and lowest species richness recorded in shallow open water (i.e. <0.3 meters) habitat within the Wetland Basin Zone. A total of four species were recorded within the Hypersaline Zone (site F). The species richness in this area was similar in the adjoining estuaries (four to five species per site).

The community composition varied across the Wetlands, and can be summarised as follows:

- Within Saltwater Creek and the Wetland Basin Zone, fish species present were either freshwater or diadromous (able to travel between salt and freshwater). In Saltwater Creek, Oxeye Herring (*Megalops cyprinoides*), Eastern Rainbowfish (*Melanotaenia splendida splendida*) and Western Carp Gudgeon (*Hypseleotris klunzingeri*) were the most abundant species. Within the Wetland Basin Zone, the Tadpole Goby (*Chlamydogobius ranunculus*) was very abundant in shallow water habitat (sites D and E).
- Species recorded within the Hypersaline Zone and adjoining Western Estuarine Zone were either diadromous or exclusively saltwater. Within the Hypersaline Zone, Tadpole Goby was abundant within shallow sections supporting the seagrass *Ruppia maritima*. Juvenile (i.e. 1-2 years) Sea Mullet (*Mugil cephalus*) and Oxeye Herring were most abundant within deeper open water habitat (i.e. 0.5 to 1.5 meters depth) of the Hypersaline Zone.
- Fish communities surveyed in Mount Stuart Creek Estuary (site G) and Branch Creek Estuary (site H) were dominated by Toadfish from the genus *Tetractenos* and to a lesser extent *Arothron*.

Table 4-1 Fish Recorded in the Wetlands and Don River Basin

Scientific Name	Common Name	Primary Habitat (spawning)	Migratory pattern	Habitat Requirements	Source
Dasyatididae:					
<i>Pastinachus sephen</i>	Cowtail Stingray	Marine	not determined	Found in coastal environments and reef habitat, also recorded in lagoons and river systems.	E
Elopidae:					
<i>Elops hawakensis</i>	Giant Herring	Marine / Freshwater	Amphidromous	A coastal fish, lagoon, bays, and estuaries, particularly around mangroves. Sometimes enters freshwater streams.	E
Megaloptidae:					
<i>Megalops cyprinoides</i>	Oxeye Herring	Marine/ Freshwater (Marine)	Catadromous	Habitat generalist, but typically more abundant in open waters, highly fecund with pelagic eggs.	A ¹² , E
Anguillidae:					
<i>Anguilla reinhardtii</i>	Long fin Eel	Freshwater (Marine)	Catadromous	Generalist, but usually more common in rivers than lakes.	C, E
Clupeidae:					
<i>Nematalosa erebi</i>	Bony Bream	Freshwater	Potamodromous	Open water generalist, common in rivers and lakes.	E
Hemiramphidae:					
<i>Hyporhamphus</i> sp.	Garfish	Marine	not determined	Coastal areas / estuaries	E
Atherinidae:					
<i>Craterocephalus stercusmuscarum</i>	Fly-specked Hardyhead	Freshwater	Potamodromous	Generally found in freshwater rivers, streams and pools.	B, C
Melanotaeniidae:					
<i>Melanotaenia splendida splendida</i>	Eastern Rainbowfish	Freshwater	Potamodromous	Preference for small streams, but also found in wetland habitats and floodplains.	B, C, E
Pseudomugilidae:					
<i>Pseudomugil signifer</i>	Pacific Blue-eye	Freshwater / estuarine	Amphidromous	Brackish conditions. Wide habitat variety, local and lentic systems, wetlands, rivers, estuaries and near-shore areas.	B, C
Poeciliidae:					
<i>Gambusia holbrooki</i>	Mosquito fish	Freshwater	Non-migratory	Most common in slow-flowing waters near weed beds.	E
Centropomidae:					

¹² Reported as a *Mugil cephalus* in A.

Scientific Name	Common Name	Primary Habitat (spawning)	Migratory pattern	Habitat Requirements	Source
<i>Lates calcarifer</i>	Barramundi	Freshwater (Marine)	Catadromous	Coastal waters, estuaries, upper river reaches. Economically important.	A, B, E
Chandidae:					
<i>Ambassis agassizii</i>	Agassiz's Glassfish	Freshwater	Potamodromous	More common in pools and reaches with high macrophyte growth. Some resilience to saline conditions.	A, E
Terapontidae:					
<i>Amniataba percoides</i>	Barred Grunter	Freshwater	Potamodromous	Creeks, ponds, clear or turbid, from headwaters to estuaries.	E
<i>Amniataba caudavittata</i>	Yellowtail Trumpeter	Marine / Freshwater	Amphidromous	Found in coastal marine waters, but also found in estuaries and freshwater sections of rivers	E
<i>Leiopotherapon unicolor</i>	Spangled Perch	Freshwater	Potamodromous	A tolerance for elevated salinity levels – though rarely found in estuaries. Prefers slow moving habitats and shallow pools. Frequently dominant species in intermittent rivers/creeks. Able to aestivate through droughts.	A, B, C, E
<i>Terapon iarbua</i>	Crescent Perch	Marine / Freshwater	Catadromous	Common in sandy intertidal areas, occurs coastally in mangroves and freshwaters	A
Lutjanidae:					
<i>Lutjanus russelli</i>	Moses' Perch	Marine / Freshwater	Amphidromous	Marine fish. Juveniles often found in estuaries and lower reaches of streams.	A
Gerreidae:					
<i>Gerres filamentosus</i>	Thread-finned Silver Biddy	Marine / Freshwater	Amphidromous	Primarily marine species though will enter lakes and lower freshwater reaches of rivers.	E
<i>Gerres subfasciatus</i>	Silver Biddy	Marine	n.a	Occurs in coastal areas and marine dominated estuaries.	E
Haemulidae:					
<i>Pomadasys argenteus</i>	Spotted Grunter	Marine / Freshwater	Amphidromous	Occurs in coastal waters and is known to enter freshwater	E
Scatophagidae:					
<i>Scatophagus argus</i>	Spotted Scat	Marine / Freshwater	Amphidromous	Found in lower reaches of freshwater streams and estuaries.	A, E
<i>Selenotoca multifasciata</i>	Banded Scat	Marine / Freshwater	Amphidromous	Found in estuaries, mangrove creeks and lower reaches of freshwater streams.	A, E
Mugilidae:					
<i>Mugil cephalus</i>	Sea mullet	Freshwater (Marine)	Catadromous	Found from coastal areas to estuaries and freshwater reaches. Commercial species.	A, E
Eleotridae:					

Scientific Name	Common Name	Primary Habitat (spawning)	Migratory pattern	Habitat Requirements	Source
<i>Hypseleotris klunzingeri</i>	Western Carp Gudgeon	Freshwater	Non-migratory	Common around aquatic vegetation in lakes, dams & streams.	E
<i>Hypseleotris compressa</i>	Empire Gudgeon	Freshwater	Potamodromous	Potamodromous. Lowland river basins, with high tolerance of saline waters.	B
<i>Ophiocara porocephala</i>	Spangled Gudgeon	Marine / Freshwater	Amphidromous	Moves between estuaries and freshwater creeks.	D
Gobiidae:					
<i>Chlamydogobius ranunculus</i>	Tadpole Goby	Freshwater / Estuarine	not determined	Found in muddy creeks draining mangrove samphire plains or freshwater floodplains. ⁷	E
Tetraodontidae:					
<i>Arothron</i> sp.	Toadfish	Marine	not determined	Coastal areas / estuaries	E
<i>Tetractenos</i> sp.	Toadfish	Marine	not determined	Coastal areas / estuaries	E

Sources: A – GHD (2010), B – Pusey et al. (2004), C – Hogan & Vallance (1998); D – Wildlife Online (DERM 2010), E – BMT WBM (2010), blue shading –species recorded in the Wetlands; no shading – recorded in the wider Don River basin outside of the Wetlands

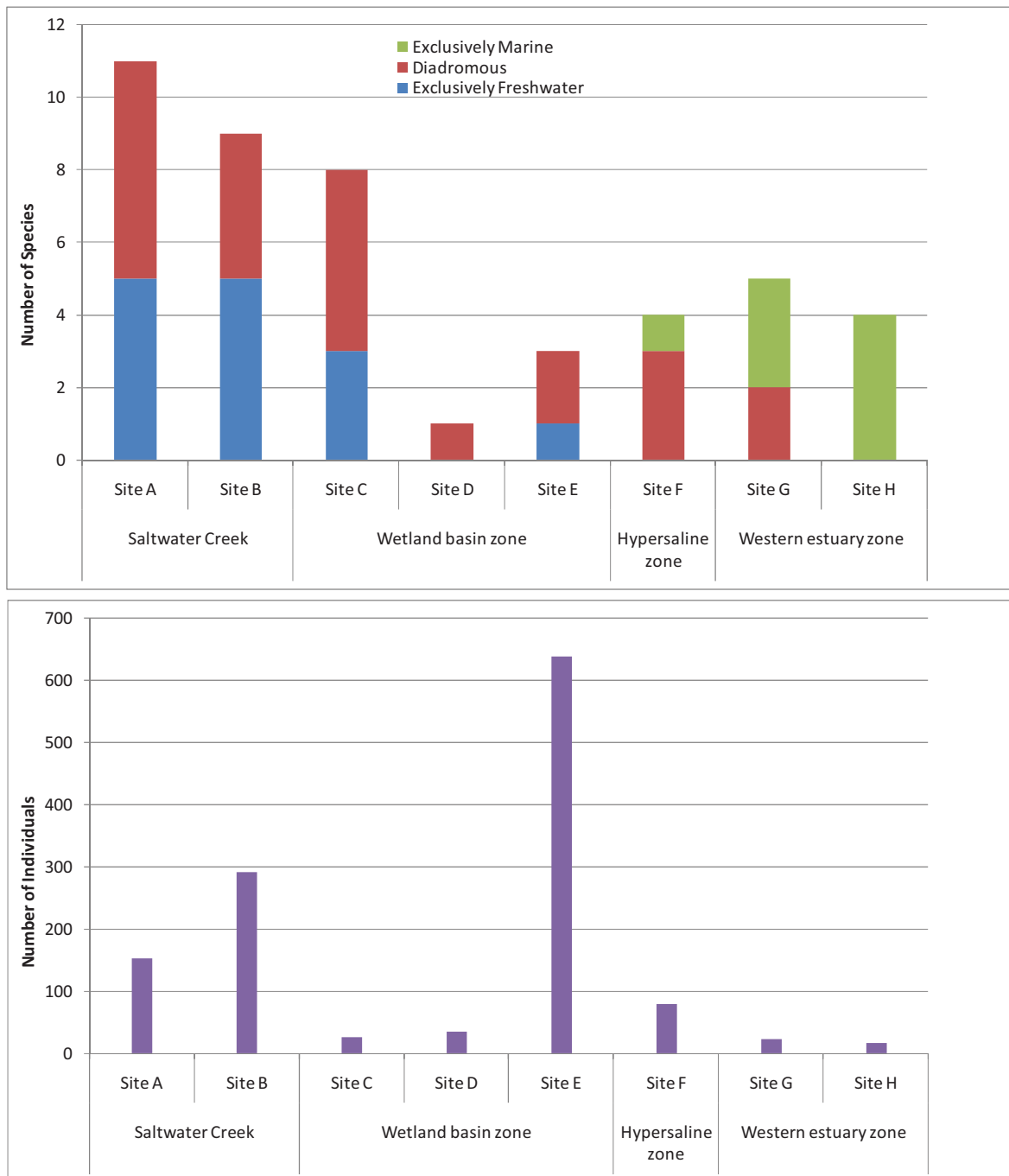


Figure 4-3 Total Number of Fish Species and Individuals Recorded at Each Site in October 2010 in the BMT WBM October 2010 – November 2010 Study

There is insufficient data to determine variability in fish communities over time (seasonal and longer term) within the Wetlands. Such information is necessary to detect any changes brought about by seasonal variation and those which result from changes in water quality, salinity etc. (refer Section 6). It would be expected however that patterns in fish community structure would be controlled in part by the following key underpinning processes:

- The physio-chemical water quality characteristics of residing water, most importantly salinity;

- Habitat connectivity, to allow movement between areas during periods of freshwater flooding and tidal inundation; and
- Distribution of structural habitat suitable fish species, including areas of submerged vegetation and snag habitat to reduce predation of other fish species and/or avifauna.

Condition and Key Threats

The bunds represent the key pressure on existing fish communities within the Wetlands in the context of the following:

- Preventing movements of fish between the section of Mount Stuart Creek within the Western Estuarine Zone and the section of Mount Stuart Creek upstream of the western (outer) bund and the causeway (inner) bund. Prior to installation of both bunds, Mount Stuart Creek would have represented the key fish movement corridor in the western half of the Wetlands. Branch Creek, the other main waterway in the western portion of the Wetlands, appears to only flow into the Wetlands during spring tides.
- The causeway (inner) bund severely inhibits movements of fish between the western sections of the Wetlands and the Wetland Basin Zone (during now flood periods). A 300 mm diameter culvert may allow some fish movements, although its small size, together with the hypersaline character of waters running through this pipe, are likely to significantly restrict fish movements.
- Adversely impacting on water and sediment quality within the Hypersaline Zone and adjacent areas, and associated fish habitat values.

Saltwater Creek therefore now represents the main connection between the Wetlands and the sea during non-flood periods, and is therefore of critical importance to maintaining the Wetland's fisheries habitat values.

The conversion of the catchment to predominantly grazing land is also likely to have increased pollutant loads entering the Wetlands. Future developments will need to be carefully managed to minimise the risk of further changes to water quality and fish habitat values.

4.3 Amphibians and Wetland-Dependent Reptiles

Description

Eleven native frog species and the introduced Cane Toad (*Rhinella marina*) (refer Appendix F) have been recorded within the study area. All of these species are currently listed as least concern under the NC Act and are not listed under the EPBC Act. The Wetlands do not contain potential habitat for other threatened frog species known from the wider region. Most of these species utilise terrestrial environments as adults, and breed in ephemeral ponds, creeks and non-saline palustrine environments.

Two species of freshwater turtles have been recorded within the study area. Snake-necked Turtle (*Chelodonia longicollis*) and Cann's Long-necked Turtle (*Chelodonia canni*) are listed as least concern under the NC Act. A third species *Elseya* sp. (possibly *irwini*) was observed (but not captured) in Saltwater Creek upstream of the Abbot Point Access Road bridge in the BMT WBM October 2010 – November 2010 survey.

Saltwater Crocodile (*Crocodylus porosus*) is listed as migratory marine under the EPBC Act and vulnerable under the NC Act. It inhabits tropical coastal rivers, swamps, estuaries and open ocean areas near the coast (Wilson 2005, DERM 2008). They breed above water level in mound nests of soil and vegetation which is tended by the adults until the eggs hatch. Evidence of Saltwater Crocodile was found on the downstream section of Goodbye Creek on the eastern side of the Wetlands (PB 2010). The BMT WBM October 2010 – November 2010 surveys did not detect any evidence of recent Saltwater Crocodile activity within Goodbye Creek or elsewhere in the Wetlands project area, however potential old slides were observed within Saltwater Creek.

Green Turtles (*Chelonia mydas*) and Flatback Turtles (*Natator depressus*), both listed as vulnerable under the EPBC Act and the NC Act, were noted as nesting along the beach between Abbot Point and Euri Creek (Bell 2003). These species have not been recorded in the Wetlands project area to date, but may nest in Curlewis Bay within the boundary of the Wetlands (but outside the APSDA). The Wetlands project area does not provide suitable habitat for these species.

Patterns in Variability and Key Underpinning Processes

There is no available data to determine patterns in habitat usage by freshwater turtles within the Wetlands. As freshwater turtles (and most frogs) are largely intolerant of saline waters, Saltwater Creek and its adjacent palustrine wetlands are likely to represent the core habitat for these species. The presence of large numbers of turtle shells along the foreshores of the Wetland Basin Zone suggest turtles may move into these areas during flood events when salinities are low.

For both turtles and frogs, patterns in abundance will vary in time in response to a range of factors, most of which are linked to changes in hydrology. For frogs, breeding is typically undertaken when there is a sufficient duration and intensity of rainfall at the right time of year to provide pools of water that will persist long enough for eggs to hatch and for the tadpoles to develop into juvenile frogs. Chambers (2008) also found that vegetation and soil microhabitats are an important factor in species distribution.

Saltwater Crocodile is likely to be mainly confined to areas containing preferred habitat, namely the main channel of Saltwater Creek and the mangrove forests surrounding Mount Stuart Creek. The shallow environments within the Wetland Basin Zone and Hypersaline Zone are not considered to support optimal habitats for this species.

Condition and Key Threats

The loss of terrestrial vegetation from areas south of the Wetlands represents a key ongoing pressure on frog assemblages within the Wetlands. The grass lands and small patches of remnant vegetation within these areas do not represent high quality frog habitats.

Riparian, palustrine and creek environments along Saltwater Creek represent relatively high quality habitats for frogs and freshwater turtles. The vegetation and stream banks are largely undisturbed, and hydrology is in a near-natural condition. Catchment clearing is expected to have resulted in a decline in water quality within Saltwater Creek (and the study area) however it is uncertain whether such changes have resulted in impacts to frog and turtle assemblages.

The bunds represent a potential movement barrier for Saltwater Crocodile. However, with the exception of sections of Saltwater Creek and parts of the Western Estuarine Zone, the Wetlands are not considered to represent particularly high quality habitat for this species.

4.4 Other Threatened Terrestrial Fauna

Description

There are several threatened fauna species that occur in the study area, and which may utilise habitats within the Wetlands (including the Wetlands project area). These species are not wetland dependent species, however the Wetlands provide functional values in terms of providing a wildlife movement corridor and foraging areas.

One threatened species has a confirmed record for the study area¹³: the Squatter Pigeon (*Geophaps scripta scripta* - southern subspecies). This species is listed as vulnerable under both the EPBC Act and NC Act has been recorded in numerous locations in the study area (PB 2009). Its preferred habitats are grassy woodlands and open forests near permanent water (Marchant and Higgins 1993), as occurs throughout the study area including the Wetlands project area.

An additional two species have been noted in previous studies, but it is unclear if these records are from within the study area:

- Black-throated Finches (*Poephila cincta cincta*), listed as endangered under both the EPBC Act and NC Act, have been recorded at Splitter's Creek (PB 2009). The Black-throated Finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by Eucalyptus, Corymbia and Melaleuca, and occasionally in tussock grasslands or other habitats (including freshwater wetlands), often along or near watercourses, or in the vicinity of water (SEWPaC 2011). Almost all recent records of the finch from south of the tropics have been in riparian habitats. The subspecies is thought to require a mosaic of different habitats in which it can find seed during the wet season (Mitchell 1996) Suitable habitat for this species occurs in the study area including the Wetlands project area.
- Single-striped Delma (*Delma labialis*) has been recorded in the region. It is listed as vulnerable under the EPBC Act (nominated for delisting) and NC Act. It inhabits open forest over thick grasses and may be present in the study area feeding on arthropods (insects etc.) (WBM 2006). Further studies would need to be undertaken to confirm its presence.

Consultation with the Department of Environment and Natural Resources identified several other threatened species as potentially occurring in the study area (possibly including the Wetlands), including Northern Quoll (*Dasyurus hallaucatus*), Coastal Sheathtail Bat (*Taphozous australis*) and Water Mouse (*Xeromys myoides*). Further targeted surveys would need to be undertaken to determine the usage of the Wetlands project area by these species.

¹³ GHD (2009) also reported Dunmall's Snake (*Furina dunmalli*) in the study area, however this appears to be a typographical error.

Patterns in Variability and Key Underpinning Processes

There is little quantitative data describing variability in the distribution and abundance of these species.

The fringing vegetation surrounding wetlands and along rivers and creeks are known elsewhere to represent an important refuge for terrestrial fauna during drought and after bushfires (Smith 1989). They tend to contract to such areas as the local climate dries or after bushfires and reoccupy the surrounding forest or woodland as the vegetation recovers or after the return of rain. Such habitats are represented within the study area including the Wetlands project area. Future development activities will need to be carefully managed to minimise impacts to these environmental values.

Condition and Key Threats

Much of the open forest and woodlands within the study area south of the Wetlands has been totally cleared since European settlement in favour of grassland for grazing of introduced livestock. This is likely to have changed the composition of terrestrial fauna assemblages in the region so that there are now probably less forest specialists and more grassland and generalist species. This represents the most significant ongoing threat to these threatened species and terrestrial fauna generally.

Other threats include:

- Modified fire regimes, which is likely to represent a key ongoing threat to many fauna species as a result of habitat modifications and simplification (refer Section 6.1.5);
- Feral animals, which can effect fauna in several ways including (refer Section 6.1.4 and 6.1.2):
 - Habitat modifications (e.g. modifications to littoral habitats by feral pigs potentially resulting in impacts to Squatter Pigeons);
 - Compete with native fauna for food and space (e.g. cane toads competing with native species for food); and
 - Predation of native fauna (e.g. Squatter Pigeon) by Red Fox and Feral Cats.

5 ENVIRONMENTAL VALUES

5.1 Approach

The Wetlands and adjoining areas support many environmental values, although from a wetlands management perspective it is important to identify outstanding and/or representative environmental values that together define the ecological character of the Wetlands. These values are described here as EVs.

The EVs underpin the management regime for the Wetlands, by providing a basis for establishing management objectives and actions.

SEWPaC (2009b) provides a methodology to identify critical components, processes and services/benefits supported by Ramsar wetlands. Although the Wetlands is not a Ramsar listed wetland, the SEWPaC (2009b) methodology provides a basis for identifying and selecting ecological features (i.e. the habitats, community, species, ecological functions described in Section 3 and 4) that are considered to represent EVs.

EVs have been selected on the basis of meeting and fundamentally underpinning one or more of the following criteria:

- 1 The ecological feature specifically underpins any of the DIWA criteria for which the Wetlands has been listed.
- 2 The ecological feature is considered a critical component in that it defines the ecological character of the Wetlands.
- 3 The ecological feature provides a particularly important service to human users.

Section 5.2 summarises the DIWA criteria met by the Wetlands. Based on this information and the approach described above, Section 5.3 provides an overall summary of the EVs.

5.2 DIWA and Ramsar Wetland Nomination Criteria

Table 5-1 is a list of DIWA criteria met by the Wetlands (based on DEH 2006) and the ecological features that underpin these criteria. At the time of their listing, DEH (2006) indicated that the Wetlands met criteria 1, 2, 3 and 5, but not criteria 4 and 6. However, it is considered that criterion 4 is partially met given that surveys undertaken for the BMT WBM October 2010 – November 2010 study recorded Little Tern abundance above the 1% population criterion.

DEH (2006) states the most significant ecological features of the Wetlands are as follows: *“The site provides an outstanding example of wetlands on a tropical prograding coast. Permanent water, a wide range of wetland habitats, very rich food resources and sheltered roosting and breeding sites cause the site to be exceptionally important for waterbirds. The importance of the site is such that it meets criteria for identifying wetlands of international importance adopted by the Ramsar Convention (e.g. 1a, 1c, 2a, 2c).”*

Table 5-1 DIWA Criteria Met by the Wetlands (based on DEH 2006), and Underpinning Elements

DIWA Criteria	Underpinning elements
1. It is a good example of a wetland type occurring within a biogeographic region in Australia.	Mangroves, saltpan, lacustrine, palustrine wetlands are all relatively good examples of wetland types within the biogeographical region.
2. It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.	All wetland types. The mosaic of wetland types within close proximity to each other, together with the connectivity of the wetlands to adjacent wetland and terrestrial systems within an otherwise highly modified environment, are considered to represent particularly important ecological role in the functioning of marine, freshwater and terrestrial ecosystems regionally.
3. It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.	During the warmer months, the site provides important feeding sites for migratory species. Permanent and semi-permanent waterbodies provide refugia for a variety of wetland dependent (waterbirds, fish, turtles etc.) and non wetland dependent fauna species.
4. The Wetlands support 1% or more of the national populations of any native plant or animal taxa.	Little Tern (<i>Sterna albibrons</i>) was observed feeding in an aggregation of approximately 300 birds within the Wetlands project area, as well as an additional 50 birds in adjacent wetland areas. The current estimate for the number of breeding birds in Australia is 3,000 (1998 figures) (DEWHA 2007). The 350 individuals recorded within the Wetlands may fulfil this criterion if 300 individuals or more are recorded within two more years of a five year period to 2014.
5. The Wetlands support native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.	Grasslands, saltmarsh, terrestrial vegetation, wetland fringe, coastal beaches. Nationally threatened species recorded in the Wetlands: Squatter pigeon. Although these species are not necessarily dependent on wetlands, the site provides a range of terrestrial and wetland habitats on which this species is dependent.

Blue shading – additional criterion considered to be met by the Wetlands based on BMT WBM October 2010 – November 2010 study

The criteria used to identify and designate wetlands of international significance (Ramsar wetlands) were reviewed in the context of the information collated in the BMT WBM October 2010 – November 2010 survey. It should be noted that while a wetland may meet one or more Ramsar listing criterion, this does not automatically mean that a site is declared as a wetland of international significance. In addition to meeting these criteria, strong justification needs to be provided that the Wetlands supports outstanding values at an international scale.

Table 5-2 examines whether the Wetlands could meet the listing criteria for wetlands of international importance. The Wetlands meets at least one of the listing criterion (threatened species). Four additional criteria may also be met, subject to further assessment. The Wetlands are not likely to meet three of the present-day Ramsar criteria.

5.3 Environmental Values

On the basis of the listing criteria and other known outlined in Sections 3 and 4 of this report, the Wetlands is seen to support six EVs. These EVs form the basis for developing management objectives and actions.

EV1 to 5 applies specifically to the section of the Wetlands within the APSDA, whereas EV6 considers the broader environmental values of the Wetlands project area, including both wetland and terrestrial habitats. Each of the EV is described below.

EV1 - Diverse estuarine, brackish and freshwater wetland types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity

This EV recognises the diverse range of wetland types supported by the Wetlands, and the values of these habitats in a landscape context. Eleven DIWA wetland types occur within the Wetlands (excluding artificial wetland types which are not considered to contribute EVs), nine of which occur in the Wetlands project area.

This EV is explicitly underpinned by:

- DIWA criterion 1 - It is a good example of a wetland type occurring within a biogeographic region in Australia.
- DIWA criterion 2 - It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
- The diversity and inter-connectivity of habitats fundamentally underpins the ecological character of the Wetlands.

EV2 - Important foraging and roost habitat for resident and migratory shorebird species, including four Threatened or Near Threatened Species the threatened Little Tern

All wetland types in the Wetlands project area serve some environmental value as a shorebird foraging habitat. Patterns in habitat usage will vary over time in response to a number of factors including rainfall patterns, patterns in prey availability and cyclic changes in the abundance of migratory shorebirds.

Table 5-2 Comparison of Ramsar and DIWA Nomination Criteria and Whether Potentially Met by the Wetlands

Present Ramsar criteria	Equivalent pre-1999 Ramsar criteria	Equivalent DIWA criteria	Criteria met
1. A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.	1a, 1b, 1c	1, 2	Possible/Likely Some areas are considered to be in near-natural condition. None of wetland types are considered unique or rare in the drainage division. The site provides outstanding representative examples of intertidal marshes on a prograded tropical coast (EPA 2006). However, it is uncertain whether this is significant at a bioregional scale.
2. A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	2a	5	Confirmed Supports threatened birds – refer section 4.1.
3. A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	2b, 2d, 3b	N/A	Likely EPA (2006) considers that the site plays an important role in maintaining biological diversity in the region, by providing one of Queensland's largest and most northerly coastal nesting areas for Black Swans (<i>Cygnus atratus</i>) and one of the most important post breeding concentration areas for waterfowl in eastern Queensland
4. A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.	2c	3	Likely The Lake is thought to provide an important refugia value during drought conditions. However, no studies have made a definitive assessment of the refugia values and functions at broad biogeographic scales.
5. A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.	3a	N/A	Unknown There are specific statistical measures for assessing whether a site 'regularly' supports a species. There are too few bird count data (in time and at whole of site scales) to assess this criterion.

Present Ramsar criteria	Equivalent pre-1999 Ramsar criteria	Equivalent DIWA criteria	Criteria met
6. A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	3c	4	Possible As for criterion 5. While Little Tern was observed to meet the 1% criterion in the BMT WBM October 2010 – November 2010 surveys, there is a need to assess whether such abundances are supported on a regular basis.
7. A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.	Did not exist	4 (fish only)	No The Wetlands does not support a high level of fish diversity
8. A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	Did not exist	N/A	No Wetland values are constrained by presence of bund and water quality degradation. Estuarine creeks likely to support nursery habitat for species of fisheries significance, although lack of connectivity to freshwater areas limits values (at a bioregional scale).
9. A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	Did not exist	N/A	No No species within the Wetlands are known or likely to be endemic to the region, nor have abundances exceeded the 1% population criterion for non-avian species.

The Wetland Basin Zone and the southern section of the Hypersaline Zone (adjacent to Branch Creek) are considered to represent key foraging habitats for the threatened Little Tern. The Hypersaline Zone and Wetland Basin Zone also provide foraging habitat for the threatened Beach Stone-curlew. The Wetlands also support habitat for the near threatened waterbirds Black-necked Stork and Freckled Duck.

This EV is explicitly underpinned by:

- DIWA criterion 3 - It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- DIWA criterion 4 - The Wetlands support 1% or more of the national populations of any native plant or animal taxa.
- DIWA criterion 5 - The Wetlands support native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- The migratory and resident waterbird assemblages of the Wetlands represent an important feature of the ecological character of the Wetlands.

EV3 - Important dry season refugia for aquatic fauna, resident shorebirds and terrestrial fauna

Important dry season refugia within the Wetlands include:

- Lake Caley, which is the deepest waterbody within the Wetland Basin Zone. This waterbody typically holds water over the dry season, but may completely dry during prolonged drought periods. This waterbody has an estuarine to freshwater character, varying seasonally in response to rainfall patterns.
- Saltwater Creek, which is thought to represent a permanent brackish to freshwater waterbody.

This EV is explicitly underpinned by:

- DIWA criterion 3 - It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- DIWA criterion 5 - The Wetlands support native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- The refugia values of the Wetlands represent an important feature of the ecological character of the Wetlands.

EV4 - Important nesting areas for waterbirds, most notably Black Swan and Little Tern

The Wetland Basin Zone and Saltwater Creek represent nesting sites for a range of waterbird species, including the Black Swan. The beach habitat in Curlewis Bay, which is located within the Wetlands but outside the Wetlands project area, is an important Little Tern nesting site.

- DIWA criterion 3 - It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- DIWA criterion 5 - The Wetlands support native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.

- Nesting represents a critical life-cycle function for the waterbird assemblages of the Wetlands, which themselves represent an important feature of the ecological character of the Wetlands.

EV5 - Important habitat for fish and other aquatic species, including species of fisheries significance

The Wetlands support a broad range of fisheries habitats. Important fish habitats within the Wetlands project area include the main drainage of Saltwater Creek and Lake Caley. The Western Estuarine Zone, which is largely located outside the Wetlands project area, contains a range of habitats important to fisheries species. Connectivity between the Western Estuarine Zone and Wetlands project area is severely impeded by the two bunds.

This EV is explicitly underpinned by:

- DIWA Criterion 2 - It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
- DIWA Criterion 3 - It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- Fish assemblages represent an important determinant and feature of the ecological character of the Wetlands.

EV6 - The Wetlands project area and the Wetlands is part of a significant fauna movement corridor for aquatic and terrestrial species, including the threatened species

Remnant vegetation within the terrestrial sections of the Wetlands project area, together with the Wetlands, forms a significant wildlife corridor in an otherwise disturbed landscape. The terrestrial areas of the Wetlands project area and surrounds also support habitat for threatened terrestrial fauna including the Squatter Pigeon.

This EV is explicitly underpinned by:

- DIWA Criterion 5. The Wetlands support native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- Recognition that the Wetlands are important to the maintenance of biodiversity values and long term survival of threatened terrestrial flora and fauna species.

6 THREATS AND RISKS

Existing and future threats to the EVs vary greatly across multiple spatial and temporal scales in terms of their potential severity. Major existing and potential future threats are summarised in Table 6-1 and are discussed below.

Table 6-1 Summary of Major Existing and Potential Future Threats to the EVs

Threat	Threat timescale	Potential impacts to Wetlands
Habitat loss and fragmentation as a result of clearing and earthworks	Existing, future	Habitat simplification and loss of connectivity between habitat patches resulting in loss of fauna diversity.
Grazing by livestock	Historical	Direct loss of vegetation, altered soils and increased pollutant loads
Weeds	Existing, future	Continuing impacts from presence and proliferation of key weed species such as rubber vine, prickly acacia, parkinsonia, lantana and Noogoora burr.
Feral animals	Existing, future	Continuing impacts from cane toads, feral pigs, red foxes and other invasive species into wetland habitats and negative impacts on the populations of wetland-dependant species.
Altered fire regimes	Existing, future	Degradation of native ecosystems, potential threat to infrastructure and human life
Altered catchment hydrology	Future	Impact of catchment development on water quality, hydrology and hydrodynamics in the wetland, creeks and groundwater which subsequently result in decline in biodiversity.
Presence and operation of bunds	Existing, future	Aquatic fauna movement barrier, alterations to tidal hydraulics and water quality
Poor water quality and dust	Existing, future	Release of pollutants into surface and/or groundwater and associated ecological effects and possible human health effects in terms of air and water quality, activation of acid sulfate soils and subsequent impacts to aquatic ecosystems
Refuse, discarded materials and barbed wire fences	Existing	Hazard to fauna from ingestion, leaching of chemicals from old tyres, risk of entanglement for fauna (flying foxes, waterbirds and possibly gliders), potential breeding sites for biting insects, general unsightliness
Poor air quality	Future	Hazard to the health of fauna and flora and water quality (via rainfall and deposition).
Light pollution	Future	Hazard to turtle hatchlings and possibly some migratory shorebirds through disorientation.
Excessive and loud intermittent noise	Future	Can cause flight response in “nervous” fauna such as shorebirds or avoidance of areas in the vicinity of its source. Evidence is also emerging that it may impact on the breeding behaviour of some songbirds as it masks their mating calls.
Hunting	Existing, future	Mortality to fauna including waterbirds, public liability issues
Climate change – increased saltwater intrusion from sea level rise	Future	Increased rates of saltwater intrusion and loss of predominant freshwater wetland areas; associated loss of species diversity and habitat and associated ecological and cultural values associated with these areas.
Climate change – changes to mangrove distribution from sea level rise	Future	Increased proliferation of mangroves at the expense of saltmarsh and <i>Melaleuca</i> communities; possible loss of existing mangrove communities in foreshore and lower estuary zones due to increased sea level rise and water-logging; associated loss of species diversity and habitat and associated ecological and cultural values associated with these areas.
Climate change – changes to fire regime	Future	Changes to rates of evaporation and increased drought conditions leading to change in Wetland inundation regimes and increased risks of wetland damage from more intense fires.
Unauthorised access and fauna disturbance	Existing, future	Impact on waterbirds from shooting, threats to ground nesting birds particularly the little tern from 4WDs and disturbance, public liability issues.

6.1 Key Threatening Processes

6.1.1 Habitat Loss and Fragmentation

Since European settlement, the study area has been extensively cleared, resulting in the fragmentation and loss of habitats. Clearing is likely to have resulted in reductions in the diversity of fauna of the area, particularly those species which are forest and woodland specialists. It also makes the fauna residing within the remaining patches of forest and woodland more prone to predation or displacement by more aggressive species. Fragmentation and loss of connectivity reduces the ability of forest and woodland specialists to move across the landscape and access all the resources they require to complete their lifecycles. Clearing and fragmentation also makes the smaller patches of vegetation prone to weed invasion and other changes in plant species composition.

6.1.2 Grazing

Much of the cleared areas of the Don River catchment have been converted to grazing lands for cattle. While grazing can be a compatible land use, inappropriate grazing regimes can lead to adverse impacts to wetland and terrestrial habitats.

Until recently (2011), cattle were able to access wetland habitats, which is likely to have resulted in a range of pressures to vegetation communities. Cattle have now been excluded from lands owned by the Coordinator General, which includes large parts of the Wetlands. There is a need to monitor the effects of this new land management regime in order to identify potential beneficial effects (e.g. native plant recruitment) and to manage any adverse impacts (e.g. weed infestation).

6.1.3 Weeds

There are numerous non-endemic plant species (i.e. weeds) that have been recorded in the study area. Weeds may impact on native flora and fauna by two main mechanisms:

- Changing fire regimes; and
- Displacing endemic flora and fauna.

Heavy infestations of introduced pasture grasses, such as Guinea Grass (*Megathyrsus maximus*) and Buffel Grass (*Pennisetum ciliare*) have altered the fuel dynamics and fire behaviour of infested areas (Stoner *et al.* 2004, Butler and Fairfax 2004). These grasses are present in much of the remnant vegetation throughout Queensland and the study area. Compared to many native species such as Kangaroo Grass (*Themeda triandra*), found within the study area, many of these introduced species have a much greater biomass, they tend to cure more quickly during periods of low rainfall and they establish in greater densities.

Introduced grasses often burn hotter and with greater flame and scorch heights than native grasses. They also take longer to burn out and occur on a more frequent basis. As a result of this the floral species composition may be altered by decreasing the cover of native species and creating conditions that facilitate the spread of introduced grasses and other weeds. It may also lead to a thinning of the tree canopy and shrub layer particularly of species that are fire sensitive or take longer to produce viable seed than the fire interval (Butler and Fairfax 2003).

Weeds displace endemic flora by out-competing them for space, light and nutrients. Weeds displace native flora by depriving them of food resources the endemic flora provided. They may also deprive the fauna of the vegetation structure they require to inhabit particular areas. For example, some species of ground-dwelling frogs avoid areas of thick introduced grasses because they are difficult to burrow into (Chambers 2006).

Fourteen plant species listed under the *Land Protection (Pest and Stock Route Management Act) 2002* and Weeds of National Significance (WONS) have been recorded in the study area in the Wildlife Online Extract and previous studies. These are listed in Appendix A.

There are dense infestations of Rubber Vine (*Cryptostegia grandiflora*) and Prickly Acacia (*Acacia nilotica*) (both WONS) around the margins of the Wetlands and along the banks of Saltwater Creek. There are lesser infestations of Parkinsonia (*Parkinsonia aculeata*), Mimosa Bush (*Acacia farnesiana*), Lantana (*Lantana camara*), Brazilian Nightshade (*Solanum seaforthianum*), Noogoora Burr (*Xanthium pungens*) and Buffel Grass (*Pennisetum ciliare*) all of which are serious environmental weeds.

There is a range of ponded pasture weed species that, while not presently a major threat in the Wetlands, could represent a future threat if habitat conditions are modified. The three key ponded pasture weed species in the broader region are Olive Hymenachne (*Hymenachne amplexicaulis*), Para Grass (*Urochloa mutica*) and Aleman Grass (*Echinochloa polystachya*). These aquatic to semi-aquatic species are now considered as invasive weeds in freshwater wetland and stream systems, and infestations are known to cause major changes to wetland hydrology and habitat values. Changes to land and water management, such as changes to grazing practices and wetland hydrology can promote the establishment and spread of these species.

6.1.4 Feral Animals

The most abundant and destructive feral animal at present appears to be feral pigs. Their wallows and footprints were located in a number of locations along Saltwater Creek and on the mudflats in the vicinity of Branch Creek by BMT WBM staff in November 2010. It is likely they are active throughout the Wetlands as the thickets of Rubber Vine, vine thicket and beach scrub provide ideal cover. Feral pigs destroy vegetation and modify the micro topography by trampling. They are also potential predators of ground nesting birds.

Rabbits, Red Fox, Black Rat, House Mouse, Common Starling and Cane Toad have also been recorded in the study area. Feral cats, Common Myna and Asian House Geckoes are also likely to find their way into the study area and will need to be controlled before they become established.

Cane toads are prevalent within the study area and compete for food with native frogs and other insectivorous species, predate on native frogs and other small fauna, and poison predatory native fauna that see them as a food source (though some species are immune or have learned to avoid eating the toxic parts of the animal).

Common Myna and Common Starling are likely to increase in numbers as the APSDA is developed as they are particularly well adapted to urban (and industrial landscapes).

Common Myna and Common Starlings are aggressive birds which compete with native species for nest hollows and food. Feral animal control needs to be done in a coordinated way so that, for example, removal of rabbits, does not lead to increased predation on native fauna by Red Fox. Feral animal control is more effective if it is coordinated with adjacent landholders. No one method has proved to be completely effective in controlling a particular species and so a number of methods are likely to be required.

6.1.5 Altered Fire Regimes

Fire is an important element in shaping the species composition and distribution of both flora and fauna in Australia. The intensity and frequency of fire has been altered in the last 200 years as a result of European land practices. These differ greatly from the fire regimes which have been practiced by Aborigines for thousands of years before European settlement. These fires were generally patchy in nature, frequent and of low intensity. Some vegetation communities (such as vine thicket) fire were deliberately excluded from being burnt (Kohen 2006).

There are presently no formal fire management arrangements for the study area other than fire suppression, which is likely to have resulted in:

- Proliferation of weeds.
- Lack of recruitment of fire dependant native flora species.
- Loss of native fauna species from catastrophic landscape or regional scale fires.
- Loss of native fauna species dependant on a mosaic of vegetation ages.

6.1.6 Altered Catchment Hydrology

With the majority of the APSDA cleared of terrestrial vegetation the hydrologic regime of the Wetlands, creeks and groundwater is already modified from its “natural” or “pre-European” condition. The change in dominant terrestrial vegetation cover from forest to grassland, together with changes to soil conditions resulting from previous cattle grazing, have contributed to a range of alterations to the site’s natural water cycle. Although a number of these changes are yet to be quantified it is reasonable to assume that alterations include:

- Reduced rainfall and runoff infiltration and interception.
- Reduced evapotranspiration.
- Changes to the groundwater levels.
- A decrease in sub-surface flows and greater overland flow.
- An increase in the frequency, peak flow rate and volume of overland flows to creeks.
- A decrease in subsurface base flows.
- Shorter but higher peak flows.

Unless adequately managed, the development of the APSDA for industrial uses has the potential to further exacerbate the effect of each of these changes thereby further threatening natural values. Evidence of the combined impact of these changes is already apparent in the catchment and includes:

- Erosion of topsoils and exposure of more erosive soil horizons;
- Erosion of creek bed and banks and associated habitats in response to changes in hydrology;
- Sediment slugs in waterways and subsequent deposition of sediments in the Wetlands; and
- Decline in aquatic species diversity and ecological functioning.

The natural wetting and drying cycle of the Wetlands has also been affected but given that the Wetlands are tidally influenced and controlled in part by the artificial bunds, the impacts noted above may be masked by these more dominant hydrologic influences.

6.1.7 Presence and Operation of the Bunds

The western (outer) and causeway (inner) bunds have modified the ecological character of the Wetlands through:

- Changes to tidal hydraulics and associated water quality modifications;
- Changes to vegetation communities; and
- Restricting aquatic fauna movement patterns.

Refer to Sections 2.2.4, 3.2.2 and 3.2.3 for further details.

6.1.8 Poor Water Quality and Dust

Water quality in the Wetlands is strongly influenced by the Wetlands' hydrology with significant changes occurring between the wet and dry seasons. The most significant change in Wetlands' water quality has been the change in salinity attributed to the construction of the two bunds however land use impacts have also impacted water quality.

Although pre-European water quality conditions cannot be established definitively, increases in sediments and nutrients from changes in land use are almost certain. Both the direct land use impacts e.g. erosion of grazed lands, and indirect impacts such as the erosion of channel bed and banks have contributed to the decline of creek and groundwater quality, which has also contributed to elevated pollutant levels in the Wetland. Dissolved oxygen, essential for aquatic fauna, is also likely to have declined as increased nutrients from the catchment are washed into creeks during storm events triggering algal blooms. A dense mat of algal growth is already evident in the Wetlands covering the majority of the Wetlands' substrate.

Other water sources which may influence the water quality of the Wetlands include treated surface water runoff from the APCT located to the north of the Wetlands, and runoff from the elevated dunes and ridges within the APCT which enter the Wetlands from the east (GHD 2009). Dust originating from industrial areas may also be a potential source of pollutants.

Stormwater (and dust) from future industrial and infrastructure development within the APSDA post development will be the key mechanism for transporting diffuse pollutants to the waterways with nutrients, sediments and gross pollutants being the primary pollutants of concern.

6.1.9 Refuse, Discarded Materials and Barbed Wire Fences

Currently there is a variety of discarded materials scattered around the study area including:

- The disused pipeline along the causeway (inner) bund.
- Discarded tyres along the western (outer) bund.
- Discarded fencing wire adjacent to Mount Stuart Creek (downstream from the western (outer) bund).
- Discarded vehicles.
- Bottles and other refuse scattered around in various areas.

The tyres and vehicles are likely to leach toxic chemicals over time as well as providing potential breeding sites for mosquitoes and other biting insects. Small fauna can become trapped inside discarded bottles and they can also provide breeding sites for biting insects. Other refuse contributes to visual pollution and detracts from the naturalness of the study area.

There is a barbed wire fence built across the Wetlands south of Lake Caley which poses a threat to fauna particularly Black Swan and Australian Pelican because these birds have a long slow takeoff trajectory. The fence posts do not pose a danger and indeed provide additional perching sites for terns and cormorants.

In the absence of management intervention, there is a risk that future industrial and infrastructure development within the APSDA could increase loads of refuse in the Wetlands. This could pose a threat to fauna through entanglement or ingestion. Accumulations of refuse can also pose a fire threat.

6.1.10 Light Pollution

Artificial lighting can have an impact on terrestrial and aquatic fauna. Sea turtle hatchlings are known to move towards artificial lights away from the ocean (instead of towards it). The hatchlings then get caught in the open during daylight where they are easy targets for terrestrial predators (*Harder 2002*). They are also at risk from being killed by vehicles and from sun exposure.

A study in the Richmond River estuary in northern New South Wales found that some Double-banded Plovers (*Charadrius bicinctus*) favoured mudflats that received high levels of artificial light at night thus affecting their normal distribution (*Rowhder and Lewis 2002*).

A study in an Adelaide city park concluded that micro bat species that forage near artificial lights may have a competitive advantage over those that don't (*Scanlon and Petit 2008*).

Artificial lighting is not an issue within the Wetlands project area at present. However, the presence of nesting turtles on the shoreline within the study area and of plover species within the study area artificial lighting from industries and roads within the APSDA could potentially have an adverse impact in the future. Such impacts can be mitigated by using sufficient lighting to achieve the purpose it is required for; using light fittings which cause minimal light dispersion outside the target area; and avoid the use of mercury lamps which tend to attract insects and other fauna.

6.1.11 Excessive and Loud Intermittent Noise

Excessive and loud intermittent noise can cause flight response in “nervous” fauna such as shorebirds or avoidance of areas in the vicinity of its source. Evidence is also emerging that it may impact on the breeding behaviour of some songbirds as it masks their mating calls.

Apart from the noise from gun shots emanating from illegal hunting there appears to be little excessive noise within the Wetlands project area. It is a potential problem in the future with industrial development in the ASPDA.

6.1.12 Hunting

Although the Wetlands were originally modified to create more freshwater wetlands and promote recreational waterfowl hunting, recreational hunting is no longer legal. Queensland’s Recreational Duck and Quail Hunting Management Plan expired on the first of September 2005 and was not renewed. The decision to cease legal duck hunting in Queensland was made after drought conditions were suspected of reducing waterfowl populations, in combination with lobbying from animal welfare groups. There is evidence (i.e. firearm shells/pellets found during BMT WBM surveys in 2011) of illegal hunting still occurring.

6.1.13 Climate Change

There have been several assessments of the implications of climate change for coastal resource in the Great Barrier Reef (GBR) catchment. The most substantive study to date was undertaken by Johnson and Marshall (2007), which assessed the vulnerability of predicted climate change and sea level rise in the GBR.

Overall, the principal threats to the values of the Wetlands from climate change can be summarised as follows:

- Increased rate and extent of saltwater inundation into coastal environments due to sea level rise and storm surge events;
- Response of mangrove, saltmarsh and fringing wetland vegetation to rising sea level;
- More intensive fire regimes that eventuate due to hotter dry seasons, and the resulting damage of ‘hot fire’ regimes on vegetation; and
- Increased wind velocity affecting vegetation and water movement.

Saltwater Intrusion

A range of studies have been conducted to predict the impacts of sea level rise on saltwater intrusion processes. Bayliss *et al.* (1997) suggested northern Australian wetland areas below four metres in elevation are assessed as being vulnerable to climate-induced changes. Given the low-lying nature of the Wetlands, it would appear the mangrove forests, the Wetland Basin Zone, Saltwater Creek Zone and other low-lying terrestrial areas of the study area are at risk of increased tidal penetration. This is likely to lead to a change in the distribution of the various vegetation communities as outlined below. More precise analysis of areas likely to be impacted could be evaluated using hydrological and catchment models.

Mangrove Expansion

The response of estuaries to sea level rise is only partially understood, but it is likely that mangrove growth may continue and expand under sea level rise scenarios, particularly in those marginal saltpan areas that are currently only receiving occasional tidal inflows. The impacts of this will be for mangroves to continue to replace salt marsh/pan and fringing *Melaleuca* communities, assuming that suitable habitat conditions exist (for example, bed levels are at a suitable height, creeks are adequately flushed etc.). Inversely, current mangrove communities along downstream tidal channels and in the lower reaches of the estuaries could be at risk from more permanent inundation and water logging if sea levels rise too quickly for the communities to naturally respond. This 'drowning' effect has not been specifically observed at broad-scales to date in the Wetlands but is regarded as a potential threat, particularly given the more extreme sea level rise predictions that are emerging.

Changes to Fire Regimes

It is generally accepted that increased frequencies and intensities of fire associated with higher temperatures, longer dry seasons and increased weed prevalence threaten the values of the study area. However, perceptions and opinions about specific impacts are conflicting and further research is required to address this issue.

6.1.14 Unauthorised Access and Fauna Disturbance

Many wetland fauna species are sensitive to pedestrian and vehicle traffic. In this context, frequent disturbance of nesting birds may lead to abandonment of the nest and wader birds will lose condition if they are unable to feed undisturbed. Furthermore, motor vehicles may directly damage eggs and ground-dwelling chicks that are unable to move from their nests. Field surveys identified tyre marks adjacent to the important Little Tern nesting area at the mouth of Mount Stuart Creek, which is external to the Wetlands project area.

6.2 Risk Assessment

A qualitative risk assessment was undertaken to determine key risks to EVs. A description of the risk assessment process and results of the risk assessment are provided in Appendix H. In summary, the risk assessment indicates that in the absence of mitigation, and taking into account existing controls, the following were rated as "extreme" risks:

- Conversion of Saltwater Creek into a mangrove lined estuary due to sea level rise. This risk is relevant to changes over long timeframes (50-100 years+). This will represent a benefit to some species (in this case estuarine species that use mangrove habitats), and a loss of values for others (i.e. freshwater species).
- Restricted fish movements and associated loss of habitat values for species of fisheries significance (particularly Barramundi) due to ongoing operation of the western (outer) bund and the causeway (inner) bund. While the western (outer) bund has created a novel habitat type that appears to have values as a fish habitat and bird feeding area (i.e. the impounded hypersaline waters), these potential benefits appear to be outweighed by the long term adverse impacts associated with the loss of mangrove habitat and loss of connectivity.

- In the absence of adequate management intervention, development in the APSDA would lead to altered hydrological regimes and water quality in creeks and the Wetlands. This increase in disturbance to aquatic ecosystems would result in adverse impacts including a loss of aquatic species abundance, diversity and habitat.

Many of the risks rated as high were also associated with impacts to habitats due to sea level rise (SLR). These include:

- Loss of dry season refugia (Lake Caley and Saltwater Creek) for wetland-dependent species, and loss of migratory and resident waterbird feeding and nesting areas at Saltwater Creek and the Wetland Basin Zone, due to sea level rise.

Other risks rated as high were:

- Disturbance of Little Tern nesting activities due to uncontrolled human access on beaches. This is presently occurring and could increase as a result of greater numbers of people working in the APSDA visiting the beach to undertake recreational activities.
- Loss of habitat for threatened terrestrial fauna, terrestrial habitat fragmentation and loss of fauna movement corridors. While there is generally poor north – south connectivity at present, further losses in connectivity of existing riparian areas as a result of infilling to create industrial lots could lead to further detrimental impacts.
- There is an expectation that controlled water discharges from development within the APSDA will be of a suitable standard to protect EVs, as required under the EPP Water. However, there is a risk that inadequate stormwater management practices, together with accidental spills, could increase pollutant loads in the Wetlands, impacting on fish habitat values.
- Altered tidal hydraulics associated with the removal of the western (outer) bund leading to the loss of freshwater habitat in Saltwater Creek. This could occur even without sea level rise, if inappropriately managed.

7 FURTHER INFORMATION

While existing information is sufficient for the preparation of management objectives and actions, more detailed baseline information is required to inform future development projects within the APSDA; and establish a baseline for ongoing monitoring activities. Note that additional studies are also required to inform management objectives and actions.

7.1 Baseline Water Quality and Sediment Quality Conditions

Water quality can show marked variation over time in response to changes in rainfall and tidal processes. It is important to understand these patterns and underlying processes in order to determine potential impacts on wetland ecosystem functioning, and to provide a basis for water quality (and water depth) monitoring.

There is a good information base for certain water quality parameters over much of the Wetlands. However, further data collection is required to:

- Describe water quality characteristics of ephemeral stream environments that drain into the Wetlands. This is expected to require a combination of event based water quality sampling (i.e. sampling during flow events), and ambient monitoring within pool environments.
- Describe patterns in contaminant concentrations in waters and sediments at sites that are representative of the major habitats within the Wetlands. This should focus on trace metals and nutrients.
- Determine key drivers for changes in water quality across the Wetlands as a whole. Basic hydrological data (flows, wetland extent, water depth etc.) should be collected at the same time as water quality data.

This sampling should aim to describe natural variability in water (and sediment) quality, and provide sufficient information for developing local water quality guideline values based on methods outlined in DERM (2009). A Sampling and Analysis Plan should be developed to document the sampling, analysis and reporting procedures.

Timing: Prior to earthworks within the APSDA.

Priority: High

Responsibility: Proponents will need to undertake relevant studies, prepare and implement appropriate management plans and monitor the impacts of their actions on water and sediment quality.

7.2 Patterns in Vegetation Community Structure

Vegetation communities can show great variation over time in response to a range of factors, particularly hydrological conditions (wetting and drying cycles, flows) and associated changes in water quality conditions. Where proponents of development in the APSDA are required to undertake

management, rehabilitation or other works that may impact upon wetland vegetation communities, a baseline study should be undertaken of the proposed work area to assess the effectiveness of future management strategies; and assessing impacts of existing pressures on wetland vegetation that may require management intervention (e.g. impacts of the causeway (inner) bund on salinity and vegetation community structure).

A combination of mapping and plot-based assessment techniques would provide a sound basis for quantitatively describing changes in vegetation community structure at representative sites within the Wetlands project area. A comprehensive analysis of historical aerial photography at the identified management area and adjoining areas would provide a context for assessing historical changes in vegetation and possibly key drivers (e.g. bund construction, inundation etc.). Surveys should also focus on mapping key weed infestations in the Wetlands and surrounds.

Timing: Prior to earthworks within the APSDA

Priority: Moderate

Responsibility: Proponents will need to undertake relevant studies, prepare and implement appropriate management plans and monitor the impacts of their actions to ensure wetland vegetation communities are maintained or enhanced.

7.3 Fauna Distribution and Habitat Usage

Most fauna studies to date either have a narrow spatial coverage (i.e. sampling within the vicinity of the footprint of a proposed development activity) or represent a snap-shot with limited temporal coverage. Further information is required to more accurately define patterns in habitat usage by wetland and terrestrial fauna, and key habitats/areas for these species. Further gap filling studies in this context are:

- Targeted surveys on habitat usage by threatened terrestrial fauna species. Two species have been recorded in the Wetlands project area to date, and an additional two species are known from the wider area and could potentially occur here. Systematic surveys are required to further define patterns in habitat usage of these species, including the identification of critical habitats.
- Additional baseline data describing patterns in the fish distribution and abundance within the Wetlands project area. Studies to date have limited temporal coverage, and do not assess changes in community structure over time. Baseline information is essential for establishing an appropriate basis for determining the success of future habitat management activities within the Wetlands project area.
- Quantitative baseline data describing spatial and temporal patterns in the waterbird abundance and nesting activities within the Wetlands project area. Multiple wet and dry season sampling would be required to assess patterns in natural variability. Such information provides a basis for determining the effectiveness of future management activities.

Timing: Prior to earthworks within the APSDA

Priority:

- Targeted threatened fauna surveys: High

- Fish surveys: Moderate to low
- Waterbird surveys: Moderate.

Responsibility: Proponents will need to undertake relevant studies, prepare and implement appropriate management plans and monitor the impacts of their actions to ensure fauna distribution and habitat usage are maintained and enhanced.

8 GLOSSARY

Aquatic/marine fauna, in the context of this report, this relates to fauna species that spend all or the majority of their life cycle in or underwater. As such this grouping primarily relates to fish, marine reptiles, aquatic mammals such as dugong and cetaceans, and aquatic/marine invertebrates.

Catadromous, refers to organisms that live in freshwater but migrate to marine waters to breed.

Habitat is a general term to describe the part of the natural environment in which an organism normally lives that is defined by both physical characteristics such as soil, moisture, range of temperature, and availability of light as well as biotic factors such as the availability of food and the presence of predators.

IMCRA bioregion refers to the Interim Marine and Coastal Regionalisation for Australia (Mesoscale) to the 200 metre isobath and derived from biological and physical data, (for example, coastal geomorphology, tidal attributes, oceanography, bathymetry and intertidal invertebrates).

Mangal, means mangrove habitat consisting of mangrove trees and shrubs and their associated faunal communities.

Potadromous refers to organisms that complete their entire lifecycle in freshwaters.

Shorebirds, as used in this report, refer to both resident and migratory species which are ecologically dependent upon wetlands from the following families: Scolopacidae; Burhinidae; Haematopodidae; Recurvirostridae; Charadriidae; and Glareolidae. Shorebirds form a sub-set of the waterbird grouping.

Values, means the perceived benefits to society, either direct or indirect that result from wetland functions. These values include human welfare, environmental quality and wildlife support.

Waterbirds, refers to those species which are ecologically dependent upon wetlands from the following families: Anseranatidae, Anatidae, Podicipedidae, Anhingidae, Phalacrocoracidae, Pelecanidae, Ardeidae, Threskiornithidae, Ciconiidae, Gruidae, Rallidae, Scolopacidae, Rostratulidae, Jacanidae, Burhinidae, Haematopodidae, Recurvirostridae, Charadriidae, Glareolidae, Laridae and Sternidae (after Kingsford and Norman 2002; Wetlands International 2006). Only those species of gulls (Laridae) and terns (Sternidae) which make extensive use of shallow, inshore waters or inland wetlands are included. Whilst at least some other species of other families traditionally regarded as “seabirds” (that is, Spheniscidae, Phaethontidae, Sulidae, Fregatidae, Stercorariidae and Alcidae) also make use of shallow, inshore waters (and thus could be therefore be considered as waterbirds), these have not been included in the waterbird group (following precedent within Wetlands 2006). Shorebirds form a sub-set of the waterbird grouping.

Wetlands, means wetlands, and is used in this report in the context of the definition under the Ramsar Convention which includes areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Wetland-dependent terrestrial fauna, in the context of this report relates to fauna species that occur within or otherwise are dependent on wetland habitats but do not spend the majority of their life

cycle underwater (for example, non-aquatic species). As such this grouping primarily relates to birds, amphibians such as frogs, non-aquatic mammals such as water mouse, non-aquatic reptiles and terrestrial invertebrates.

Wetland flora, in the context of this report relates to flora species that are characterised as wetland or wetland-dependent species or populations.

Wetland ecosystem components are the physical, chemical and biological parts or features of a wetland.

Wetland ecosystem processes are the dynamic forces within the ecosystem between organisms, populations and the non-living environment. Interactions can be physical, chemical or biological.

Wetland ecosystem benefits or services (includes the term ecosystem services), are the benefits that people receive from wetland ecosystems. In general, benefits and services are based on or underpinned by wetland components and processes and can be direct (for example, food for humans or livestock) or indirect (for example, wetlands provide habitat for biota which contribute to biodiversity).

Wetland type describes a specific element of a wetland or marine area with a specific set of biological and physical attributes. These are described in detail in DIWA (Environment Australia 2001).

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APPENDIX A: 2010 WATER QUALITY ASSESSMENT

A1. Background

This appendix describes the results of water quality assessments undertaken by BMT WBM in October and November 2010. This sampling was undertaken to fill several important information gaps required to develop management objectives and actions. Specifically, field assessments were undertaken to:

- Describe broad scale spatial patterns in various water quality parameters across the Kaili (Caley) Valley Wetlands (the Wetlands); and
- Identify the potential effect of tidal processes on salinity and water levels within the Wetlands.

A2. Methodology

Three approaches were used to sample and analyse patterns in water quality conditions within the Wetlands:

- *In-situ* continuous measurements;
- *In-situ* measurements; and
- Laboratory-based grab samples

Sample collection and handling procedures were consistent with the DERM (2009) Monitoring and Sampling Manual 2009. Sites were located within representative areas throughout the Wetlands, which are shown in Table A-1 and Figure A-1. Additional *in-situ* spot measurements were also collected opportunistically throughout the wetland system, which are also shown in Figure A-1.

Table A-1 Location of Water Quality Survey Sites Selected for Continuous *in-situ* Measurements and Collection of Samples for Analytical Analysis

Site Name	Location	Easting ¹	Northing	<i>In-situ</i> measurements	<i>In-situ</i> continuous measurements	Analytical analysis
Site 1	Saltwater Creek Zone	616913	7793115	√	√	√
Site 2		615568	7794025	√	√	√
Site 3	Wetland Basin Zone	612178	7796310	√	√	√
Site 4		609636	7796495	√	√	x
Site 5		608922	7796099	√	√	√
Site 9		611673	7800253	√	x	√
Site 6	Western Estuary Zone	607568	7795468	√	√	√
Site 7		607617	7796837	√	√	√
Site 8	Hypersaline Zone	607762	7796937	√	√	√

¹ Datum: Universal Transverse Mercator (UTM) WGS 84, Zone 55.



<p>Figure: A-1</p> <p>Rev: E</p>		<p>BMT WBM</p> <p>www.bmtwbm.com.au</p>	
<p>Title:</p> <p>Water Quality Sampling Locations</p>		<p>Scale: 1:50,000</p> <p>North Arrow</p> <p>Approx. Scale</p>	
<p>LEGEND</p> <ul style="list-style-type: none"> Kall Valley Wetland Boundary as Defined through DINVA Listing APSDA Boundary Road Railway Regrowth Watercourse (DERM) 		<p>Wetlands Project Area</p> <ul style="list-style-type: none"> In-situ Data Collection Continuous Data Collection Grab Samples for Analytical Analysis 	

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

In-situ Continuous Measurements

Continuous measurements of electrical conductivity, pressure (water depth) and temperature were undertaken at eight sites (Figure A-1). A submersible water quality data-logger was deployed at each site for a four week period beginning the 25th of October 2010. This allowed the capture of data continuously over spring and neap tide cycles, set at 12 minute intervals. Each unit was serviced fortnightly to remove any fouling on the instruments, which may interfere with measurements.

In-situ Spot Measurements

In-situ measurements of physio-chemical water quality parameters were collected throughout the Wetlands on three occasions: (i) 25th - 29th of October 2010; (ii) 23rd - 24th November 2010; and (iii). Locations for *in-situ* measurements are shown in Figure A-1.

The following parameters were measured using a calibrated portable water quality probe (Yeokal 611): water temperature (°C); electrical conductivity (µS/cm and ms/cm) pH; dissolved oxygen (mg/L and % saturation); redox potential (mV); salinity (g/L); and turbidity (NTU). Measurements were made at the surface (0.1 meters), and where applicable mid-depth and near the bed (5-20 cm above the bed).

Grab Samples for Analytical Analyses

Water samples were collected at the sites shown in Table A-1 for analytical analysis. Samples were collected from mid-depth, with all sampling and handling procedures undertaken in accordance with DERM (2009). All storage containers were chilled on ice immediately following sample collection. Collected samples were labelled and kept cool in an ice filled esky until their arrival at the laboratory (next day).

Samples were supplied to the NATA approved Advanced Analytical Laboratories in Brisbane. Laboratory analyses were undertaken for the parameters outlined in Table A-2.

Table A-2 Analytical Water Quality Parameters and their Minimum Detection Limits

Parameters measured	Detection limit
General	
Total suspended solids	2 mg/L
Total dissolved solids	1 mg/L
Nutrients	
Total nitrogen	0.1 mg/L
Total kjeldahl nitrogen	0.1 mg/L
Nitrate	0.01 mg/L
Nitrite	0.01 mg/L
Ammonia	0.01 mg/L
Total phosphorus	0.02 mg/L
Filterable reactive phosphorus	0.01 mg/L
Algae	
Chlorophyll a	0.001 mg/L
Metals and metalloids	

Parameters measured	Detection limit
Aluminum	0.020 mg/L
Arsenic	0.005 mg/L
Cadmium	0.0007 mg/L
Chromium	0.002 mg/L
Copper	0.001 mg/L
Iron	0.020 mg/L
Lead	0.001 mg/L
Manganese	0.005 mg/L
Nickel	0.003 mg/L
Zinc	0.005 mg/L
Mercury	0.0001 mg/L
Phosphate	0.01 mg/L

A3. Results and Discussion

Electrical Conductivity / Salinity

Figures A-2, A-4 and A-5 shows the electrical conductivity ($\mu\text{S}/\text{cm}$) of waters (a measure of salinity) and pressure derived water depth (metres) recorded at the seven logger locations. Results have also been compared to local rainfall data recorded at Bowen Airport (station number 33257), which is located approximately 12 km south-west of Site 1 on Saltwater Creek. It should be noted that rainfall data obtained from the Bureau of Meteorology (BOM) has been backdated 24hrs to give more precise indication of actual time of rainfall at the site.

The following summarises patterns in electrical conductivity/salinity among the wetland habitat zones.

Saltwater Creek

- Electrical conductivity (EC) remained consistent over time within sites, but did vary in response to rainfall events. At upstream Site 1, EC was consistently around 3800 $\mu\text{S}/\text{cm}$ (slightly brackish), whereas downstream at Site 2 the conductivity remained at approximately 1600 $\mu\text{S}/\text{cm}$ (freshwater);
- Figure A-3 shows EC surface values (i.e. 0.1m depth) recorded along the length of Saltwater Creek on the 28th of October 2010. Consistent with results obtained by the loggers, EC increased with distance upstream.

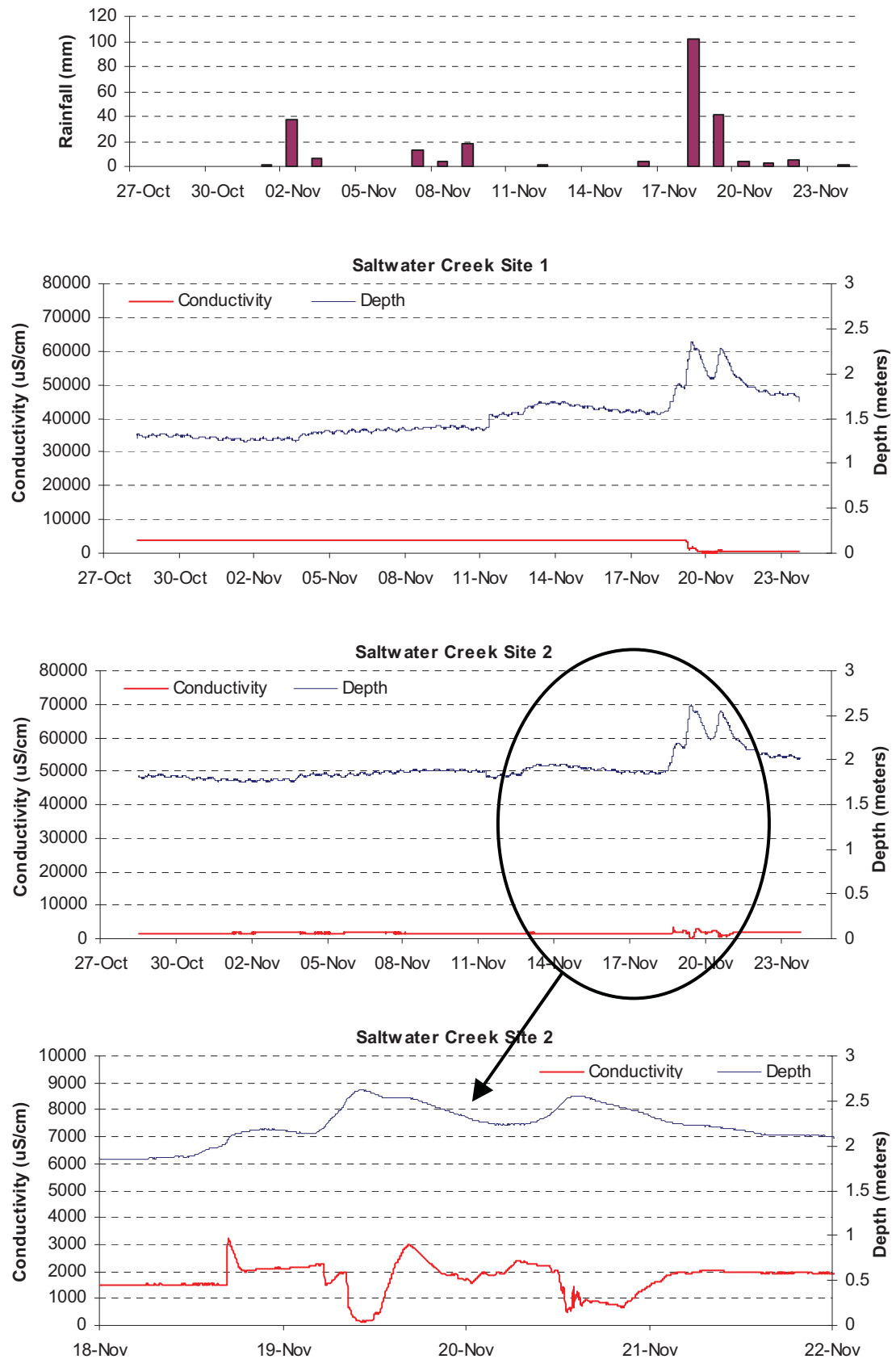


Figure A-2 EC (µS/cm) and Pressure Derived Depth (meters) Recorded at Sites 1 and 2 in Saltwater Creek (27.10.2010 to the 24.11.2010)

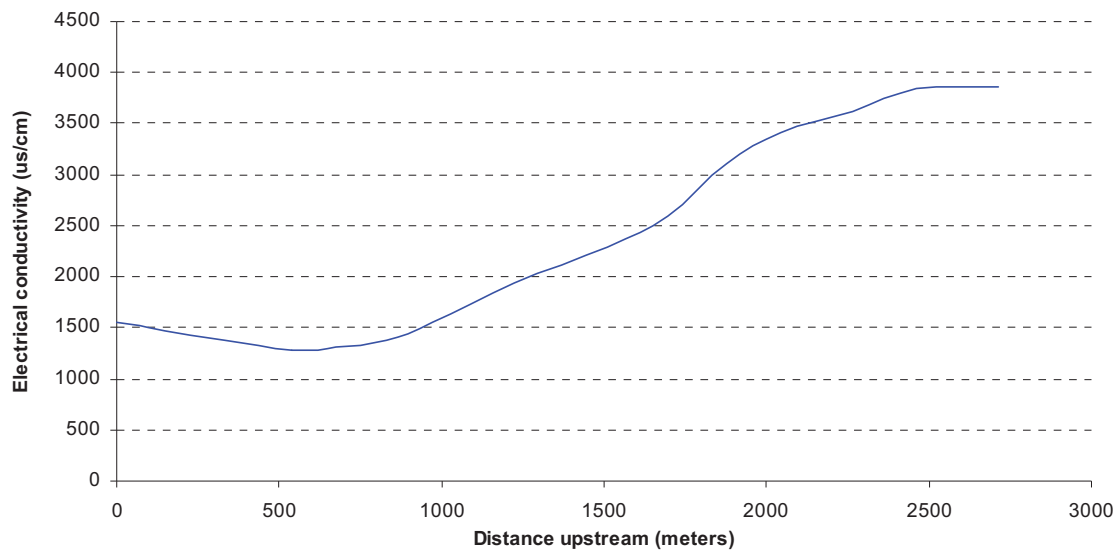


Figure A-3 In-situ Electrical Conductivity (µS/cm) Recorded in Surface Waters (0.1 meters) along Saltwater Creek in October 2010.

- The slightly greater EC at Site 1 may reflect a slightly greater marine influence in upstream areas of the creek. A small channel was observed adjacent to Site 1 connecting Saltwater Creek to a small estuary system to the north-east. Despite 3.0 meter spring tides occurring between the 5th and 7th November 2010, there was no change in water depth and EC data at Site 1, which suggests there was limited/no water exchange occurred between the channel and Saltwater Creek. It is possible that waters may enter Saltwater Creek via this channel during large spring tide events.
- Small rainfall events of <40mm did not result in substantial changes in EC, whereas small changes in water level were recorded².
- During larger rainfall events on the 19th and 20th November 2010 (143 mm), changes in water levels and EC were observed. At Site 2, EC temporarily increased from 1513 µS/cm to 3343µS/cm, suggesting that a pulse of slightly brackish water was pushed downstream. At Site 1, EC declined steadily from 3744 µS/cm to 246 µS/cm.
- These results indicate that salinity in Saltwater Creek varies over time in response to rainfall. The range of EC values recorded in the BMT WBM October 2010 – November 2010 study are consistent with previous investigations which suggest that Saltwater Creek has a predominantly freshwater character.

Wetland Basin Zone

- In the period leading to the moderate rainfall event (i.e. pre-18th November 2010), EC within the Wetland Basin Zone ranged from hypersaline in the west to marginal estuarine conditions in the east. EC values during this period were:
 - Site 3 = 19,421 to 27,979 µS/cm;

² Changes in depth on the 11th of November were a result of gear maintenance.

- Site 4 = 13,554 to 48,804 $\mu\text{S}/\text{cm}$; and
- Site 5 = 17,615 to 70,153 $\mu\text{S}/\text{cm}$.
- Following the 18th November rainfall event, EC declined across the wetland basin, ranging from approximately 7,000 to 18,000 $\mu\text{S}/\text{cm}$.
- Temporal patterns in EC values among sites was as follows:
 - EC values at Site 3 (located in the eastern sector of the basin) showed less variation over time than observed at Sites 4 and 5. Consistent with EC patterns in EC in nearby Saltwater Creek, EC values declined following rainfall events on the 3rd, 12th and 18th of November. In contrast to temporal patterns observed at Saltwater Creek, EC values at Site 3 gradually increased between these rainfall / flow events. This is a reflection of the greater influence on tidal processes in the basin compared with the situation at Saltwater Creek.
 - While EC values at Site 4 were greater than Site 3, temporal patterns were consistent between sites (i.e. fluctuate in response to changes in rainfall). There were also changes in EC at fine temporal scales (i.e. within days) that were not observed at Site 3. For example, EC values on the 29th of October ranged from 35,025 to 45,577 $\mu\text{S}/\text{cm}$. These variations were not associated with tidal cycles or rainfall patterns, but are instead suspected to be a response to wind driven mixing of waters.
 - Site 5 had the highest EC values and greatest range of EC values³. Similar to other sites, EC values temporarily declined on 12th and 18th of November, coincident with moderate rainfall events. Changes in water depth during the measurement period were apparently related to catchment input rather than cyclic tidal variations.
- Anecdotal reports from landholders suggest that during spring tides, tidal waters enter the main wetland section at Site 5 from the estuaries to the west. However, even though spring tides of 3.0 meters occurred between the 5th to the 7th of November, both depth and EC data collected at this site indicates that saline water did not enter the Wetlands during the recorded spring tide period. However, an increase in EC was recorded at Site 5 prior to this period. It should be noted that the heights of king tides at Abbot Point area are generally 3.4 to 3.5 meters. It is possible that tidal flushing of the Hypersaline and Wetland Basin Zones occurs at tidal heights greater than 3 meters.

³ The decrease in depth recorded on the 9th of November is an error produced from logger maintenance.

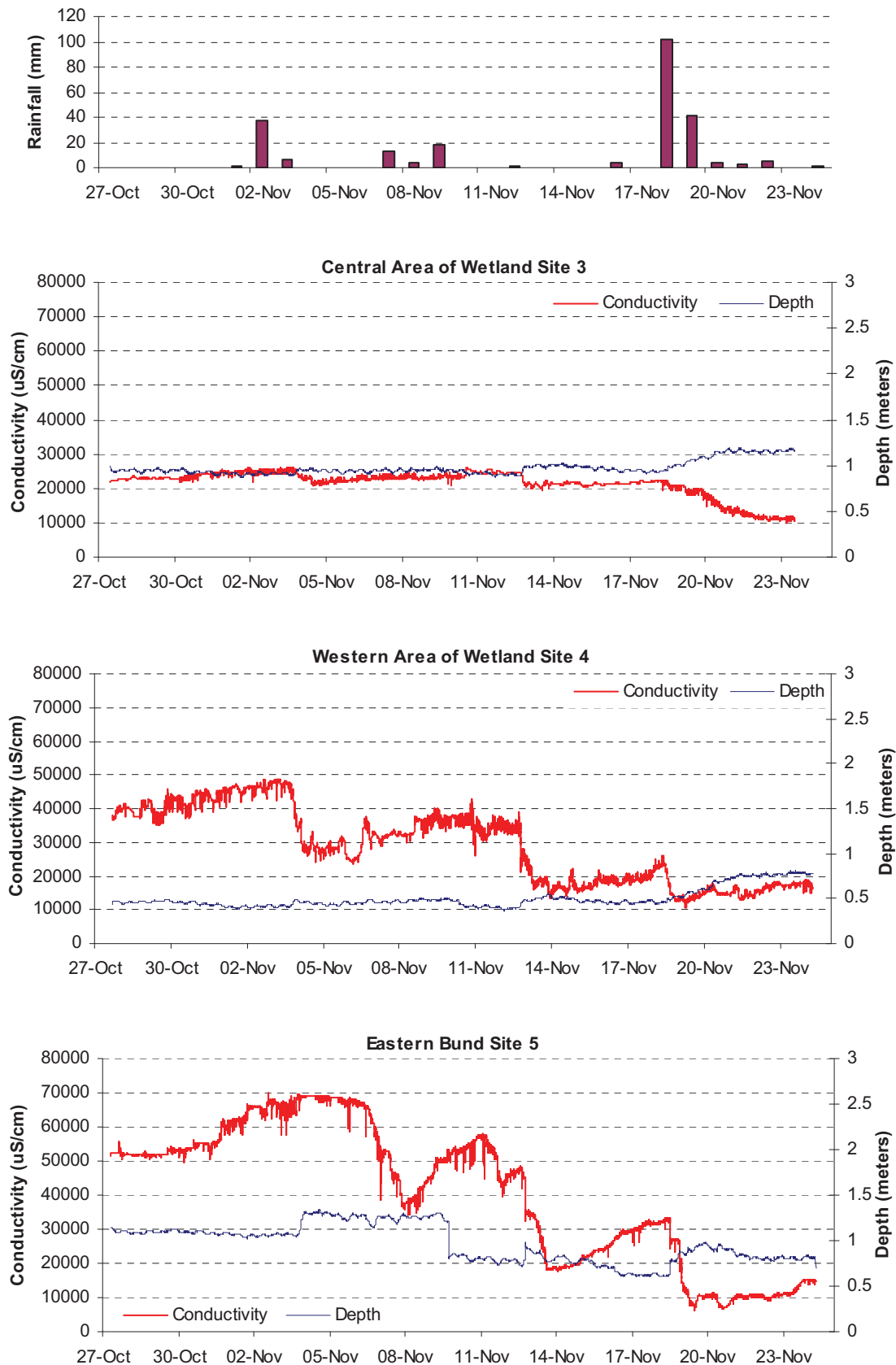


Figure A-4 EC ($\mu\text{S}/\text{cm}$) and Pressure Derived Depth (meters) Recorded at sites 3, 4 and 5 in the Wetland Basin from the 27.10.2010 to the 24.11.2010

Hypersaline Zone

In-situ water quality readings were collected on four separate occasions throughout July, September, and October 2010. EC concentrations values during dry periods were generally greater than 80,000 $\mu\text{S/cm}$ (salinity > 60 g/L), which is indicative of hypersaline conditions. A measurement undertaken following catchment rainfall in November 2010 indicated that electrical conductivity had declined to 33,000 $\mu\text{S/cm}$. This indicates that the 367mm of rainfall recorded during November (Bowen Airport station number 33257) was sufficient to reduce hypersaline levels to EC concentrations consistent with those generally recorded in estuarine environments.

Western Estuarine Zone

Mount Stuart Creek Estuary

EC values at Mount Stuart Creek estuary can be broadly grouped into the following:

- 27/10/2010 to 3/11/2010 EC ranged from approximately 60,000 to 75,000 $\mu\text{S/cm}$;
- 3/11/2010 to 18/11/2010 EC ranged from approximately 40,000 to 71,000 $\mu\text{S/cm}$; and
- 18/11/2010 to 24/11/2010 EC ranged from approximately 24,000 to 60,000 $\mu\text{S/cm}$.

Consistent with other sections of the Wetlands, EC declined in response to rainfall events on the 3rd, 12th and 18th of November. Furthermore, EC values were generally lowest during high tide and highest at low tide. Hypersaline conditions were recorded on several low tides (noting that seawater has an equivalent EC of approximately 51,500 $\mu\text{S/cm}$, whereas values >70,000 $\mu\text{S/cm}$ were recorded during certain low tides). It is suspected that the higher EC during low tide periods is a consequence of leakage of hypersaline waters through the western (outer) bund wall.

Branch Creek Estuary (refer photos A and B)

Due to the shallow nature of waters at Branch Creek estuary, accurate water depth measurements could not be taken with depth sensor. EC data from this site are as follows:

- EC values ranged from freshwater up to 53,000 $\mu\text{S/cm}$ (equivalent of seawater). These values were far lower than recorded at nearby Mount Stuart Creek; and
- The intermittent data records reflected changes in water levels due to changes in tidal inundation patterns and catchment runoff. The logger was continuously submerged from 16:30 on the 18th of November until 16:24 on the 21st of November, during which EC values ranged from 353 to 17,178 $\mu\text{S/cm}$. Higher EC values were collected earlier in the measurement period, reflecting patterns in tidal inundation.

Analytical Sample Analysis

The BMT WBM October 2010 – November 2010 study assessed nutrient concentrations at nine sites throughout the Wetlands in November 2010. These results are summarised in Table A3.

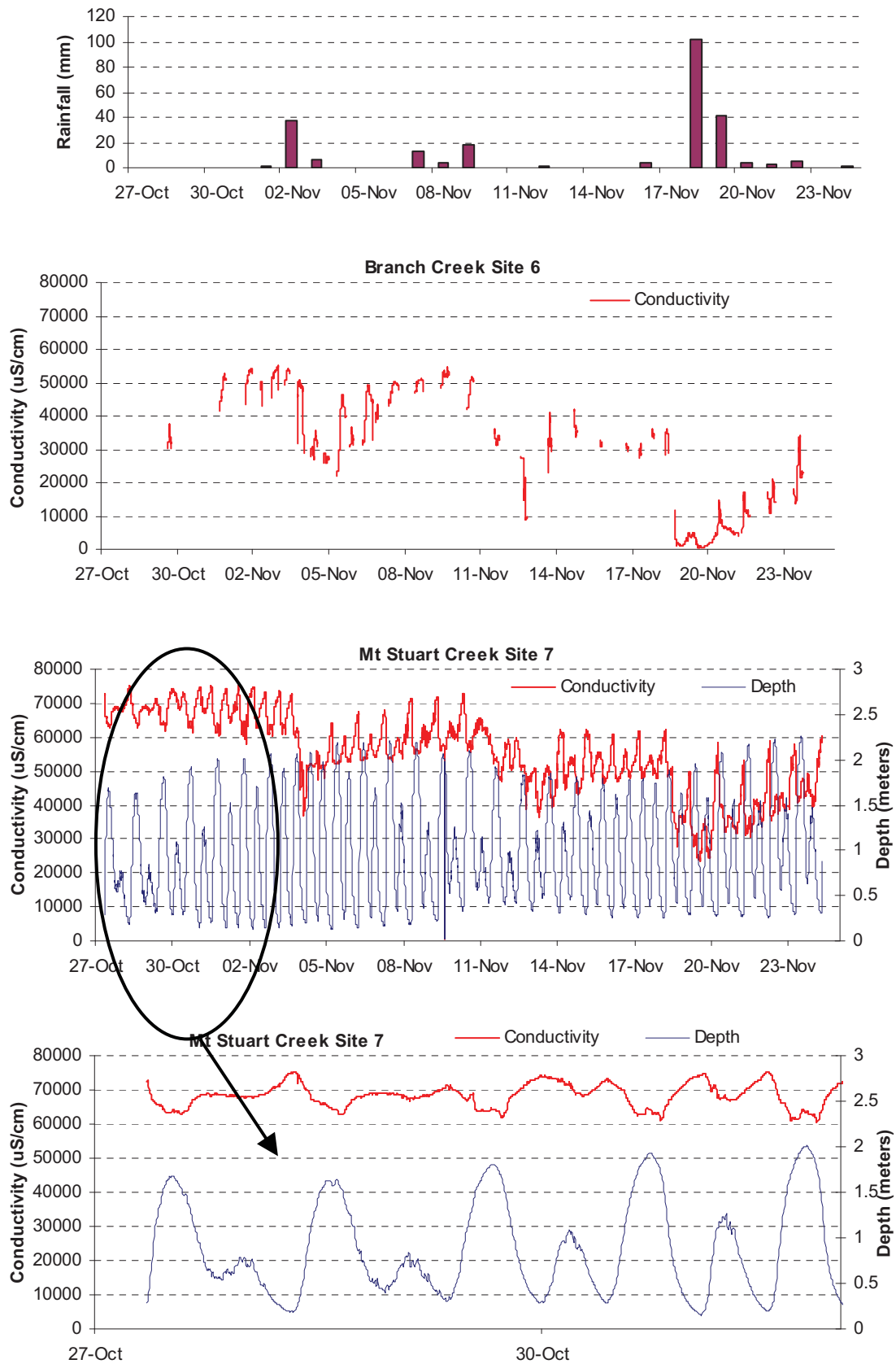


Figure A-5 EC ($\mu\text{S}/\text{cm}$) and Pressure Derived Depth (meters) Recorded at Sites 6 and 7 in the Western Estuarine Zone from the 27.10.2010 to the 24.11.2010



Photo (A) Upper Estuary Location of Logger at Site 6



Photo (B) Tide Encroaching Across Flats in the Hypersaline Zone

Table A-3 Analytical Analysis of Samples Collected in November 2010

Parameter	PQL (µg/L)	ANZECC Freshwater (µg/L) ⁴	ANZECC Marine (µg/L)	Site 1 Saltwater Creek Zone	Site 2	Site 3	Site 9	5	6	7	8
Aluminium	20	55 ⁵	-	3100	2000	330	220	1600	5000	5400	420
Arsenic	5	24 / 13	-	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	0.7	0.2	5.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Chromium	2	ID / 1 ⁶	27.4 / 4.4	4.7	3.4	<2	<2	2.6	8.4	6.8	<2
Copper	1	1.4	1.3	5.5	10	1.9	1.5	1.5	8.3	3.1	<1
Iron	20	ID	ID	2200	1600	390	620	1300	3800	4100	350
Lead	1	3.4	4.4	<1	<1	<1	<1	<1	1.4	1.2	<1
Manganese	5	1900	-	430	250	86	250	110	120	410	110
Nickel	3	11	70	<3	<3	<3	5.4	<3	<3	<3	<3
Zinc	5	8	15	25	55	6.3	26	14	36	16	11
Mercury	0.1	0.6	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Nitrogen	0.1	0.350 – 1.200	Estuaries	1.1	1.9	1.1	0.9	1.3	1.2	1	1.3
Nitrate as N	0.01		0.250	0.02	0.02	<0.01	<0.01	0.01	0.01	0.02	<0.01
Nitrite as N	0.01	0.010	0.030	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Ammonia as N	0.1	0.010	0.015	0.2	0.1	<0.1	<0.1	0.2	0.1	0.2	0.2
Phosphate as P	0.01	-	-	0.05	0.03	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Total Phosphorus	0.02	0.010 – 0.050	0.020	0.15	0.12	0.08	0.05	0.14	0.14	0.16	0.21
Total Dissolved Solids	1	-	-	490	500	7820	1550	9960	15700	33500	21600
Total Suspended Solids	2	-	-	6	11	31	3	15	78	100	6
Chlorophyll "a"	1 (mg/m ³)	10 ⁸	2	1	2	5	2	2	3	1	10

Note: Indicates exceedance of freshwater ANZECC / ARMCANZ trigger value, and indicates exceedance of Marine ANZECC / ARMCANZ trigger value

⁴ ANZECC / ARMCANZ marine and freshwater trigger values given for 95% level of protection

⁵ Note that aluminium toxicity is provided for waters with pH>6.5

⁶ Arsenic as AsIII / AsV

⁷ Default trigger values presented are ANZECC / ARMCANZ guidelines for slightly disturbed wetlands and estuaries ecosystems within tropical Australia

⁸ Trigger values have been converted from µg/L to mg/m³

APPENDIX B: 2010 FISH SURVEY

B1. Background

This appendix describes the results of fish community assessments undertaken by BMT WBM in October 2010. Specifically, field assessments were undertaken to:

- Describe broad scale spatial patterns in fish communities across the Kaili (Caley) Valley Wetlands (the Wetlands); and
- Identify potential fisheries habitat values of various habitats within the Wetlands.

B2. Methodology

Fish surveys were conducted from the 25th to the 29th of October 2010, inclusive. A total of eight sites were sampled encompassing all key wetland types occurring across the study area (refer to Figure B-1 and Table B-1). At each location in-situ physio-chemical water quality parameters were recorded (refer to Appendix A) and the location was recorded using a Global Positioning System (GPS) with ± 5 meters accuracy. Descriptive notes were collected on key aquatic habitat characteristics, with notable features, aquatic flora and fauna recorded with a digital camera.

Table B-1 Location of Fish Survey Sites

Site Name	Zone	Equivalent WQ Site	Easting	Northing
Site A	Saltwater Creek Zone	Site 1	616913	7793115
Site B		Site 2	615567	7794006
Site C	Wetland Basin Zone	Site 3	612328	7796238
Site D		-	610224	7799029
Site E		Site 5	608935	7796115
Site F	Hypersaline Zone	Site 8	607764	7796954
Site G	Western Estuarine Zone	Site 7	607617	7796837
Site H		Site 6	607134	7795156



LEGEND

- Kaili Valley Wetland Boundary as Defined through DWA Listing
- APSDA Boundary
- Road
- Railway
- Regrowth Watercourse (DERM)
- Wetlands Project Area
- Fish Survey Location

Title: Survey Locations of Fish Communities

Figure: B-1

Rev: E

North

0m 1km 2km
 Approx. Scale

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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In order to sample the widest range of fish species and size classes, a variety of fish sampling methods were used as follows:

- Gill Netting - Three 2.5 x 30m gill nets, with varying in mesh size (i.e. stretched mesh of 25, 50 and 75mm), were deployed at sites with suitable physical dimensions. Nets were set for a standard three hour soak time and field personnel remained within close proximity to the nets so that any fauna captured was immediately released.
- Baited Box Traps - Baited mesh (0.5mm) box traps were used at all sites and represented the key trapping technique for small bodied fish species. Ten collapsible baitfish traps were deployed for a 1 hour period across a range of structural micro habitats.
- Fyke Nets - Fyke nets were deployed within tidal estuarine environments. To reduce the risks associated with estuarine crocodiles, fyke nets were deployed at low tide, facing upstream with the net wings tucked into the trap. On high tide, personnel returned to the fyke nets and opened the wings out to either side of the channel using a rope pull system. Once the channel partially drained, the net was retrieved and fauna collected were returned back to the water. Nets were five meters in width (dual wings) with 12mm mesh, a one meter wide entrance and two non-return cones.
- Beach Seining - Beach seine netting was carried out in shallow sites, contingent upon substrate type, the amount of snags present and the potential for estuarine crocodiles. Net dimensions were 30 x 1.5m with a 12mm mesh. Deployment involved a person wading out into the water or traversing an arc within an aluminium vessel with one end of the net and returning to the shore, while a second person on the shore handled the other end of the net.
- Small Seine Net - A small net (3m long, 2m drop and 5mm stretched mesh) was used to capture juvenile and small bodied fish species at sites that were able to be traversed within the water. Hauls of ten meters were undertaken at each of these locations, with up to three replicates if sufficient area was available.

All captured fish were identified, counted and measured for total length. Any wounds, lesions or deformities on captured fish were also recorded. Any exotic species captured were euthanized in accordance with procedures outlined in DEEDI Animals Ethics Approval, whereas all other fish species were released at the site of capture. All fishing was undertaken under Fisheries Permit number 102210.

B3. Results

Species Richness

A total of 23 fish species from 18 families and 1257 individuals were captured in BMT WBM October 2010 – November 2010 surveys (Table B-2, Figure B-2). Species richness ranged from one to 11 species per site, being lowest in shallow waters of the wetland basin (sites D and E), and greatest at the Saltwater Creek sites (sites A and B). Site C, located in deep waters of the wetland basin (in the area known as Lake Caley) also had moderately high species richness, whereas the one site located in the hypersaline zone (site F) and the two sites in the Western Estuarine Zone had intermediate species richness (4 to 5 species recorded).

The composition of fish assemblages varied among zones. Saltwater Creek and the wetland basin sites were comprised of equal numbers of freshwater and diadromous (that is, species that move between fresh and marine waters) species. By contrast, the Western Estuarine Zone sites and the hypersaline zone were comprised of both marine specialists and diadromous species.

When flooded, the wetland area provides a large potential foraging area for catadromous fish such as barramundi, which feed on fish, frogs, and invertebrates in flooded vegetation as juveniles. As flood waters contract, these juveniles become confined in remnant pools until subsequent wet seasons allow a return to the floodplain, or connectivity with the ocean for an offshore migration.

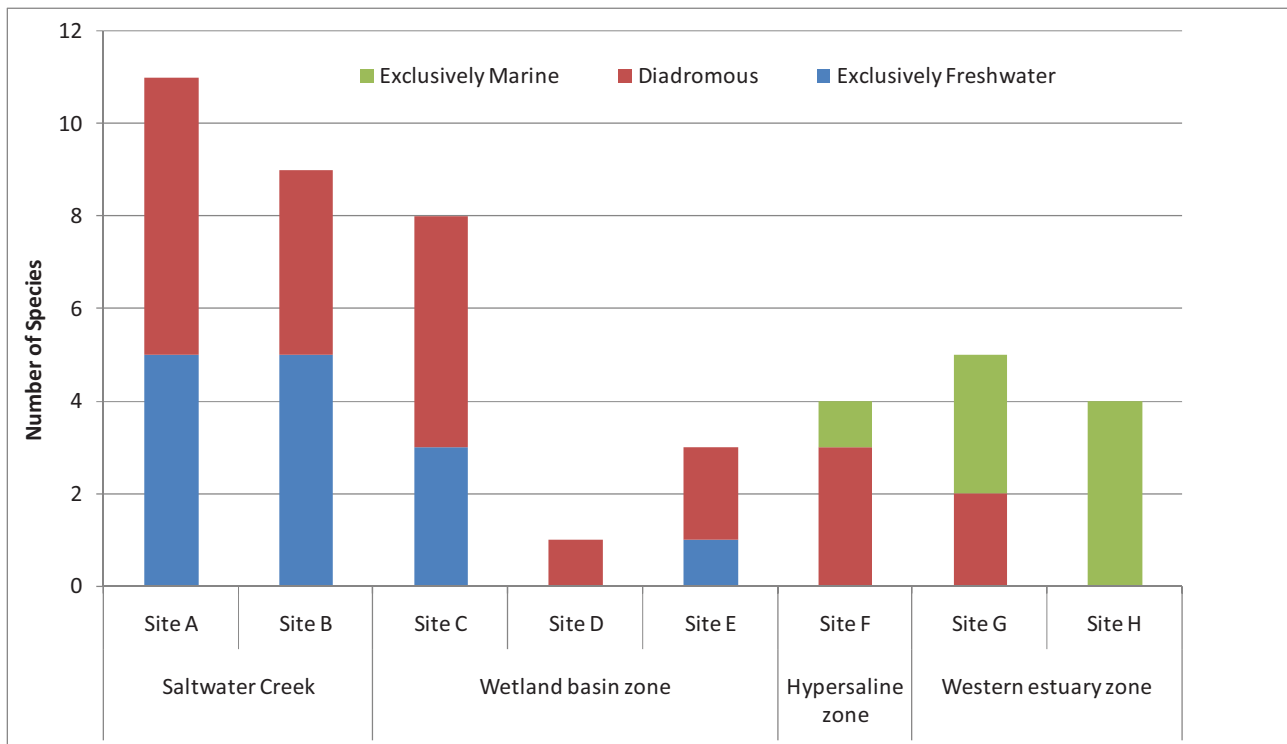


Figure B-2 Number of Fish Species and Individuals Recorded at Each Location during October 2010, Number of Species Categorised by Habitat Utilisation (i.e. freshwater, marine, diadromous)

Abundance

The most abundant fish species recorded was the Tadpole Goby (*Chlamydogobius ranunculus*), which accounted for approximately 59% of all individuals collected. This figure is strongly skewed by the large numbers of this species recorded at site E in the wetland basin zone (631 individuals recorded). As a result, this site also had recorded the highest overall abundance of fish (639 fish), but low species richness.

Table B-2 Fish Recorded within the Wetlands - October 2010

Scientific Name	Common Name	Saltwater Creek Zone		Wetland Basin Zone			Hypersaline Zone	Western Estuarine Zone		Total
		Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	
Chondrichthys	Cartilaginous Fishes									
Dasyatidae:										
<i>Pastinachus sephen</i>	Cowtail Stingray	0	0	0	0	0	0	0	1	1
Osteichthys	Bony Fishes									
Elopidae:										
<i>Elops hawaiiensis</i>	Giant Herring	0	0	5	0	0	0	0	0	5
Megalopidae:										
<i>Megalops cyprinoides</i>	Oxeye Herring	26	12	0	0	0	4	0	0	42
Anguillidae:										
<i>Anguilla reinhardtii</i>	Longfin Eel	5	0	0	0	0	0	0	0	5
Clupeidae:										
<i>Nematalosa erebi</i>	Bony Bream	17	6	3	0	0	0	0	0	26
Hemiramphidae:										
<i>Hyporhamphus</i> sp.	Garfish	0	0	0	0	0	0	1	0	1
Melanotaeniidae:										
<i>Melanotaenia splendida splendida</i>	Eastern Rainbowfish	50	100	0	0	0	0	0	0	150
Poeciliidae:										
<i>Gambusia holbrooki</i>	Eastern Gambusia	0	0	0	0	1	0	0	0	1
Centropomidae:										
<i>Lates calcarifer</i>	Barramundi	3	1	2	0	0	0	0	0	6
Chandidae:										
<i>Ambassis</i> sp.	Glass Perch	3	26	0	0	7	0	0	0	36
Terapontidae:										
<i>Amniataba percoides</i>	Barred Grunter	5	0	0	0	0	0	0	0	5
<i>Amniataba caudavittata</i>	Yellowtail Trumpeter	0	0	4	0	0	0	0	0	4
<i>Leiopotherapon unicolor</i>	Spangled Perch	0	1	3	0	0	0	0	0	4
Gerreidae:										
<i>Gerres filamentosus</i>	Thread-finned Silver Biddy	0	2	5	0	0	0	0	0	7
<i>Gerres subfasciatus</i>	Silver Biddy	0	0	0	0	0	1	0	3	4
Haemulidae:										
<i>Pomadasys argenteus</i>	Spotted Grunter	0	0	0	0	0	0	1	0	1
Scatophagidae:										
<i>Scatophagus argus</i>	Spotted Scat	3	0	0	0	0	0	0	0	3
<i>Selenotoca multifasciata</i>	Banded Scat	1	0	0	0	0	0	0	0	1
Mugilidae:										

B-6

Scientific Name	Common Name	Saltwater Creek Zone		Wetland Basin Zone			Hypersaline Zone	Western Estuarine Zone		Total
		Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	
<i>Mugil cephalus</i>	Sea Mullet	5	10	0	0	0	5	3	0	23
Eleotridae: <i>Hypseleotris klunzingeri</i>	Western Carp Gudgeon	35	134	2	0	0	0	0	0	171
Gobiidae: <i>Chlamydogobius ranunculus</i>	Tadpole Goby	0	0	1	34	631	70	0	0	736
Tetraodontidae: <i>Arothron</i> sp	Toadfish	0	0	0	0	0	0	2	1	3
<i>Tetractenos</i> sp.	Toadfish	0	0	0	0	0	0	16	12	28
Total		153	292	25	34	639	80	23	17	1257

By way of comparison, the next highest abundance of fish recorded at a single site was 292 at site B in Saltwater Creek. Saltwater Creek had high numbers of Eastern Rainbowfish (*Melanotaenia splendida splendida*) and Western Carp Gudgeon (*Hypseleotris klunzingeri*), which are freshwater species. Both of these species were largely absent from sections of the Wetlands. Oxeye Herring (*Megalops cyprinoides*), Bony Bream (*Nematalosa erebi*) and Glass Perch (*Ambassis* sp.) were also relatively abundant, particularly at sites in Saltwater Creek.

Three species were recorded exclusively in the Western Estuarine Zone (i.e. sites G & H). These were the Cowtail Stingray, Garfish and Spotted Grunter, which are all marine/estuarine species. Similarly, three species were recorded only at wetland basin sites (i.e. sites C, D & E): Giant Herring, Yellowtail Trumpeter and Mosquitofish.

Species of Conservation Significance

No fish species found within the BMT WBM October 2010 – November 2010 study are listed under Commonwealth (*Environment Protection and Biodiversity Conservation Act 1999*) or State (Queensland *Nature Conservation Act 1992*) legislation. Similarly, none of these species are considered threatened or near threatened under International Union for the Conservation of Nature (IUCN) or other recognised conservation schemes.

Pest Species

One exotic species was recorded: Eastern Gambusia or Mosquitofish (*Gambusia holbrooki*). This species is a declared pest species under the *Fisheries Regulation 1995*. This species aggressively competes with other fish species for habitat and food resources, and has been implicated in population declines of various small bodied fish species (Arthington 1996).

One individual Eastern Gambusia was recorded in the BMT WBM October 2010 – November 2010 survey, at site E within the wetland basin. Whilst primarily a freshwater species, they are also known to tolerate a wide range of salinity concentrations, up to that of marine waters (McDowall 1996). It is possible that this species could be more abundant and widespread than observed by the recent survey, particularly during prolonged wet periods.

Species of Fisheries Significance

The main species of fisheries significance recorded in the Wetlands are Barramundi (*Lates calcarifer*) and Sea Mullet (*Mugil cephalus*). Barramundi is an iconic sport and commercially significant fish species. Barramundi was recorded at Saltwater Creek and the wetland basin in low numbers, although anecdotal reports from local residents suggest that this species can be plentiful within Saltwater Creek. The habitats within and surrounding the Wetlands are expected to provide suitable breeding, nursery and feeding grounds for this species. The Wetlands would also support potentially important feeding areas for Sea Mullet.

It is likely however that the artificial bunds would represent a significant movement barrier to fish species, reducing potential fish habitat values. It is also likely that the shallow nature of the wetland basin during dry periods would also limit the values of this area for large-bodied fish species such as Mullet and Barramundi.

Fish Community Overview

The fish community of the Wetlands is comprised of a combination of freshwater and estuarine/marine fish species, as well a high proportion (almost 50%) of species that utilise both marine and freshwaters at various stages throughout their life. Accordingly, the fish community varies across the Wetlands, depending on salinity and the degree of connectivity between marine and freshwaters.

The community composition varied across the Wetlands. Within Saltwater Creek and the main wetland basin, fish species present were either freshwater or diadromous (able to travel between salt and freshwater). In Saltwater Creek, Oxeye Herring (*Megalops cyprinoides*), Eastern Rainbowfish (*Melanotaenia splendida splendida*) and Western Carp Gudgeon (*Hypseleotris klunzingeri*) were the most abundant species. Within the Hypersaline and Wetland Basin Zones the Tadpole Goby (*Chlamydogobius ranunculus*) was very abundant in shallow water habitat (sites D and E), with a large number recorded (631 individuals) adjacent to the causeway (inner) bund (site E).

Species recorded within the bunded hypersaline zone and adjoining estuaries were either diadromous or exclusively saltwater. Within the hypersaline zone, Tadpole Goby was abundant within shallow sections of submergent macrophyte cover (*Ruppia* sp.) and juvenile (i.e. 1-2 years) Sea Mullet (*Mugil cephalus*) and Oxeye Herring within deeper open water habitat (i.e. 0.5 to 1.5 metres depth). Fish communities surveyed in Mount Stuart Creek Estuary (site G) and Branch Creek Estuary (site H) were dominated by toadfish from the genus *Tetractenos* and to a lesser extent *Arothron*.

There is insufficient data to determine variability in fish communities over time (seasonal and longer term) within the Wetlands. Such information is necessary to detect any changes brought about by seasonal variation and those which result from changes in water quality, salinity etc (refer Section 6).

In general, it is expected that fish communities would display considerable seasonal variation, particularly in response to high freshwater flows during summer. At this time these high flows temporarily improve connectivity between the various zones of the Wetlands, allowing fish passage between freshwater and estuarine areas. Conversely, long dry spells are expected to cause significant changes in fish community structure, particularly in the hypersaline areas. This results in evaporation of freshwaters which reduces habitat area and causes very high salinity in the remaining water bodies. As salinity increases a greater number of fish species are excluded, with only the more salt tolerant species surviving.

Connectivity between the various wetland habitats/zones, as well as the adjacent marine environment is one of the key factors effecting the fish communities in the Wetlands. Reefs and seagrasses are present in close proximity to the Wetlands, offering a mosaic of fresh and saltwater habitats for a range of species. In many cases nearshore environments act as breeding or nursery grounds for offshore species. There are also direct physical relationships between the Wetlands and adjacent marine areas, related to rainfall and the offshore transport of nutrients and detritus.

Connectivity for both freshwater flows from rainfall and tidal flushing is another key process driving the structure and distribution of fish communities in the Wetlands. This process influences the salinity of the Wetlands, which varies significantly from freshwater to hypersaline. Most fish species have a comparatively narrow range of salinities they can tolerate.

Many parts of the Wetlands, particularly within the Hypersaline Zone and around the saltpans within the Western Estuary and Western Basin Zones have a relatively simple and homogenous habitat structure. Generally, it has been shown environments containing a greater diversity of physical habitat structures (e.g. vegetation, woody debris, boulders etc.) typically support a greater diversity of fish species.

APPENDIX C: 2010 FAUNA AND FLORA ASSESSMENT METHODS

High level fauna and flora surveys were carried out by experienced and qualified ecologists on two separate occasions. These surveys were undertaken to fill important information gaps regarding:

- Potential presence of threatened flora species (Black Ironbox *Eucalyptus raveretiana*). Targeted searches were undertaken along Saltwater Creek;
- Assessment of major weed infestations within the Wetlands project area and adjacent terrestrial areas within the Abbot Point State Development Area. Surveys aimed to identify key infestations and weed species in these areas;
- Patterns in habitat usage of wetland habitats by waterbirds, including migratory waders. This assessment was undertaken in the period following the arrival of migratory waders into Australia; and
- General patterns in fauna usage of the Wetlands project area.

The first survey period was from the 25 and 30 October 2010 inclusive and was done by recording opportunistic sightings during the targeted fish survey. The weather was generally fine and warm and the surveys were conducted between 7:30 am and 6:00 pm. Observations were made from a 4WD vehicle, a 3m aluminium punt and on foot.

The second survey was a dedicated fauna and flora survey and was carried out by Mark Sanders (EcoSmart Ecology) and David Barnes (BMT WBM) in the period from the 8 and 12 November 2010 inclusive under the following permits: QPWS: WISP06137309; and Animal Ethics: CA 2009/06/358.

Surveys were again carried out from a 4WD vehicle, a 3m aluminium punt and on foot. Location data was obtained using hand held GPS units in conjunction with aerial photography. Survey techniques included:

- Observations through binoculars;
- Photographs taken with a telephoto lens;
- Call playback for some bird species;
- Listening for calls;
- Lifting of logs, sheets of tin and other materials to search for reptiles; and
- Anabat II (Titley Electronics) to record microbats. The Anabat II was only deployed for one night due to the threat of storms.

A wide range of sites that were representative of the habitats found within the study area were sampled. The flora survey targeted locations where previous surveys had not been carried out and targeted threatened species and identifying significant weed species.

Identification was made using appropriate field keys including Simpson and Day (2004) and Wilson (2009).

APPENDIX D: THREATENED FLORA

A specimen of Black Ironbox (*Eucalyptus raveretiana*) was located on the banks of Saltwater Creek but an exact location was not provided in the report (PB 2009). This species is listed as Vulnerable under both the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Nature Conservation Act 1992*. It is a tree to 30 m tall, which occurs in riparian woodlands on alluvial flats along river banks on sandy and/or alluvial soils (Calvert et al 2005). It is distributed from Rockhampton to Ayr (Melzer and Plumb 2007).

No other threatened flora species have been recorded in the study area. However several species have been noted to potentially occur in the study area as follows:

- Two threatened flora species (or their habitat) were identified in a search of the EPBC Matters report as potentially occurring within the Wetlands and APSDA:
 - *Croton magneticus* is a shrub or small tree found in isolated populations on Magnetic Island, Mount Stuart near Townsville and between Greenvale to Gloucester Island in vine thickets on skeletal granite, limestone or sandstone soils and amongst granite outcrops, including rocky seashores (Calvert et al 2005, Townsville City Council 2003). It is most likely to occur on Mount Luce and in less degraded areas of Breakfast Creek and Goodbye Creek if it is present in the area (PB 2010).
 - *Leucopogon cuspidatus*, a small dense shrub to approximately 2 m, is commonly associated with montane environments including granite outcrops so it may occur on Mount Luce and in less degraded areas of Breakfast Creek and Goodbye Creek, if it is present in the area (PB 2010). It is currently listed as Vulnerable under the EPBC Act but is under consideration for being delisted from this Act (public comments closed on the 27 November 2010) (DEWHA 2010a).
- *Aristida granitica* was identified as a species possibly occurring in the terrestrial lands of the Abbot Point State Development Area. This species is a grass that grows to 75 cm tall, occurring on granite sand soils (Sharp and Simon 2002). The current known distribution for this species is near Townsville. Mount Luce is the most likely area for this species to occur if it is present. No specimens were located during the BMT WBM survey in October – November 2010.

No rare and threatened plants were listed in the Wildlife Online Extract for the area.

APPENDIX E: REGIONAL ECOSYSTEMS IN THE STUDY AREA

Regional Ecosystem (RE) code	Short description	Vegetation Management Act 1999 status	Comments	Wetland/Vegetation (Directory of Wetlands in Australia code)	Wetland type (Important Wetlands in Australia code)
11.1.1	<i>Sporobolus virginicus</i> on marine clay plains	Least concern			Intertidal marshes (A8)
11.1.2	Samphire forbland on marine clay plains	Least concern	Occurs as a single RE or the dominant RE in a mixed polygon with RE 11.1.4		Intertidal marshes (A8)
11.1.2a	Estuarine wetlands (e.g. mangroves). Bare mud flats on Quaternary estuarine deposits, with very isolated individual stunted mangroves such as <i>Avicennia marina</i> and/or <i>Ceriops tagal</i> . May have obvious salt crusts on the soil surface.	Least concern			Intertidal salt flats (A7)
11.1.2b	Estuarine wetlands (e.g. mangroves). Samphire forbland on Quaternary estuarine deposits. Mainly salt pans and mudflats with clumps of saltbush including one or several of the following species; <i>Halosarcia</i> spp. (e.g. <i>Halosarcia indica</i> subsp. <i>julacea</i> , <i>Halosarcia indica</i> subsp. <i>leiostachya</i>), <i>Sesuvium portulacastrum</i> , <i>Sarcocornia quinqueflora</i> subsp. <i>quinqueflora</i> , <i>Suaeda australis</i> , <i>S. arbusculoides</i> , <i>Tecticornia australasica</i> .	Least concern			Intertidal salt flats (A7)

Regional Ecosystem (RE) code	Short description	Vegetation Management Act 1999 status	Comments	Wetland/Vegetation (Directory of Important Wetlands in Australia code)	Wetland type
	<i>Scleria ciliaris</i> , <i>Marsilea mutica</i> , <i>Salsola kali</i> , algal crusts and the grass <i>Sporobolus virginicus</i> . Sedges may be common.				
11.1.3	Sedgeland on marine clay plains	Of concern	Not shown on current Department of Environment and Resource Management (DERM) mapping but mapped in previous studies	Intertidal marshes (A8)	
11.1.4		Least concern	Occurs as a single RE or as a subdominant RE in a mixed polygon with RE 11.1.4	Intertidal forested wetlands (A9)	
11.2.2	Complex of <i>Spinifex sericeus</i> , <i>Ipomoea pes-caprae</i> and <i>Casuarina equisetifolia</i> grassland and herbland on fore dunes	Of concern		Sandy beaches (A5)	
11.2.3	Microphyll vine forest ("beach scrub") on sandy beach ridges and dune swales	Of concern	Corresponds with the Nationally Threatened Ecological Community, Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions – listed as endangered under the EPBC Act	Coastal dune vegetation – no DIWA equivalent	
11.2.5	Corymbia-Melaleuca woodland complex of beach ridges and swales	Least concern	Occurs as a single RE or as the dominant RE in a mixed polygon with RE 11.2.3 or with REs 11.2.3 and 11.2.2 or the sub dominant RE with RE 11.2.3	Coastal dune vegetation – no DIWA equivalent	

Regional Ecosystem (RE) code	Short description	Vegetation Management Act 1999 status	Comments	Wetland/Vegetation of Important Wetlands in Australia code)	Wetland type
11.3.7	<i>Corymbia</i> spp. woodland on alluvial plains.	Least concern	Occurs as the dominant RE in a mixed polygon with RE 11.3.9 in some areas. In other areas it is a less dominant RE in a mixed polygon with REs 11.3.9, 11.3.10 and 11.3.25 and in a separate mixed polygon with RE 11.3.31 and RE 11.3.7	Terrestrial vegetation - no DIWA equivalent	
11.3.9	<i>Eucalyptus platyphylla</i> , <i>Corymbia</i> spp. woodland on alluvial plains	Least concern	Occurs as a single polygon or in mixed polygons	Terrestrial vegetation - no DIWA equivalent	
11.3.10	<i>Eucalyptus brownii</i> woodland on alluvial plains	Least concern	Occurs in mixed polygons as a subdominant RE	Terrestrial vegetation - no DIWA equivalent	
11.3.13	<i>Grevillea striata</i> on coastal alluvial plains	Of concern	Occurs as a minor component in a mixed polygon with RE 11.3.31 and RE 11.3.7	Terrestrial vegetation - no DIWA equivalent	
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	Least concern	Occurs as a single polygon or in mixed polygon as a minor component	Streams and rivers (B1, B2)	
11.3.25b	Riverine wetland or fringing riverine wetland. <i>Melaleuca leucadendra</i> and/or <i>M. fluviatilis</i> , <i>Nauclea orientalis</i> open forest.	Least concern		Streams and rivers (B1, B2)	
11.3.27x1c	11.3.27x1c Palustrine wetland, sedgeland to grasslands on Quaternary deposits	Least concern	Occurs as a single RE or in mixed polygons with RE 11.1.2b	Freshwater lagoons and marshes (A11)	

Regional Ecosystem (RE) code	Short description	Vegetation Management Act 1999 status	Comments	Wetland/Vegetation of Important Wetlands in Australia code)	Wetland/Vegetation type
					Brackish to saline lagoons and marshes (A10)
11.3.29		Least concern	Occurs as the dominant RE in a mixed polygon with RE 11.3.5		Terrestrial vegetation - no DIWA equivalent
11.3.30	<i>Eucalyptus crebra</i> , <i>Corymbia dallachiana</i> woodland on alluvial plains	Least concern	Occurs a sub-dominant or minor component of a number of different mixed polygons		Terrestrial vegetation - no DIWA equivalent
11.3.31	<i>Ophiuros exaltatus</i> , <i>Dichanthium</i> spp. grassland on alluvial plains	Least concern	Occurs as the dominant RE in a mixed polygon with REs 11.3.7 and 11.3.13. Note this is a grassland regional ecosystem		Terrestrial vegetation - no DIWA equivalent
11.3.32	<i>Allocasuarina luehmannii</i> open woodland on alluvial plains	Least concern	Occurs as the dominant RE in a mixed polygon with REs 11.3.30 and 11.3.33		Terrestrial vegetation - no DIWA equivalent
11.3.33	<i>Eremophila mitchellii</i> open woodland on alluvial plains	Least concern	Occurs as the sub-dominant RE in a mixed polygon with REs 11.3.30 and 11.3.32. Note this is a regional ecosystem that naturally has a very sparse tree cover		Terrestrial vegetation - no DIWA equivalent
11.3.35	<i>Eucalyptus platyphylla</i> , <i>Corymbia clarksoniana</i> woodland on alluvial plains	Least concern	Occurs as the subdominant RE in a mixed polygon with RE 11.3.5		Terrestrial vegetation - no DIWA equivalent
11.12.1	<i>Eucalyptus crebra</i> woodland on igneous rocks	Least concern	Occurs as a single RE or as the		Terrestrial vegetation - no DIWA

Regional Ecosystem (RE) code	Short description	Vegetation Management Act 1999 status	Comments	Wetland/Vegetation of Important Wetlands in Australia code)	Wetland/Vegetation type
			dominant RE in a mixed polygon with RE 11.12.4		equivalent
11.12.4	-evergreen vine thicket and microphyll vine forest on igneous rocks	Least concern	Occurs as a sub-dominant RE with RE 11.12.1 on the western edge of the DIWA boundary for the Kaili (Caley) Valley Wetlands (the Wetlands)		Terrestrial vegetation - no DIWA equivalent
11.12.7	<i>Eucalyptus crebra</i> woodland with patches of semi-evergreen vine thicket on igneous rocks (boulder-strewn hillsides)	Least concern			Terrestrial vegetation - no DIWA equivalent
11.12.9	<i>Eucalyptus platyphylla</i> woodland on igneous rocks	Least concern	Occurs as the sub-dominant RE in a mixed polygon with REs 11.12.1, 11.12.4 and 11.12.10		Terrestrial vegetation - no DIWA equivalent
11.12.10	<i>Corymbia clarksoniana</i> woodland on igneous rocks	Of concern	Occurs as a minor RE in a mixed polygon with REs 11.12.1, 11.12.9 and 11.12.4		Terrestrial vegetation - no DIWA equivalent
11.12.13	<i>Eucalyptus crebra</i> , <i>Corymbia</i> spp., <i>E. acmenoides</i> woodland on igneous rocks. Coastal hills	Least concern			Terrestrial vegetation - no DIWA equivalent

APPENDIX F: FAUNA SPECIES LISTS

All common names and majority of scientific names (except where there have been recent changes) follow Clayton et al. (2006).

Coral
Sea

Abbot Point

Abbot
Bay

Carriak's
Bay

Lake
Calley

Abbot Point
Coal Terminal

Abbot Point Road

Goody Creek

Collinsville-
Newlands Branch Railway

East Creek

Saltwater Creek

Mount
Little

Stark Creek

Mount Stark Creek

North Coast Railway Line

Tabletop Creek

Branch Creek

Spring Creek

Wilmington
Station

Plain Creek

Wilmington
Siding

Branch Creek

Spring Creek

Wilmington
Siding

Branch Creek

Spring Creek

Wilmington
Siding

Branch Creek

Spring Creek

Wilmington
Siding

Branch Creek

Spring Creek

Figure: F-1

Rev: E

Other Fauna Data - Location Records

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



LEGEND



- Kaali Valley Wetland Boundary as Defined through DIWA Listing
- APSDA Boundary
- Road
- Railway
- Regrowth Watercourse (DERM)



- Wetlands Project Area
- Fauna Observation Point (BMT WBM, November 2010)
- Survey Site (ECOServe, November 2004)
- Black Kite Nest

Table F-1 **Migratory Wetland and Migratory Marine Bird Species Listed under the EPBC Act Recorded in or near the Kaili (Caley) Valley Wetlands (the Wetlands)**

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/ Numbers	1% Threshold for the Population in the EAA Flyway
<i>Actitis hypoleucos</i>	Common Sandpiper	Migratory Wetland	Least concern	Recorded within the study area in the wet season (GHD 2010).	250
<i>Apus pacificus</i>	Fork-tailed swift	Migratory Marine	Least Concern	One record from the Wildlife Online Extract since 1980 (EPA 2010)	
<i>Bulbulcus ibis</i> (syn. <i>Ardea ibis</i>)	Cattle Egret	Migratory Wetland	Least concern	Recorded in the grassland in the southern part of the study area in the wet season (GHD 2010)	
<i>Calidris acuminata</i>	Sharp-tailed Sandpaper	Migratory Wetland	Least concern	Fifty individuals recorded within the study area including in grassland in the southern part of the study area in the wet season (GHD 2010); observed in various locations in the study area (refer Figure 4-1) (BMT WBM November 2011)	1,600
<i>Calidris ferruginea</i>	Curlew Sandpiper	Migratory Wetland	Least Concern	Two records from the Wildlife Online Extract since 1980 (EPA 2010); and observed in various locations in the study area (refer Figure 4-1) (BMT WBM November 2011)	1,800
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory Wetland	Least concern	Recorded within the study area in the wet season (GHD 2010); observed in various locations in the study area (refer Figure 4-1)	3,250

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/ Numbers	1% Threshold for the Population in the EAA Flyway
<i>Charadrius veredus</i> (<i>Charadrius asiaticus veredus</i>)	Oriental Plover	Migratory Wetland	Least concern	(BMT WBM November 2011) Recorded within the study area in the dry and wet season (GHD 2010).	700
<i>Chlidonias leucopterus</i>	White-winged Black Tern	Migratory Wetland	Least concern	Recorded within the study area in the wet season (GHD 2010).	
<i>Egretta alba</i> (syn. <i>Ardea alba</i>)	Great Egret	Migratory Wetland	Least concern	Two individuals regularly observed at a large lagoon on Nulla Creek (WBM 2006); seven observed at fauna observation point 24 (refer Figure 4-1) (BMT WBM November 2011)	
<i>Egretta sacra</i>	Eastern Reef Egret	Migratory Wetland	Least concern	Recorded within the study area in the dry season (GHD 2010); at fauna observation point 6 (refer Figure 4-1) (BMT WBM November 2010)	
<i>Gallinago hardwickii</i>	Latham's Snipe	Migratory Wetland	Least concern	Recorded within the study area in the wet season (GHD 2010).	
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Migratory Wetland; Migratory Terrestrial	Least concern	Recorded within the Wetlands in the wet season including a nest on the eastern side (GHD 2010); two individuals observed near Dingo Beach and various points within the study area including fauna observation points 3,22 and 24 (refer Figure 4-2) (BMT WBM October/ November	

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/ Numbers	1% Threshold for the Population in the EAA Flyway
				2011)	
<i>Heteroscelus incanus</i>	Wandering Tattler	Migratory Wetland	Least concern	Recorded adjacent to the study area on the rocky foreshore(GHD 2010)	Not Available
<i>Hydroprogne caspia</i> (syn. <i>Sterna caspia</i>)	Caspian Tern	Migratory Wetland	Least concern	One hundred and seventy-five individuals recorded within the study area in the dry and wet season (GHD 2010)	
<i>Limosa limosa</i>	Black-tailed Godwit	Migratory Wetland	Least concern	Observed in a number of locations in the study area (refer Figure 4-1) (BMT WBM November 2011)	1,600
<i>Nettapus coromandelianus albigennis</i>	Australian Cotton Pygmy- goose	Migratory Wetland	Near Threatened	Lakes provide breeding habitat and drought refuge for this species (WBM 2006)	
<i>Numenius madagascariensis</i>	Eastern Curlew	Migratory Wetland	Near Threatened	Nests and roosts in the intertidal areas of Dingo Beach in the northern part of the study area (WBM 2006); Recorded within the study area (GHD 2010); one or two individuals noted mainly in and around the mangroves between Mount Stewart Creek and Branch Creek on the western side of the study area (refer Figure 4-1) (BMT WBM November 2010)	380

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/ Numbers	1% Threshold for the Population in the EAA Flyway
<i>Numenius phaeopus</i>	Whimbrel	Migratory Wetland	Least concern	Recorded within the Wetlands and nearby foreshore (GHD 2010); nine individuals noted mainly in and around the mangroves on the western side of the study area (refer Figure 4-1) (BMT WBM November 2010)	1,000
<i>Sterna albifrons</i> (syn. <i>Sterna albifrons</i>)	Little Tern	Migratory Marine	endangered	Recorded within the study area in the wet season (GHD 2010); two individuals were recorded on Abbot Point eastern ocean beach and several birds were also observed over open water at Abbot Point (WBM 2006); approximately 350 birds observed across the study area (BMT WBM November 2010).	
<i>Sterna hirundo</i>	Common Tern	Migratory Wetland	Least concern	Observed feeding on the inshore waters around Abbot Point (WBM 2006)	
<i>Tringa nebularia</i>	Common Greenshank	Migratory Wetland	Least concern	Recorded within the study area in the wet season (GHD 2010)	600
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Migratory Wetland	Least concern	Two individuals recorded within a large lagoon on Nulla Creek (WBM 2006); Eight records from the Wildlife Online Extract since 1980 (DERM 2010)	1,000

Table F-2 Resident Waterbirds/Shorebirds, and Terrestrial Fauna

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
Resident Waterbirds/ Shorebirds (refer Figure 4-2 for locations)				
<i>Anas castanea</i>	Chestnut teal	Not listed	Least concern	Recorded in wetland habitats (PB 2009)
<i>Anas gracillis</i>	Grey Teal	Not listed	Least concern	270 recorded east of the causeway (inner) bund during the wet season (GHD 2010); in wetland habitats (PB 2009); numerous in various locations within the study area (BMT WBM November 2011).
<i>Anas superciliosa</i>	Pacific Black Duck	Not listed	Least concern	314 recorded east of the causeway (inner) bund during the wet season (GHD 2010); in wetland habitats (PB 2009); very common across the study area (BMT WBM November 2011)
<i>Anhinga melanogaster</i>	Darter	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in wetland habitats (PB 2009); nests, young and adults particularly common along Saltwater Creek and fauna observation points 2,24 in the study area (BMT WBM November 2011)
<i>Anseranus semipalmata</i>	Magpie Goose	Not listed	Least concern	135 recorded east of the causeway (inner) bund during the wet season (GHD 2010); in wetland habitats (PB 2009); in various locations in the study area (BMT WBM November 2011)
<i>Ardea intermedia</i>	Intermediate Egret	Not listed	Least Concern	Recorded within the Wetland in the wet season (GHD 2010); in wetland habitats (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Ardea pacifica</i>	White-necked Heron	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Aythya australis</i>	Hardhead	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010)
<i>Butorides striatus</i>	Striated Heron	Not listed	Least Concern	Recorded in the wet season (GHD 2010) at fauna observation point 9 (BMT WBM November 2011)
<i>Charadrius ruficapillus</i>	Red-capped Plover	Not listed	Least concern	191 recorded east of the causeway (inner) bund during the wet season (GHD 2010); very numerous in various locations across the Wetlands on intertidal flats and along the southern shoreline (BMT WBM November 2011); recorded at survey site 4 (Ecoserve November 2004)
<i>Chenonetta jubata</i>	Australian Wood Duck	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Chlidonias hybrida</i>	Whiskered Tern	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Chroicocephalus novaehollandiae</i>	Silver Gull	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); at fauna observation point 5 (BMT WBM November 2011)
<i>Cygnus atratus</i>	Black Swans	Not listed	Least concern	444 recorded east of the inner bund during the wet season (GHD 2010); recorded in wetland habitats (PB 2009); at various locations across the study area including Saltwater Creek with approximately 400-500 birds near Lake Caley (BMT WBM November 2010)
<i>Dendrocygna acutata</i>	Wandering Whistling-duck	Not listed	Least concern	163 recorded east of the causeway (inner) bund during the wet season (GHD 2010); recorded in

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				wetland habitats (PB 2009); at various locations across the study area including Saltwater Creek (BMT WBM November 2010)
<i>Dendrocygna eytoni</i>	Plumed Whistling-duck	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); Recorded in wetland habitats (PB 2009)
<i>Egretta garzetta</i>	Little Egret	Not listed	Least concern	Recorded in wetland habitats (PB 2009); at various locations across the study area including fauna observation point 5 (BMT WBM November 2010)
<i>Egretta novaehollandiae</i>	White-faced Heron	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009); observed in various locations in the study area (BMT WBM November 2011)
<i>Elseyornis melanops</i>	Black-fronted Dotterel	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009); at various locations across the study area (BMT WBM November 2010)
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Not listed	Near Threatened	Recorded in the dry and wet seasons (GHD 2010); within the lagoon on Saltwater Creek (WBM Oceanics 2006); eight records from the Wildlife Online Extract since 1980 (EPA 2010); adults and juveniles noted in various locations across the study area (refer Figure 4-2) (BMT WBM November 2010)
<i>Esacus magnirostris</i>	Beach Stone-curlew	Not listed	Vulnerable	Two records from the Wildlife Online Extract since 1980 (EPA 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Gallinula tenebrosa</i>	Dusky Moorhen	Not listed	Least Concern	Recorded in the wet season (GHD 2010); recorded in wetland habitats (PB 2009); at fauna observation point 2 (BMT WBM November 2010)
<i>Gallirallus philippensis</i>	Buff-banded Rail	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Gelochelidon nilotica</i>	Gull-billed Tern	Marine	Least Concern	Recorded in a number of locations within the study area including fauna observation points 4,8 (BMT WBM November 2010)
<i>Grus rubicunda</i>	Brolga	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009)
<i>Haematopus longirostris</i>	Pied Oystercatcher	Not listed	Least Concern	Recorded in the wet season (GHD 2010); at fauna observation point 6 and south of fauna observation point 13 (BMT WBM November 2010)
<i>Himantopus himantopus</i>	Black-winged Stilt	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in wetland habitats (PB 2009)
<i>Nycticorax caledonicus</i>	Nankeen Night Heron	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in wetland habitats (PB 2009)
<i>Pandion haliaeetus</i>	Osprey	Not listed	Least Concern	Recorded in the wet season over coastal waters and the foreshore near the Wetlands (GHD 2010)
<i>Pelecanus conspicillatus</i>	Australian Pelican	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in wetland habitats (PB 2009); numerous at various locations across the study area (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Phalacrocorax carbo</i>	Great Cormorant	Not listed	Least concern	Noted at fauna observation point 2 (BMT WBM November 2010)
<i>Phalacrocorax melanoleucas</i>	Little Pied Cormorant	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in wetland habitats (PB 2009); noted at fauna observation point 2 (BMT WBM November 2010)
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	Not listed	Least Concern	Recorded in the wet season (GHD 2010); recorded in wetland habitats (PB 2009); noted at fauna observation points 2 and 3 and a group of up to 10 birds observed around the culvert in the causeway (inner) bund (BMT WBM November 2010)
<i>Phalacrocorax varius</i>	Pied Cormorant	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010)
<i>Platalea flavipes</i>	Yellow-billed Spoonbill	Not listed	Least concern	Recorded in wetland habitats (PB 2009)
<i>Platalea regia</i>	Royal Spoonbill	Not listed	Least concern	Recorded in cleared lands and wetland habitats (PB 2009)
<i>Podiceps cristatus</i>	Great Crested Grebe	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Porphyrio porphyrio</i>	Purple Swamphen	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in cleared lands and wetland habitats (PB 2009)
<i>Porzana tabuensis</i>	Spotless Crane	Not listed	Least Concern	Recorded in the dry season (GHD 2010)
<i>Sterna caspia</i>	Caspian Tern	Not listed	Least concern	Recorded in wetland habitats (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Stictonetta naevosa</i>	Freckled Duck	Not Listed	Near Threatened	The study area provides breeding habitat and drought refuge for this species (WBM Oceanics 2005)
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in wetland habitats (PB 2009)
<i>Threskiornis molucca</i>	Australian White Ibis	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared and wetland habitats (PB 2009); noted at various locations across the study area (including a rookery) including Saltwater Creek (BMT WBM November 2010)
Migratory and Resident Terrestrial Birds (refer Figure 4-4 for locations where recorded in BMT WBM survey)				
<i>Accipiter fasciatus</i>	Brown Goshawk	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Acrocephalus australis</i>	Clamorous Reed-warbler	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in wetland habitats (PB 2009); at fauna observation point 24 (BMT WBM November 2011)
<i>Aegotheles cristatus</i>	Australian Owllet-nightjar	Not listed	Least Concern	Recorded in eucalypt/ corymbia woodland (PB 2009)
<i>Alectura lathamii</i>	Australian Brush-turkey	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in melaleuca shrubland (PB 2009); observed at fauna observation points 6 and ANA 0911 (BMT WBM November 2010); at survey sites 3,4 and 5 (Ecoserve November 2004)
<i>Anthus novaeseelandiae</i>	Richard's Pipit	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in riparian woodland, cleared lands and wetland

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				habitats (PB 2009); at fauna observation point 8 and quite numerous in intertidal areas and grassy areas around the Wetlands (BMT WBM November 2010)
<i>Aprosmictus erythropterus</i>	Red-winged Parrot	Not listed	Least Concern	Recorded in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland and riparian woodland (PB 2009); at fauna observation point 2 (BMT WBM November 2010)
<i>Aquila audax</i>	Wedge-tailed Eagle	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in melaleuca shrubland, eucalypt/ corymbia woodland, riparian woodland and cleared lands (PB 2009); two individuals near fauna observation point 17 over/adjacent to Mount Luce (BMT WBM November 2010)
<i>Ardeotis australis</i>	Australian Bustard	Not Listed	Least Concern	Recorded in eucalypt/corymbia woodland and cleared lands (PB 2009); and at fauna observation point 18 (BMT WBM November 2010)
<i>Artamus cinereus</i>	Black-faced Woodswallow	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and cleared lands (PB 2009)
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); in eucalypt/corymbia woodland and cleared lands (PB 2009); and noted at fauna observation point 4 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	Not listed	Least Concern	Recorded in the dry season (GHD 2010); recorded in eucalypt/corymbia woodland and cleared lands (PB 2009); and at survey site 3 (Ecoserve November 2004)
<i>Cacatua roseicapilla</i>	Galah	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009)
<i>Calyptorhynchus banksii banksii</i>	Red-tailed Black-cockatoo	Not listed	Least Concern	Recorded in the wet season (GHD 2010); recorded in melaleuca shrubland and eucalypt/ corymbia woodland (PB 2009); and at fauna observation point 27 (BMT WBM November 2010)
<i>Caprimulgus macrurus</i>	Large-tailed nightjar	Not listed	Least Concern	Recorded in mangroves along Saltwater Creek in the dry season and in littoral rainforest in the wet season (GHD 2010); in eucalypt/ corymbia woodland and vine thicket (PB 2009); and at survey site 3 (Ecoserve November 2004)
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Not listed	Least Concern	Recorded in beach scrub and riparian woodland (PB 2009)
<i>Cacomantis variolosus</i>	Brush Cuckoo	Not listed	Least concern	Noted at fauna observation point 2 (BMT WBM November 2010)
<i>Centropus phasianus</i>	Pheasant Coucal	Not listed	Least Concern	Recorded in the dry season (GHD 2010); recorded in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, vine thicket, riparian woodland cleared lands and wetland habitats (PB 2009); at fauna observation points 2,8,28,33 and

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				ANA 0411 (BMT WBM November 2010); and at survey site 5 (Ecoserve November 2004)
<i>Chalcites basalis</i>	Horsefield's Bronze-cuckoo	Not listed	Least Concern	Recorded in open forest near survey site 2 in the wet season (GHD 2010)
<i>Chlamydera maculata</i>	Spotted Bowerbird	Not listed	Least Concern	Recorded in melaleuca shrubland and eucalypt/corymbia woodland (PB 2009)
<i>Chlamydera nuchalis</i>	Great Bowerbird	Not listed	Least Concern	Recorded in melaleuca shrubland, eucalypt/corymbia woodland, vine thicket and riparian woodland (PB 2009)
<i>Chrysococcyx lucidus</i>	Shining Bronze-cuckoo	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and in melaleuca shrubland and eucalypt/corymbia woodland (PB 2009)
<i>Chrysococcyx minutillus</i>	Little Bronze Cuckoo	Not listed	Least Concern	Recorded in beach scrub and eucalypt/corymbia woodland (PB 2009); and at survey site 5 (Ecoserve November 2004)
<i>Cincloramphus cruralis</i>	Brown Songlark	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); and in cleared lands (PB 2009)
<i>Circus approximans</i>	Swamp Harrier	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Circus assimilis</i>	Spotted Harrier	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Cisticola exilis</i>	Golden-headed Cisticola	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); in cleared lands and wetland habitats (PB 2009); and at fauna observation points 8,9,24 (BMT WBM November 2011)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and in beach scrub and eucalypt/ corymbia woodland (PB 2009)
<i>Colluricincla megarrhyncha</i>	Little Shrike-thrush	Not listed	Least Concern	Recorded in the dry season and in littoral rainforest in the wet season (GHD 2010); and at fauna observation points 29,33 and ANA0911 (BMT WBM November 2010)
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in melaleuca shrubland, eucalypt/ corymbia woodland, vine thicket, riparian woodland and cleared lands (PB 2009)
<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	Not listed	Least Concern	Recorded in beach scrub and melaleuca shrubland (PB 2009)
<i>Coracina tenuirostris</i>	Cicadabird	Not listed	Least Concern	Observed at fauna observation point ANA0911 (BMT WBM November 2010)
<i>Corvus coronoides</i>	Australian Raven	Not listed	Least Concern	recorded in eucalypt/ corymbia woodland, riparian woodland and cleared lands (PB 2009); and at fauna observation points 8,24,28,33 (BMT WBM November 2011)
<i>Corvus orru</i>	Torresian Crow	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); and at fauna observation point 9 (BMT WBM November 2011)
<i>Coturnix ypsilophora</i>	Brown Quail	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010);

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				and in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland, vine thicket riparian woodland and cleared lands (PB 2009)
<i>Cracticus nigrogularis</i>	Pied Butcherbird	Not listed	Least Concern	Recorded in the dry season (GHD 2010); and in eucalypt/ corymbia woodland and riparian woodland (PB 2009)
<i>Cracticus quoyi</i>	Black Butcherbird	Not listed	Least Concern	Observed at fauna observation point 16 (BMT WBM November 2011)
<i>Cracticus torquatus</i>	Grey Butcherbird	Not listed	Least Concern	Recorded in melaleuca shrubland and eucalypt/ corymbia woodland (PB 2009)
<i>Cuculus pallidus</i>	Pallid Cuckoo	Not listed	Least Concern	Recorded in beach scrub, riparian woodland and cleared lands (PB 2009)
<i>Dacelo leachii</i>	Blue-winged Kookaburra	Not listed	Least Concern	Recorded in melaleuca shrubland and eucalypt/ corymbia woodland (PB 2009)
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Not listed	Least Concern	Recorded in the dry season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland and cleared lands (PB 2009); and at fauna observation point ANA0911 (BMT WBM November 2011)

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<i>Dicaeum hirundinaceum</i>	Mistletoebird	Not listed	Least Concern	Recorded in the dry season and in littoral rainforest in the wet season (GHD 2010); in beach scrub, eucalypt/ corymbia woodland, vine thicket and riparian woodland (PB 2009); and at fauna observation point ANA0911 (BMT WBM November 2011)
<i>Dicrurus bracteatus bracteatus</i>	Spangled Drongo (eastern Australia)	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland and riparian woodland (PB 2009); and at fauna observation point ANA0911 (BMT WBM November 2011)
<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and riparian woodland (PB 2009); at fauna observation points 9 and ANA0911 (BMT WBM November 2011); and at survey site 3 (Ecoserve November 2004)
<i>Eudynamys scolopacea</i>	Common Koel	Not listed	Least Concern	Recorded in littoral rainforest and open forest in the dry season (GHD 2010); recorded in beach scrub, eucalypt/corymbia woodland and riparian woodland (PB 2009); and at fauna observation point 29 (BMT WBM November 2010)

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<i>Eurystomas orientalis</i>	Dollarbird	Not listed	Least Concern	Recorded in littoral rainforest in the dry season and in the study area in the wet season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland and riparian woodland (PB 2009); at fauna observation point 28 (BMT WBM November 2010); and at survey site 5 (Ecoserve November 2004)
<i>Falco cenchroides</i>	Nankeen Kestrel	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in cleared lands (PB 2009); and at survey site 4 (Ecoserve November 2004)
<i>Falco peregrinus</i>	Peregrine Falcon	Not listed	Least Concern	Observed at fauna observation point 15 (BMT WBM November 2011)
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern subspecies)	Vulnerable	Vulnerable	Recorded in numerous locations in the study area (PB 2009). Preferred habitat is grassy woodlands, open forest near permanent water (Marchant and Higgins 1993). Reasonably common in grazing areas in central Queensland.
<i>Geopelia humeralis</i>	Bar-shouldered Dove	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009); at fauna observation point 16,33 and ANA0911 (BMT WBM November 2010); and at survey sites 4 and 5 (Ecoserve November 2004)
<i>Geopelia striata</i>	Peaceful Dove	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/corymbia

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				woodland, riparian woodland and cleared lands (PB 2009); and at survey sites 3 (Ecoserve November 2004)
<i>Gerygone levigaster</i>	Mangrove Gerygone	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); and at fauna observation point 16 (BMT WBM November 2010)
<i>Gerygone palpebrosa</i>	Fairy Gerygone	Not listed	Least Concern	recorded in beach scrub and vine thicket (PB 2009); and at fauna observation points 16,33 (BMT WBM November 2011)
<i>Grallina cyanoleuca</i>	Magpie-lark	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009); and at fauna observation points 4,8 (BMT WBM November 2010)
<i>Gymnorhina tibicen</i>	Australian Magpie	Not listed	Least Concern	Recorded in melaleuca shrubland, eucalypt/corymbia woodland, and cleared lands (PB 2009)
<i>Haliastur sphenurus</i>	Whistling Kite	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in eucalypt/corymbia woodland, cleared lands and wetland habitats (PB 2009); and at fauna observation points 2 and 24 (BMT WBM November 2010)
<i>Haliastur indus</i>	Brahminy Kite	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in melaleuca shrubland, cleared lands and wetland habitats (PB 2009); and at fauna observation points 6 and 11 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Hirundo ariel</i>	Fairy Martin	Not listed	Least concern	Noted at fauna observation point 2 (BMT WBM November 2010)
<i>Hirundo neoxena</i>	Welcome Swallow	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009); and at fauna observation point 2 in large numbers (± 100) nesting under the road bridge over Saltwater Creek, and fauna observation point 6 (BMT WBM November 2010)
<i>Lalage leucomela</i>	Varied Triller	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland and vine thicket, (PB 2009); and at fauna observation points 2, 11, 29, 33 and ANA0911 (BMT WBM November 2010)
<i>Lichenostomus fasciularis</i>	Mangrove Honeyeater	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); and at fauna observation points 9 and 12 (BMT WBM November 2011)
<i>Lichenostomus flavus</i>	Yellow Honeyeater	Not listed	Least Concern	Recorded in the dry and wet season in the Wetland and littoral rainforest (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland, vine thicket and riparian woodland (PB 2009); at fauna observation points 2, 6, 33 and ANA0911 (BMT WBM November 2010); and at survey sites 5 (Ecoserve November 2004)
<i>Lichmera indistincta</i>	Brown Honeyeater	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in beach scrub and melaleuca shrubland (PB 2009); at

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				fauna observation point 8 (BMT WBM November 2011); and at survey sites 3 and 5 (Ecoserve November 2004)
<i>Lonchura castaneothorax</i>	Chested-breasted Manikin	Not listed	Least Concern	Recorded in cleared lands (PB 2009)
<i>Lopholaimus antarcticus</i>	Topknot Pigeon	Not listed	Least Concern	A flock of about 20 individuals observed at fauna observation point 33 (BMT WBM November 2010)
<i>Melithreptus albogularis</i>	White-throated Honeyeater	Not Listed	Least Concern	Recorded at fauna observation point 29 (BMT WBM November 2010)
<i>Malurus melanocephalus</i>	Red-backed Fairy-wren	Not listed	Least Concern	Recorded in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009); and at fauna observation points 29 and 33 (BMT WBM November 2010)
<i>Manorina flavigula</i>	Yellow-throated Miner	Not listed	Least Concern	Recorded in melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009); and at fauna observation point 8 (BMT WBM November 2011)
<i>Meliphaga lewinii</i>	Lewin's Honeyeater	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in beach scrub (PB 2009); at fauna observation point 33 (BMT WBM November 2010); and at survey site 5 (Ecoserve November 2004)
<i>Merops ornatus</i>	Rainbow Bee-eater	Migratory Terrestrial	Least Concern	Recorded in the dry and wet season (GHD 2010); eighty records from the Wildlife Online Extract since 1980 (EPA 2010); and in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland, riparian

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				woodland and cleared lands (PB 2009)
<i>Microeca flavigaster</i>	Lemon-bellied Flycatcher	Not listed	Least Concern	Recorded in littoral rainforest in the dry season (GHD 2010)
<i>Milvus migrans</i>	Black Kite	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in eucalypt/corymbia woodland, vine thicket, riparian woodland cleared lands and wetland habitats (PB 2009); and at fauna observation points 2 and 9, a nest was noted along Saltwater Creek at fauna observation point "Kite Nest" (BMT WBM November 2010)
<i>Mirafra javanica</i>	Singing Bushlark	Not listed	Least Concern	Recorded in the wet season (GHD 2010); observed at fauna observation points 8,9 and 28 (BMT WBM November 2011)
<i>Myiagra alecto</i>	Shining Flycatcher	Not listed	Least Concern	Male and female observed at fauna observation point 16 (BMT WBM November 2011)
<i>Myiagra rubecula</i>	Leaden Flycatcher	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in riparian woodland (PB 2009); and at fauna observation point 16 (BMT WBM November 2011)
<i>Myzomela obscura</i>	Dusky Honeyeater	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); in beach scrub and melaleuca shrubland (PB 2009); and at survey sites 3 and 5 (Ecoserve November 2004)
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	Not listed	Least Concern	Recorded in beach scrub and melaleuca shrubland (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Nectarinia jugularis</i>	Yellow-bellied Sunbird	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); in melaleuca shrubland, eucalypt/ corymbia woodland, and riparian woodland (PB 2009); and at fauna observation points 2,6,33 and ANA0911 (BMT WBM November 2010)
<i>Neochmia modesta</i>	Plum-headed Finch	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and in beach scrub, riparian woodland and cleared lands (PB 2009)
<i>Ninox novaeseelandiae</i>	Southern Boobook	Not listed	Least Concern	Recorded in eucalypt/ corymbia woodland (PB 2009)
<i>Ocyphaps lophotes</i>	Crested Pigeon	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in melaleuca shrubland, eucalypt/ corymbia woodland, riparian woodland and cleared lands (PB 2009); at fauna observation point 17 (BMT WBM November 2010); and at survey site 4 (Ecoserve November 2004)
<i>Oriolus sagittatus</i>	Olive-backed Oriole	Not listed	Least Concern	Recorded in beach scrub and vine thicket (PB 2009)
<i>Pachycephala rufiventris</i>	Rufous Whistler	Not listed	Least Concern	Recorded in eucalypt/ corymbia woodland and riparian woodland (PB 2009)
<i>Petrochelidon ariel</i>	Fairy Martin	Not listed	Least Concern	Recorded in the dry season (GHD 2010)
<i>Philemon buceroides</i>	Helmeted Friarbird	Not listed	Least Concern	Recorded in Wetland in the dry season and in littoral rainforest in the wet season (GHD 2010); in beach scrub, eucalypt/corymbia woodland and riparian woodland (PB 2009); and at fauna observation points

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				2,33 and ANA0911 (BMT WBM November 2010)
<i>Philemon citriogularis</i>	Little Friarbird	Not listed	Least Concern	Recorded in melaleuca shrubland and eucalypt/corymbia woodland (PB 2009)
<i>Platycercus adscitus planiceps</i>	Pale-headed Rosella (southern form)	Not listed	Least Concern	Recorded in the dry season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland and riparian woodland (PB 2009); and at fauna observation points 17,29 (BMT WBM November 2010)
<i>Podargus strigoides</i>	Tawny Frogmouth	Not listed	Least Concern	Recorded in the dry season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009); and at survey site 4 (Ecoserve November 2004)
<i>Poephila cincta cincta</i>	Black-throated Finch	endangered	endangered	Recorded at Splitter's Creek (PB 2009); other suitable habitat occurs within the study area
<i>Ptilinopus superbus</i>	Superb Fruit-dove	Not listed	Least Concern	Recorded in the wet season in littoral rainforest (GHD 2010)
<i>Ptilonorhynchus nuchalis</i>	Great Bowerbird	Not listed	Least Concern	Recorded in the wet season in littoral rainforest (GHD 2010); and at fauna observation point 2,29 (BMT WBM November 2010)
<i>Ramsayornis modestus</i>	Brown-backed Honeyeater	Not listed	Least Concern	Noted at fauna observation point 2 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Rhipidura fuliginosa</i>	Grey Fantail	Not listed	Least Concern	Recorded in beach scrub, melaleuca shrubland, eucalypt/ corymbia woodland and riparian woodland (PB 2009)
<i>Rhipidura leucophrys leucophrys</i>	Willie Wagtail (southern form)	Not listed	Least Concern	Recorded in the dry and wet season (GHD 2010); and in eucalypt/corymbia woodland and cleared lands (PB 2009)
<i>Rhipidura rufifrons</i>	Rufous Fantail	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	Not listed	Least Concern	Recorded in melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009)
<i>Sphecotheres vieilloti</i>	Figbird	Not listed	Least Concern	Recorded in the dry season (GHD 2010); recorded in beach scrub, eucalypt/corymbia woodland, vine thicket and riparian woodland (PB 2009); and at fauna observation points 2, 12, 33 and ANA0911 (BMT WBM November 2010)
<i>Strepera graculina graculina</i>	Pied Currawong (eastern form)	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in eucalypt/corymbia woodland and cleared lands (PB 2009); and at fauna observation points 17 and 33 (BMT WBM November 2010)
<i>Sturnus vulgaris</i>	Common Starling	Not listed	Introduced	Recorded in cleared lands (PB 2009)
<i>Taeniopygia bichenovii</i>	Double-barred Finch	Not listed	Least Concern	Recorded in beach scrub, eucalypt/ corymbia woodland and cleared lands (PB 2009); and at fauna observation point 2 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Taeniopygia guttata</i>	Zebra Finch	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in beach scrub, eucalypt/ corymbia woodland and cleared lands (PB 2009); and at survey sites 3,4 and 5 (Ecoserve November 2004)
<i>Todiramphus sanctus</i>	Sacred Kingfisher	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and in riparian woodland and cleared lands (PB 2009)
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	Not listed	Least Concern	Recorded in beach scrub and eucalypt/corymbia woodland (PB 2009)
<i>Trichoglossus haematodus moluccanus</i>	Rainbow Lorikeet	Not listed	Least Concern	Recorded in the dry season (GHD 2010); recorded in beach scrub and melaleuca shrubland (PB 2009); and at fauna observation points 16,17 and 33 (BMT WBM November 2010)
<i>Turnix pyrrhorthorax</i>	Red-chested Button-quail	Not listed	Least Concern	Recorded in melaleuca shrubland, riparian woodland and cleared lands (PB 2009)
<i>Tyto alba</i>	Barn Owl			Recorded in riparian woodland and cleared lands (PB 2009)
<i>Vanellus miles miles</i>	Masked Lapwing (northern subspecies)	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in cleared lands and wetland habitats (PB 2009); and common across the Wetlands both along the shoreline and amongst the patches of Mangrove Clubrush and along Saltwater Creek (fauna observation points 2, 11, 20, 28, 29 and 30 - 5 individuals) (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Vanellus tricolor</i>	Banded Lapwing	Not listed	Least Concern	Recorded at fauna observation point 19 (BMT WBM November 2010)
<i>Zosterops lateralis</i>	Silvereye	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); and in beach scrub and riparian woodland (PB 2009)
<i>Zosterops luteus</i>	Yellow White-eye	Not listed	Least Concern	Recorded in the dry season (GHD 2010)
Mammals (refer Figure 4-4 for locations)				
<i>Canis lupus dingo</i>	Dingo	Not listed	Introduced	Recorded in the dry season (GHD 2010); in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland, cleared lands and wetland habitats (PB 2009); and at survey site 4 (Ecoserve November 2004)
<i>Chaerephon jobensis</i>	Northern Free-tailed Bat	Not listed	Least concern	Recorded in the dry season (GHD 2010)
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and at survey site 3 (Ecoserve November 2004)
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010)
<i>Isodon macrourus</i>	Northern Brown Bandicoot	Not listed	Least concern	Recorded in eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009)
<i>Macropus agilis</i>	Agile Wallaby	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland and cleared lands (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	Not listed	Least concern	Observed at fauna observation points 18 and 19 and numerous tracks on the intertidal areas between fauna observation points 8 and 10 (BMT WBM November 2010); and at survey site 4 (Ecoserve November 2004);
<i>Melomys cervinipes</i>	Fawn-footed Melomys	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and at survey site 5 (Ecoserve November 2004)
<i>Miniopterus australis</i>	Little Bentwing-bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010)
<i>Miniopterus schreibersii</i>	Eastern Bentwing-bat	Not listed	Least concern	Recorded in the wet season (GHD 2010)
<i>Mormopterus beccarii</i>	Beccari's Freetail-bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010)
<i>Mus musculus</i>	House Mouse	Not listed	Introduced	Recorded at survey site 4 (Ecoserve November 2004)
<i>Oryctolagus cuniculus</i>	Rabbit	Not listed	Introduced	Recorded in the dry season (GHD 2010); and in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland and cleared lands (PB 2009)
<i>Planigale ingrami</i>	Long-tailed Planigale	Not listed	Least Concern	Recorded at survey site 4 (Ecoserve November 2004)
<i>Pteropus alecto</i>	Black Flying-fox	Not listed	Least concern	Recorded in beach scrub and eucalypt/ corymbia woodland (PB 2009)
<i>Rattus fuscipes</i>	Bush Rat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Rattus rattus</i>	Black Rat	Not listed	Introduced	Recorded in the wet season (GHD 2010)
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and cleared lands and wetland habitats (PB 2009)
<i>Scotorepens greyii</i> or <i>S. sanborni</i>	Little Broad-nosed Bat or Northern Broad-nosed Bat	Not listed	Least concern	Recorded in the dry season (GHD 2010)
<i>Sus scrofa</i>	Feral Pig	Not listed	Introduced	Recorded in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland, riparian woodland, vine thicket, cleared lands and wetland habitats (PB 2009)
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	Not listed	Special least concern	Recorded wet season (GHD 2010); and in beach scrub, eucalypt/corymbia woodland, vine thicket and cleared lands (PB 2009)
<i>Taphozus georgianus</i> or <i>T. australis</i>	Common Sheath-tail-bat or Coastal Sheath-tail-bat	Not listed	Least concern	Recorded in the dry season (GHD 2010)
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and in beach scrub, melaleuca shrubland, eucalypt/corymbia woodland riparian woodland and vine thicket (PB 2009)
<i>Thylogale stigmatica</i>	Red-legged Pademelon	Not listed	Least concern	Recorded in the dry season (GHD 2010)
<i>Vespadelus trougtoni</i>	Eastern Cave Bat	Not listed	Least concern	Recorded in the dry and wet seasons (GHD 2010); and at survey site 5 (Ecoserve November 2004)
<i>Vulpes vulpes</i>	Red Fox	Not listed	Introduced	Recorded in beach scrub, vine thicket, cleared lands and wetland habitats (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
Marine Reptiles				
<i>Chelonia mydas</i>	Green Turtle	Vulnerable	Vulnerable	Nesting along the beach between Abbot Point and Euri Creek (Bell 2003)
<i>Natator depressus</i>	Flatback Turtle	Vulnerable	Vulnerable	Nesting along the beach between Abbot Point and Euri Creek (Bell 2003)
<i>Crocodylus porosus</i>	Saltwater Crocodile	Migratory marine	Vulnerable	Evidence on downstream section of Goodbye Creek on the eastern side of Wetlands (PB 2010); but possible slides don't appear to have been used recently (BMT WBM November 2010)
Aquatic Reptiles (refer Figure 4-4 for locations)				
<i>Chelodonia longicollis</i>	Snake-necked Turtle	Not listed	Least Concern	Corpses recorded in a pasture along a fence line (GHD 2010); and in aquatic/wetland habitats (PB 2009)
<i>Chelodonia cannii</i>	Cann's Long-necked Turtle	Not listed	Least Concern	Recorded in the dry season (GHD 2010); recorded in aquatic/wetland habitats (PB 2009); carapaces found 500 m north of observation point 8, in the vicinity of observation point 30 and in the causeway (inner) bund culvert 750 m south of observation point 32 (BMT WBM November 2010)
<i>Elseya</i> sp. (possibly <i>irwini</i>)		Not listed	Least Concern	Recorded at fauna observation point 28 in Saltwater Creek (BMT WBM November 2010)
Terrestrial Reptiles				

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Antaresia maculosa</i>	Spotted Python	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland (PB 2009); and at fauna observation point 14 (BMT WBM November 2011)
<i>Boliga irregularis</i>	Brown Tree Snake	Not listed	Least Concern	Recorded in beach scrub, eucalypt/corymbia woodland and riparian woodland (PB 2009); and at survey site 5 (Ecoserve November 2004)
<i>Calyptotis temporalis</i>	Broad-templed Calyptotis	Not listed	Least Concern	Recorded in beach scrub (PB 2009);
<i>Carlia munda</i>		Not listed	Least Concern	Recorded at survey site 3 (Ecoserve November 2004)
<i>Carlia mundivensis</i>		Not listed	Least Concern	Recorded at survey site 5 (Ecoserve November 2004)
<i>Carlia pectoralis</i>	Open-litter Rainbow Skink	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); recorded in beach scrub, and eucalypt/corymbia woodland (PB 2009); recorded on Mount Luce circa site 33 (BMT WBM 2010); and recorded at survey site 5 (Ecoserve November 2004)
<i>Carlia schmeltzii</i>		Not listed	Least Concern	Recorded at fauna observation points 33 and ANA0911 (BMT WBM November 2010); and at survey site 5 (Ecoserve November 2004)
<i>Carlia vivax</i>	Tussock Rainbow-skink	Not listed	Least Concern	Recorded in beach scrub, melaleuca scrubland, eucalypt/corymbia woodland and riparian woodland (PB 2009)
<i>Cryptoblepharus pulcher</i> (was <i>C. virgatus</i>)	Cream-striped Elegant	Not listed	Least Concern	Recorded in the dry season (GHD 2010); in

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
	Snake-eyed Skink			mangroves near outer bund, northern bank of Mount Stewart Creek (BMT WBM 2010); and at survey site 3 (Ecoserve November 2004)
<i>Cryptophis nigrostriatus</i>	Black-striped Snake	Not listed	Least Concern	Recorded in beach scrub and eucalypt/corymbia woodland (PB 2009)
<i>Ctenotus robustus</i>	Robust Ctenotus	Not listed	Least Concern	Recorded in beach scrub, and cleared lands (PB 2009)
<i>Delma tinctoria</i>	Excitable Delma	Not listed	Least Concern	Recorded in the dry season (GHD 2010); and in beach scrub and cleared lands (PB 2009)
<i>Demansia vestigiata</i>	Black Whipsnake	Not listed	Least Concern	Recorded in beach scrub (PB 2009, BMT WBM 2010), and eucalypt/corymbia woodland (PB 2009); and at fauna observation point ANA 0911 (BMT WBM November 2011)
<i>Dendrelaphis punctulata</i>	Common Tree Snake	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in beach scrub, eucalypt/corymbia woodland, vine thicket riparian woodland and cleared lands (PB 2009); and at fauna observation points 6,10 and ANA 0911 (BMT WBM November 2011)
<i>Diporiphora australis</i>	Tommy Roundhead	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and cleared lands (PB 2009); and at survey site 3 (Ecoserve November 2004)
<i>Eulamprus punctulatus</i>		Not listed	Least Concern	Recorded at survey site 5 (Ecoserve November 2004)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Gehria dubia</i>		Not listed	Least Concern	Recorded at survey sites 3 and 5 (Ecoserve November 2004)
<i>Glaphyromorphus punctulatus</i>	Fine-spotted Mulch-skink	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010)
<i>Hemidactylus frenatus</i>	Asian House Gecko	Not listed	Introduced	Recorded in the dry season (GHD 2010)
<i>Heteronotia binoei</i>	Bynoe's Gecko	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); in beach scrub, melaleuca scrubland, eucalypt/corymbia woodland, vine thicket and riparian woodland (PB 2009); and at fauna observation point 14 (BMT WBM November 2011)
<i>Lialis burtonis</i>	Burton's Legless Lizard	Not listed	Least Concern	Recorded in the dry season (GHD 2010)
<i>Menefia timlowii</i>		Not listed	Least concern	Observed at fauna observation point ANA0911 (BMT WBM November 2011)
<i>Morelia spilota</i>	Carpet Python	Not listed	Least Concern	Recorded in the dry season (GHD 2010); and in beach scrub, eucalypt/corymbia woodland, cleared lands and aquatic/wetland habitats (PB 2009)
<i>Morethia taeniopleura</i>	Fire-tailed skink	Not listed	Least Concern	Recorded in beach scrub, and eucalypt/corymbia woodland (PB 2009)
<i>Oxyuranus scutellatus</i>	Taipan	Not listed	Least Concern	Recorded in the wet season (GHD 2010)
<i>Pseudechis australis</i>	King Brown Snake	Not listed	Least Concern	Recorded in riparian woodland and cleared lands (PB 2009)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Suta suta</i>	Curl Snake	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and cleared lands (PB 2009)
Amphibians (refer Figure 4-4 for locations)				
<i>Crinia deserticola</i>	Desert Frog	Not listed	Least Concern	Recorded in aquatic/ wetland habitats (PB 2009)
<i>Cyclorana alboguttata</i>	Striped Burrowing Frog	Not listed	Least Concern	Recorded in the wet season (GHD 2010); in beach scrub, melaleuca scrubland, eucalypt/ corymbia woodland, riparian woodland, cleared lands and aquatic/wetland habitats (PB 2009); and one adult located buried approximately 20 cm below the soil surface at the base of a Moreton Bay Ash at fauna observation point 5 (BMT WBM November 2010)
<i>Cyclorana novaehollandiae</i>	New Holland Frog	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and recorded in beach scrub, melaleuca scrubland, eucalypt/ corymbia woodland, riparian woodland, cleared lands and aquatic/wetland habitats (PB 2009)
<i>Litoria bicolor</i>		Not listed	Least Concern	Recorded at fauna observation point 29 (BMT WBM November 2010)
<i>Litoria caerulea</i>	Green Tree Frog	Not listed	Least Concern	Recorded in the dry season (GHD 2010); and recorded in beach scrub, eucalypt/ corymbia woodland and aquatic/wetland habitats (PB 2009)
<i>Litoria gracilentia</i>	Dainty Green Tree Frog	Not listed	Least Concern	Recorded in beach scrub (PB 2009)
<i>Litoria inermis</i>	Peter's Frog	Not listed	Least Concern	Recorded in beach scrub, melaleuca scrub,

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
				eucalypt/ corymbia woodland, riparian woodland, cleared lands and aquatic/ wetland habitats (PB 2009)
<i>Litoria nasuta</i>	Rocket Frog	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and aquatic/ wetland habitats (PB 2009)
<i>Litoria rothii</i>	Roth's Tree Frog	Not listed	Least Concern	Recorded in eucalypt/corymbia woodland and aquatic/ wetland habitats (PB 2009)
<i>Litoria rubella</i>	Desert Tree Frog	Not listed	Least Concern	Recorded in beach scrub, melaleuca scrubland, eucalypt/corymbia woodland, riparian woodland aquatic/wetland habitats (PB 2009)
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	Not listed	Least Concern	Recorded in the wet season (GHD 2010); and in melaleuca scrubland and aquatic/wetland habitats (PB 2009)
<i>Opisthodon ornatus</i> (formerly <i>Limnodynastes ornatus</i>)	Ornate Burrowing Frog	Not listed	Least Concern	Recorded in the dry and wet seasons (GHD 2010); and in beach scrub, eucalypt/ corymbia woodland, cleared lands and aquatic/wetland habitats (PB 2009)
<i>Rhinella marina</i>	Cane Toad	Not listed	Introduced	Recorded in the dry and wet seasons (GHD 2010); and at survey sites 3 and 4 (Ecoserve November 2004)
Butterflies and Moths (<i>Lepidoptera</i>) (refer Figure 4-4 for locations)				
<i>Alcides zodiaca</i>	Zodiac Moth	Not listed	Least Concern	Observation point 12 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Arhopala centaurus</i>	Purple Oak-blue	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Arhopala micale</i>	Shining Oak-blue	Not listed	Least Concern	Observation point 6 (BMT WBM November 2010)
<i>Belenois java</i>	Caper White	Not listed	Least Concern	Observation point 6 (BMT WBM November 2010)
<i>Catopsilia pomona</i>	Lemon Migrant	Not listed	Least Concern	Observation point 12 (BMT WBM November 2010)
<i>Cepora perimale</i>	Caper Gull	Not listed	Least Concern	Observation points 12 and 33 (BMT WBM November 2010)
<i>Cressida cressida</i>	Big Greasy	Not listed	Least Concern	Observation points 3,6,11 and ANA0911 (BMT WBM November 2010)
<i>Danaus affinis</i>	Swamp Tiger	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Danaus chrysippus</i>	Lesser Wanderer	Not listed	Least Concern	Observation points 6 and 33 (BMT WBM November 2010)
<i>Danaus plexippus</i>	Wanderer	Not listed	Least Concern	Observation points 6 (BMT WBM November 2010)
<i>Euploea core</i>	Common Australian crow	Not listed	Least Concern	Observation points 6 and 33 (BMT WBM November 2010)
<i>Euploea tulliolus</i>	Purple Crow	Not listed	Least Concern	Observation points 33 and ANA0911 (BMT WBM November 2010)
<i>Hypochorysops apelles</i>	Copper Jewel	Not listed	Least Concern	Observation point 16 (BMT WBM November 2010)
<i>Hypolimnias alimena</i>	Blue-banded Eggfly	Not listed	Least Concern	Observation point 12 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Hypolimnas bolina</i>	Common Eggfly	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Hypolycaena phorbas</i>	Black-spotted Flash	Not listed	Least Concern	Observation point 5 (BMT WBM November 2010)
<i>Junonia orithya</i>	Blue Argus	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Leptotes plinius</i>	Plumbago Blue	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Melanitis leda</i>	Evening Brown	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Mycalesis perseus</i>	Dingy Brush Brown	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Papilio aegaeus</i>	Orchid Swallowtail	Not listed	Least Concern	Observation points 33 and ANA0911 (BMT WBM November 2010)
<i>Papilio demoleus</i>	Chequered Swallowtail	Not listed	Least Concern	Observation point ANA0911 (BMT WBM November 2010)
<i>Theclinessthes sulphitus</i>	Samphire Blue	Not listed	Least Concern	Observation point 8 (BMT WBM November 2010)
Dragonflies and Damselflies (<i>Odonata</i>) (refer Figure 4-4 for locations)				
<i>Anax</i> sp.		Not listed	Least Concern	Observation point 27 (BMT WBM November 2010)
<i>Crocothemis nigrifrons</i>		Not listed	Least Concern	Observation point 28 (BMT WBM November 2010)
<i>Diplacodes haematodes</i>		Not listed	Least Concern	Observation point 31 (BMT WBM November 2010)

Scientific Name	Common Name	Status EPBC Act	Status NC Act	Location/additional information
<i>Diplacodes trivialis</i>		Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)
<i>Hydrobasileus brevistylus</i>		Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)
<i>Incitinogomphus australis</i>	Australian Tiger	Not listed	Least Concern	Observation points 2 and 31 (BMT WBM November 2010)
<i>Ischnura heterosticta</i>		Not listed	Least Concern	Observation point 33 (BMT WBM November 2010)
<i>Lathrecista asiatica festa</i>		Not listed	Least Concern	Observation points 2 and ANA0911 (BMT WBM November 2010)
<i>Macrotristria godingi</i>		Not listed	Least Concern	Observation point 27 (BMT WBM November 2010)
<i>Orthetrum serapia</i>		Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)
<i>Orthetrum calidonicum</i>		Not listed	Least concern	Observation point 33 (BMT WBM November 2010)
<i>Pseudagrion</i> sp.		Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)
<i>Rhyothemis graphiptera</i>	Graphic Flutterwing	Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)
<i>Rhyothemis phyllis</i>	Banded Flutterwing	Not listed	Least Concern	Observation point 2 (BMT WBM November 2010)

APPENDIX G: GREAT BARRIER REEF WETLAND MAPPING

The freshwater/ brackish sections of the Kaili (Caley) Valley Wetlands (the Wetlands) are mapped as a Great Barrier Reef (GBR) Wetland by DERM (refer Figure 3-2). GBR Wetlands are freshwater wetlands within GBR catchments of high ecological significance (DERM 2011a). As part of the Queensland Government's commitment to halting wetland loss, restoring degraded wetlands and the degradation of the GBR from sediment runoff they have put in place Temporary State Planning Policy 1/11 Protecting Wetlands of High Ecological Significance in GBR Catchments to prevent further loss of wetlands and from damage caused by some aspects of development, specifically high impact earthworks (DERM 2011b). This temporary policy sets out requirements for:

- Positioning of development;
- Hydrology (protection/enhancement);
- Water quality – stormwater; and
- Ecological values :
 - Vegetation retention/ restoration and land degradation;
 - Ecological corridors;
 - Pests and invasive species;
 - Noise, light and visual disturbance; and
 - Operational management, maintenance and monitoring.

The more saline section is mapped as Wetland Management Area (refer Figure 3-2). Wetland management areas comprise of a wetland of ecological significance plus a 100-metre trigger area (DERM 2010c). Development triggers for wetlands as listed in Schedule 7 of the SP Regulation include:

- Reconfiguring a lot if:
 - Any part of the land is situated wholly or partly within a wetland management area; and
 - The reconfiguration results in more than six lots being created, or any lot resulting from the reconfiguring is less than 5 ha.
- Material change of use, other than for a domestic activity, if any part of the land is situated wholly or partly within a wetland management area.

APPENDIX H: RISK ASSESSMENT

Approach

The primary purpose of this risk assessment is to identify key risks to Environmental Values (EVs) in the absence of management intervention. The risk analysis involved:

Risk Identification

On the basis of the technical and scientific research in the BMT WBM October 2010 – November 2010 study, the risks of future impacts on EVs were defined. The focus of the study was on adverse impacts on the values. Table H-1 shows risks to values considered in the risk assessment.

Consequence

The consequence is the outcome of the event and is considered in relation to the achievement of objectives. For the purposes of this assessment, consequence was defined according to the predicted level of impact on the EVs identified in Section 5. The consequence scale identified through this process is presented in Table H-2.

Table H-1 Risks to Environmental Values

EV	Risks to Values	Primary Threats
EV2	1) Loss of habitat for threatened non-wetland dependent species	Unmanaged clearing, corridor design which does not adequately cater for threatened species' needs, ongoing impacts due to habitat fragmentation, weeds, altered fire regimes
EV2	2) Loss of feeding habitat for Little Tern 3) Loss of habitat for Saltwater Crocodile	Sea level rise, nest disturbance Sea level rise, altered hydrology Sea level rise
EV1, 6	4) Increase in vegetation fragmentation	Unmanaged clearing, corridor design which does not adequately address the need to minimise terrestrial vegetation fragmentation, weeds, altered fire regimes
EV1	5) Reduced estuarine/marine vegetation	Unmanaged clearing, inappropriate corridor design sea level rise, altered tidal hydraulics
EV1	6) Loss of freshwater habitat in Saltwater Creek	Altered tidal hydraulics
EV1, 6	7) Loss of aquatic and terrestrial fauna movement corridors	Corridor design which does not adequately address aquatic and terrestrial fauna movement, unmanaged clearing, weeds and altered fire regimes
EV3	8) Loss of dry season refugia (Lake Caley and Saltwater Creek) for wetland-dependent species	Altered hydrology, grazing
EV2&4	9) Loss of migratory and resident waterbird feeding and nesting areas at Saltwater Creek, Lake Caley and the Basin	Altered hydrology, grazing, corridor design which does not adequately address the need to minimise disturbance to the Little Tern feeding area

EV	Risks to Values	Primary Threats
EV5	10) Reduced fisheries habitat values, particularly for barramundi and mud crab	Altered hydrology, pollutants, inadequately managed wetland rehabilitation works
EV5	11) Loss of aquatic species habitat, abundance and diversity	Altered catchment hydrology and reduced water quality from polluted stormwater, leakage of other water sources and contaminant spills.

Table H-2 Consequence Scale

Consequence scale	Success criteria	
	Based on Management Objectives	Based on impact to EVs
Insignificant	No impediment to achievement of aim	No impact to value
Minor	Isolated instances where impediment to achievement of aim	Minor / short-term impact to value
Moderate	Regular occasions where impediment to achievement of aim	Moderate / medium-term impact to value
Major	Continuous impediment to achievement of aim	Major / long-term impact to value
<i>Catastrophic</i>	<i>Aim cannot be achieved</i>	<i>Permanent and irreversible impact to value</i>

Likelihood

Likelihood refers to the 'conditional' likelihood; that is the likelihood of the risk of impact occurring is assessed as if the climate change scenario was going to happen (Australian Greenhouse Office 2006). In this context, this required an assessment of whether the identified risk is considered likely to occur based on the predicted ecosystem response. Therefore, the likelihood of a specific risk arising may differ depending on which scenario is being considered.

Table H-3 was used as a guide to determine the likelihood of impacts. In considering likelihood the following was considered:

- Proposed future activities within the APSDA and APCT; and
- Existing statutory controls.

Table H-3 Likelihood Categories (Source: AGO 2006)

Rating	Recurrent risks	Single events
Almost certain	Could occur several times per year	Probability >50%
Likely	May arise about once per year	50/50 chance
Possible	May arise once in ten years	Probability <50% but still quite high
Unlikely	May arise once in 10 to 25 years	Probability low but far greater than zero
Rare	Unlikely during the next 25 years	Probability very small, close to zero

The above information was then used to determine the likelihood and consequence of the risks using the risk matrix shown in Table H-4.

Table H-4 Risk Matrix

	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	medium	medium	high	extreme	extreme
Likely	low	medium	high	high	extreme
Possible	low	medium	medium	high	high
Unlikely	low	low	medium	medium	medium
Rare	low	low	low	low	medium

Risk Analysis

Table H-5 is a risk register which presents the results of the risk analysis. In the absence of mitigation, and taking into account existing controls, the following were rated as “extreme” risks:

- Conversion of Saltwater Creek into a mangrove lined estuary due to sea level rise. This risk is relevant to changes over long timeframes (50-100 years+). As with many of the identified risks associated with changes in environmental values due to sea level rise, it is important to note that while an existing value may be lost, it will be replaced by a new value. This will represent a benefit to some species (in this case estuarine species that use mangrove habitats), and a loss of values for others (i.e. freshwater species).

Table H- 5 Risk Register – Without Mitigation

Risks ID	Primary Threats	Consequence	Likelihood	Unmitigated Risk
1. Loss of feeding habitat for Little Tern	Sea level rise + inadequate setback	Major	Rare	
	Altered tidal hydraulics due to inadequate mgt of bund removal	Major	Possible	
2. Loss of habitat for Saltwater Crocodile	Sea level rise and inadequate setback	Moderate	Rare	
3. Changes to and possible loss of estuarine/ marine vegetation	Unmanaged clearing, inappropriate corridor design	Major	Rare	
	Sea level rise and inadequate setback	Catastrophic	Rare	
4. Loss of freshwater habitat in Saltwater Creek	Altered tidal hydraulics due to inadequate mgt of bund removal (no sea level rise) - intermittent	Major	Possible	
	Above with sea level rise – conversion to estuary	Catastrophic	Likely	
5. Loss of habitat for threatened non-wetland-dependent species (Squatter Pigeon)	Ongoing pressures	Major	Possible	
	Unmanaged clearing with ongoing pressures	Major	Possible	
6. Increase in terrestrial vegetation fragmentation				
7. Loss of terrestrial fauna movement corridors				
8. Loss of dry season refugia (Lake Caley and Saltwater Creek) for wetland-dependent species	Altered catchment hydrology due to catchment devt + ongoing pressures	Major	Rare	
	Altered tidal hydraulics due to inadequate mgt of bund removal – mangrove encroachment (no sea level rise)	Major	Possible	
9. Loss of migratory & resident waterbird feeding and nesting areas at Saltwater Creek and the Basin	Above with sea level rise (mangrove encroachment)	Major	Likely	
10. Reduced fisheries habitat values, particularly for barramundi and mud crab (tidal creeks)	Ongoing pressures associated with waterway barriers (do nothing)	Major	Almost certain	
	Altered catchment hydrology and increase pollutant loadings due to catchment devt.	Major	Possible	
	Altered tidal hydraulics due to inadequate mgt of bund removal + ongoing pressures	Major	Rare	
11. Loss of aquatic habitat, species abundance diversity	Impacts from increased frequency of minor storm runoff and reduced water quality from polluted stormwater, leakage of other water sources and contaminant spills.	Major	Almost certain	

- Restricted fish movements and associated loss of habitat values for species of fisheries significance (particularly Barramundi) due to ongoing operation of western (outer) bund and the causeway (inner) bund (noting that passage through the causeway (inner) bund during non-flood periods is presently via a 30 cm diameter culvert). The bunds presently and will continue to

represent major impediments to fish (and other aquatic fauna) movements in and out of the Kaili (Caley) Valley Wetlands (the Wetlands). While the western (outer) bund has created a novel habitat type that appears to have values as a fish habitat and bird feeding area (i.e. the impounded hypersaline waters), these potential benefits appear to be outweighed by the long term adverse impacts associated with the loss of mangrove habitat and loss of connectivity.

- Loss of aquatic species habitat, abundance and diversity – increases in impervious area across the catchment will also increase the frequency of disturbance to aquatic ecosystems. In a natural catchment such disturbances are rare and ecosystems have evolved to quickly recover from these occasional events. In the absence of management intervention, catchment development can lead to altered hydrological regimes and water quality, and subsequent adverse impacts to aquatic ecosystems.

Many of the risks rated as High were also associated with impacts to habitats due to sea level rise. These include:

- Loss of dry season refugia (Lake Caley and Saltwater Creek) for wetland-dependent species, and loss of migratory and resident waterbird feeding and nesting areas at Saltwater Creek and the Wetland Basin Zone, due to sea level rise. Sea level rise could result in more regular tidal exchange within the wetland basin and Saltwater Creek, potentially leading to increased salinities and the development of mangrove communities in these areas. This may lead to the loss of tidal flats within the wetland basin and the loss of water lilies and instream vegetation within Saltwater Creek, which may be unfavourable for some waterbird species.

Other risks rated as High were:

- Disturbance of Little Tern due to uncontrolled human access. . This is presently occurring at low levels and could increase as a result of greater numbers of people working in the APSDA visiting the beach to undertake recreational activities.
- Loss of habitat for threatened terrestrial fauna, terrestrial habitat fragmentation and loss of fauna movement corridors due to future catchment development. While there is generally poor north – south connectivity at present, further losses in connectivity could lead to additional detrimental impacts.
- There is an expectation that controlled water discharges from the APSDA will be of a suitable standard to protect environmental values, as required under the EPP Water. However, there is a risk that inadequate stormwater management practices, together with accidental spills, could increase pollutant loads in the Wetlands, impacting on fish habitat values.
- Altered tidal hydraulics associated with the removal of the western (outer) bund leading to the loss of freshwater habitat in Saltwater Creek. This could occur even without sea level rise, if inappropriately managed.

Moderate risks include:

- Loss of estuarine vegetation due to inadequate setbacks. Sea level rise is expected to result in the landward retreat of estuarine and aquatic vegetation.



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