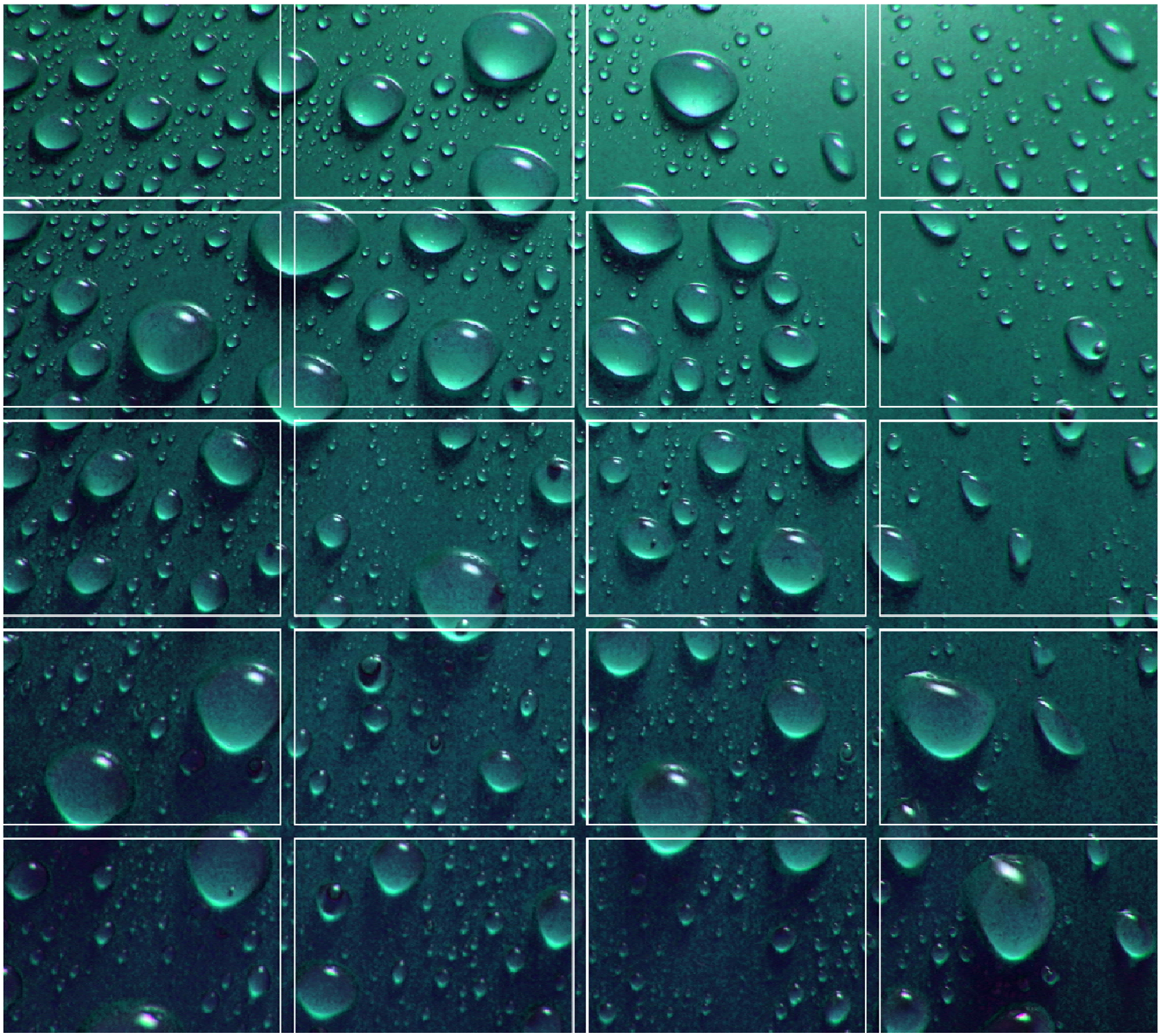
Annex F

Flora And Fauna (Ecology)



Ammonium Nitrate Storage and Distribution Facility

Ecology Assessment

Crawfords Freightlines Pty Ltd

October 2012

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Crawfords Ammonium Nitrate Distribution and Storage Facility, Sandgate NSW

Ecology Assessment

Crawfords Freightlines Pty Ltd

October 2012

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Date:	*15 October, 2012*

Environmental Resources Management Australia Pty Ltd Quality System

Quality-ISO-9001-PMS302

FINAL REPORT

Crawfords Freightlines Pty Ltd

Ammonium Nitrate Storage and Distribution Facility - Lot 12 Old Maitland Road Sandgate, NSW

Ecology Assessment

October 2012

Reference: 0143175_Eco_Rp01

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Crawfords Freightlines Pty Ltd (Crawfords) to undertake an ecology assessment of its 22.4 hectare (ha) leased property at Lot 12 Old Maitland Road Sandgate, NSW (the site), where it currently operates an ammonium nitrate storage and distribution facility. Operations involving the storage of ammonium nitrate on this site have been undertaken for approximately 10 years. All activities are currently undertaken on developed industrial land and the adjacent wetland habitats which provide habitat for threatened species will not be cleared. However, flood and surface water run-off from the site has the potential to introduce hazardous chemicals into the adjacent wetland habitats. Therefore this report focuses on the survey and assessment of species and communities that could potentially be adversely affected by these impacts including: Green and Golden Bell Frog (Litoria aurea); threatened and migratory birds; groundwater dependent ecosystems (GDEs) and aquatic ecology.

Wetland habitats surrounding the site provide potential habitat for a number of threatened species, including the Magpie Goose (Anseranas semipalmata) and Black-necked Stork (Ephippiorhynchus asiaticus) which were both recorded during the field surveys. Suitable habitat is also present for a number of other state and commonwealth listed threatened bird species. Eleven commonwealth listed migratory bird species were recorded during the field surveys. The Green and Golden Bell Frog is historically known from surveys undertaken in the 2HD Swamp complex, however was not recorded during this assessment. The site is generally surrounded by wetland GDEs, particularly the Typha/Phragmites Reed Swamp to the north and the 2HD Swamp to the east.

The assessment of surface water quality at locations adjacent to the site identified elevated concentrations of nitrates and total phosphorus in the 2HD Swamp and at a location downstream from the swamp (north-west of the Crawfords site). In the absence of true pre-development baseline data, the water quality in 2HD Swamp was compared to water quality at a ponded area upstream of the Crawfords site, nominated as a reference site that approximated the environment of the 2HD Swamp.

In-situ water quality was relatively similar between the reference site and all other sampling sites, with the exception of pH which was markedly higher at the 2HD sites indicating alkaline waters of the swamp (and downstream). Dissolved oxygen was lowest at Site 3 which probably reflects the stagnant, vegetation-choked nature of the site.

A total of 11 different macroinvertebrates were recorded from four sampling locations. Sensitivity of the macroinvertebrates recorded was analysed using SIGNAL 2 ratings and indicated that two types of sensitive macroinvertebrates were recorded in relatively high abundances. This result suggests that water quality in the wetlands of the Study Area is sufficient to support these species. The majority of macroinvertebrates recorded however are from groups considered tolerant or very tolerant to low water quality and pollutants.

A low diversity of macrophytes was recorded in the Study Area; this may be associated with the occurrence of Panicum repens which dominates almost all vegetated areas adjacent to open water. This exotic species may be outcompeting native macrophytes.

2HD Swamp is an artificial aquatic ecosystem and is unlikely to function as a natural ecosystem in terms of water flows, water quality and the availability of a range of aquatic habitats. In addition, the swamp supports a variety of introduced species including aquatic fauna (eg Mosquitofish (Gambusia holbrooki)) and a variety of exotic flora species that are widespread in and around the swamp.

The continuation of activities on the site is unlikely to significantly impact the surrounding habitat areas.

1 INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Crawfords Freightlines Pty Ltd (Crawfords) to undertake an ecology assessment of its leased property at Lot 12 Old Maitland Road, Sandgate, New South Wales (the Crawfords property).

1.1 PROJECT OVERVIEW

Crawfords operate a storage and distribution depot for bagged ammonium nitrate product on behalf of a range of customers. The site is located on industrial premises owned by Sierra Sun Pty Ltd and Crawfords currently lease Shed C and Shed D, and all outdoor storage areas. The only other tenant at the site is 'Scafflink Australia' who occupy a small fenced off area (and associated offices) in the eastern corner of the site. Crawfords are negotiating to take over the lease of Shed A and Shed B, which were previously occupied by 'Impact Fertilisers' who stored and distributed bulk fertiliser.

1.2 SITE DESCRIPTION

The Crawfords property is approximately 22.24 ha and is bounded by the Main Northern Railway (Newcastle – Maitland) to the west, the Newcastle Inner City Bypass (Shortland to Sandgate) which is under construction in the south and freshwater wetlands to the north and east. Wetland areas adjacent to the Crawfords property were also included in the Study Area for this assessment. There is potential for activities onsite to impact the adjacent habitats as a result of flooding and surface water run-off.

Flood mapping from BMT WBM (2012) shows that in the event of a flood, water would flow onto the Crawfords property from west of the rail line entering the property along the western boundary. The flood water would then exit the property to the northeast into the 2HD Swamp before continuing to move north through the native reed swamp while remaining to the east of the rail line. Due to this flood modelling likely impact areas associated with pollution from onsite run-off were considered to be the wetland areas to the north and east of the Crawfords property and these areas were subsequently the focus for this study. *Figure 1.1* defines the Study Area for this assessment.

1.3 SCOPE OF WORKS

The ecology assessment included the survey and assessment of the following ecological matters:

- Green and Golden Bell Frog;
- threatened and migratory birds;
- Groundwater Dependent Ecosystems (GDEs); and
- aquatic ecology.

These matters were selected for the focus of the assessment due to a number of factors; the Director-Generals Requirements (DGRs), previous records of the Green and Golden Bell Frog and threatened bird species and the surrounding habitats with potential to be impacted.

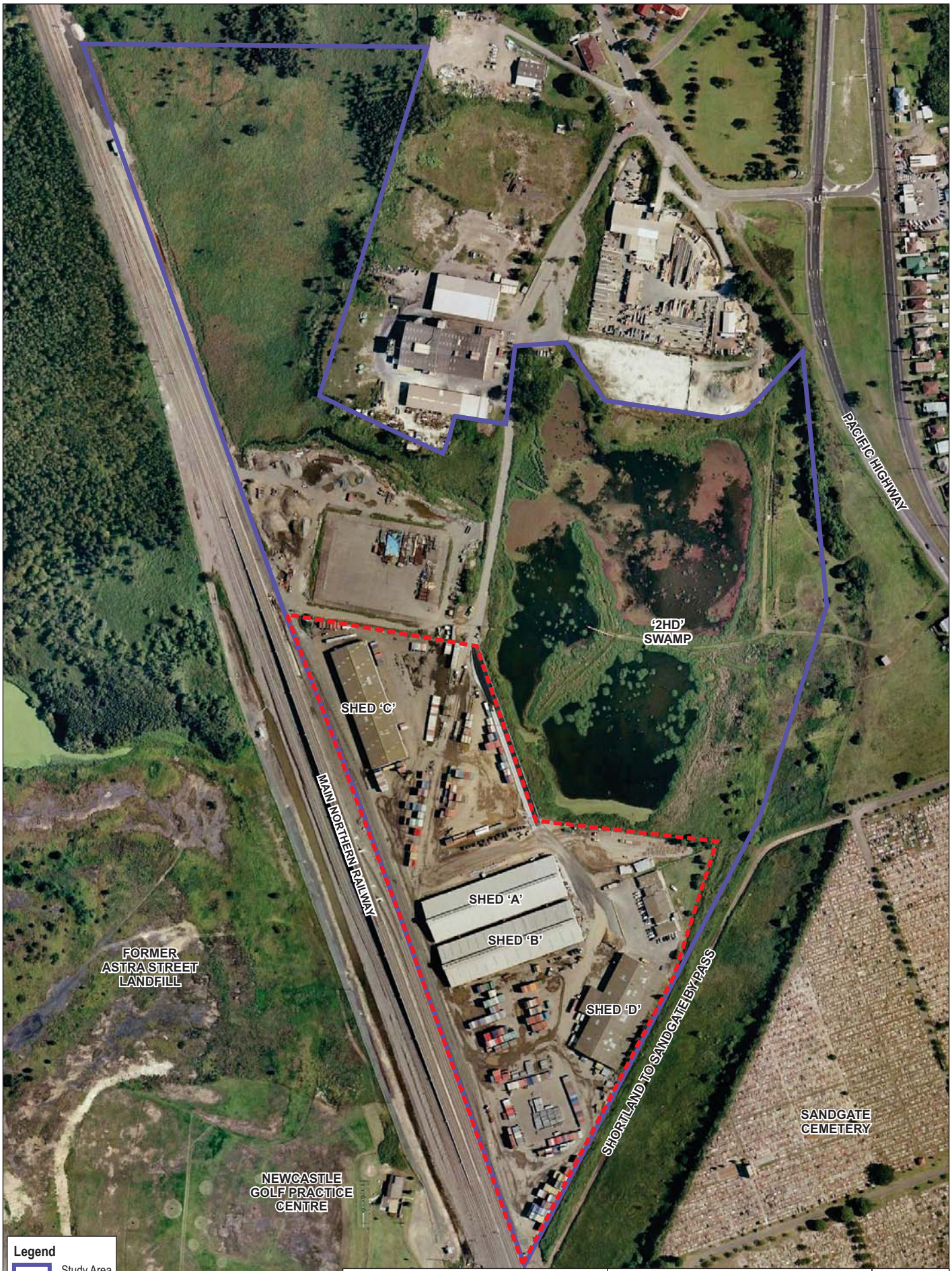

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Figure 1.1 - The Study Area

Crawfords Freightlines Pty Ltd - Ecology Assessment

Environmental Resources Management ANZ

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2 *LEGISLATION*

This chapter outlines the legislation and policies relevant to this assessment.

2.2 *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999*

The *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act) is the primary piece of Federal legislation relating to the environment. Under the EPBC Act any action that has, or is likely to have, a significant impact on a Matter of National Environmental Significance (NES) requires approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. An action is defined as a project, development, undertaking, activity (or series of activities), or alteration to any of these. Matters of NES include:

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international importance;
- listed threatened species and communities;
- internationally protected migratory species;
- Commonwealth marine areas; and
- nuclear actions.

The site is not listed as or located on or adjacent to a World Heritage property or a National Heritage place. The land is not designated as Commonwealth land and nuclear actions are not listed within 10 kilometres of the site. There is a Ramsar listed Wetland in the local area. Potential impacts to the wetland are discussed in Chapter 6 of this report. Database searches indicate there are a number of threatened ecological communities, and a number of Commonwealth listed threatened species and migratory species recorded within a 10 km radius of the site. An assessment of whether the development will have or is likely to have a significant impact on these matters of national environmental significance is provided in the ecological assessment as outlined in Chapter 6.

2.3 *ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979*

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the statutory framework for planning in NSW. Under Sections 5A and 79C, consideration must be made to the potential impacts of a proposed development on threatened species, populations, communities and their habitats.

An Assessment of Significance (Seven Part Test) is required if threatened biodiversity is found to be potentially impacted by the proposed development. The Assessment of Significance determines if the project will have a significant impact on threatened biodiversity.

The results of this assessment concluded that Seven Part Tests were not required for listed threatened species as impacts from the proposal were not anticipated.

2.4 *THREATENED SPECIES CONSERVATION ACT 1995*

Projects determined by a statutory authority of the NSW State Government are required to be assessed in accordance with the EP&A Act, as amended by the *Threatened Species Conservation Act 1995 (*TSC Act). The TSC Act lists threatened species, populations and ecological communities under Schedules 1 and 2 of the Act, that are priorities for conservation within NSW. Schedule 3 of the TSC Act lists Key Threatening Processes for species, populations and ecological communities within NSW.

Section 5 lists threatened species, populations and communities listed under the TSC Act with potential to occur in the Study Area.

2.5 *STATE ENVIRONMENTAL PLANNING POLICY 14 COASTAL WETLANDS*

State Environmental Planning Policy (SEPP) 14 aims to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State. SEPP 14 identifies wetlands of significance in coastal NSW and developments within these areas are deemed designated developments under the EP&A Act.

The site is within close proximity of a State Environmental Planning Policy SEPP 14 - Coastal Wetland (840) known as Hexham Swamp. This is a state significant wetland and the potential impact of the development on the adjacent wetlands is addressed in *Section 3.3.1*.

2.6 *THE NSW STATE GROUNDWATER DEPENDENT ECOSYSTEMS POLICY 2002*

Groundwater dependent ecosystems (GDEs) are ecosystems which have their species composition and their natural ecological processes by groundwater (ARMCANZ & ANZECC 1996).

The State Groundwater Dependent Ecosystems Policy is specifically designed to identify and protect ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored.

The policy also provides guidance on how to identify, protect and manage GDEs. The State Groundwater Dependent Ecosystems Policy describes the legislation relevant to protecting GDEs. In NSW, land use planning and developments are controlled under the EP&A Act. The EP&A Act requires the potential effects on groundwater of proposed developments to be assessed as part of the environmental impact assessment process.

3 EXISTING ENVIRONMENT

This chapter provides a brief description of the geology, geography and hydrology of the Study Area and surrounds.

3.1 LANDFORM, GEOLOGY AND SOILS

3.1.1 Landform and Topography

The study area is located within the physiographic region known as the Lower Hunter Plains and is covered by the Soil Landscapes of the Newcastle 1:100 000 Sheet (Matthei 1995). The landform within the study area is largely characterised by the broad estuarine plain of the Hunter River which varies in width throughout the wider area to between 2 kilometres (km) and 8 km. Local relief within the area varies between sea level and <10 metres (m), although much of the area is limited to elevations of less than 2 m (Matthei 1995).

3.1.2 Geology

The underlying geology of the study area comprises the Permian Tomago Coal Measures, Permian Mulbring Siltstone and Quaternary estuarine/lacustrine sediments. The Permian Tomago Coal Measures are characterised by shale, mudstone, sandstone, coal, tuff and clay, the Permian Mulbring Siltstone by siltstone, claystone, thin sandstone and limestone, and the Quaternary estuarine/lacustrine sediments by silts and clays (RTA 2006).

3.1.1 Soil Landscapes

The soils located within the study area are comprised of those listed under the classification of Hexham Swamp. Soils traditionally comprise a black pedal-silty clay loam A horizon of 100 millimetres (mm) – 200 mm in depth and a gleyed sticky plastic clay B-horizon also to a depth of between 100 – 200 mm. This soil type has a pH level between 5.5 and 6, is prone to seasonal waterlogging, has low fertility and has a high potential for acid sulfate soil (RTA 2006).

3.1.2 Acid Sulphate Soils

A search of the Department of Natural Resources (DNR) Acid Sulfate Soils Risk Map indicated that there is a high and low risk respectively, for acid sulfate soils (ASS) within 2HD Swamp and Sandgate Cemetery (RTA 2006).

3.2 WATER RESOURCES

The study area lies within the catchment of Ironbark Creek, one of the largest tidal creeks draining to the Hunter River. Its catchment covers some 12,500 ha and has a diversity of land uses, including urban and limited rural residential, industrial and commercial, important communication and transport corridors, recreation, conservation, agriculture, mining, forested land and wetlands. Drainage from the study area is generally north towards a network of channels, which drain from the adjoining low-lying pastures into Iron Bark Creek.

3.3 PROTECTED AREAS

3.3.1 *State Environmental Planning Policy 14 (Coastal Wetlands)*

Hexham Swamp is located to the northwest of the study area and is listed under SEPP 14 (Site 840) and is therefore of State significance. The wetland has been disturbed and modified by previous development in the area. Development has included installation of flood gates and urbanisation, preventing normal cycles of tidal inundation and altering hydrological characteristics. Changes to the hydrological regime have facilitated colonisation of much of the wetland by emergent macrophytes (aquatic plants), including Common Reed (*Phragmites australis*) and Broad-leaf Cumbungi (*Typha orientalis*) and has allowed stands of Swamp Oak (*Casuarina glauca*) to become established (HWR Ecological 2005).

The area to the immediate north and northwest of the Crawfords property, including the northern section of the Study Area, is also listed as SEPP 14 wetlands.

3.3.2 *Ramsar Wetlands*

The Hunter Estuary site comprises Kooragang Nature Reserve and the Shortland Wetlands site. The two areas are approximately 2.5 km apart and are connected by a wildlife corridor consisting of Ironbark Creek, the Hunter River and Ash Island (NPWS 2012). These sites are situated on opposite sides of the study area. For designated Ramsar wetlands, the EPBC Act requires anyone proposing an action which may have a significant impact on the ecological character of the site, must refer the action to the Minister for Environment so that the action may undergo an environmental assessment and approval process.

4 METHODOLOGY

This chapter describes the methodology undertaken to assess the ecological attributes of the Study Area.

4.1 DESKTOP ASSESSMENT

A desktop assessment was undertaken to collate existing literature, database records and vegetation mapping of the Study Area and surrounds, as described in the following sections.

4.1.1 Database Search

Database searches were undertaken to collect records of threatened and migratory species listed under the TSC Act and EPBC Act previously recorded within a 10 kilometre (km) radius of the Study Area. The following databases were searched in June 2012:

- the NSW Department of Environment, Climate Change and Water (DECCW) Atlas of NSW Wildlife database;
- the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) on-line search tool for Matters of National Environmental Significance (MNES); and
- Hunter Wetland Centre bird survey results 2011.

All results were applied to the Study Area using a Geographic Information System (GIS), clipped to a search radius of 10 km and then interpreted to inform the ecological field investigations. Refer to *Section 5.1.1* for further discussion on the results from the searches.

4.1.2 Background Literature

Literature relevant to the ecology of the Study Area was collected from online databases using web-based search tools, and from public and in-house libraries. Background literature specific to the project included:

- HWR Ecological (2005) Proposed Upgrades of SH23 Shortland to Sandgate Ecological Assessment;
- HWR Ecological (2006) Proposed Upgrade of SH23 Shortland to Sandgate Green & Golden Bell Frog Assessment;
- RTA (2006) Newcastle Inner City Bypass Sandgate to Shortland Review of Environmental Factors;

- Department of Environment and Climate Change NSW (DECC) (2007) Draft Management Plan for the Green and Golden Bell Frog Key Population in the Lower Hunter; and

- Department of Land and Water Conservation (DLWC) (2002) The NSW State Groundwater Dependent Ecosystems Policy.

Literature review on the biology and ecology of the Green and Golden Bell Frog was undertaken and reports for nearby developments were also consulted to obtain information and records of the species in the locality and the historically recorded population at the 2HD swamp in particular. Literature review on the types of GDEs likely to occur in the study area and potential impacts of the activities occurring on the development site were investigated. Refer to *Section 5.1.2* for further discussion on the results from the searches.

4.1.3 Existing Vegetation Mapping

Existing vegetation mapping datasets for the study area were obtained from the Hunter & Central Coast Regional Environmental Management Strategy (HCCREMS) (March 2003). The datasets were applied to the Study Area using a GIS and inspected for their spatial accuracy against current aerial imagery of the Study Area. This data was used as the basis for further field investigations to assess floristic composition of vegetation communities in the study area. Refer to *Section 5.1.2* for further discussion on the results of the mapping.

4.2 FIELD INVESTIGATIONS

Field investigations were undertaken in two survey periods by two ecologists between 14-19 March and 12-14 June 2012.

4.2.1 Green and Golden Bell Frog

Conditions during the survey period were varied. The first two survey nights had very light winds and warm temperatures and were within a week of significant rainfall which is considered suitable survey conditions. The final survey night had cooler temperatures and strong winds which are considered poor survey conditions. The surveys were undertaken very late in the seasonal survey window for the species. Overall, the conditions during the survey were not consistent with suitable survey effort for the species under the EPBC Act Guidelines (DEWHA 2010). Surveys methods are described below.

Habitat Identification

A site walkover was initially undertaken to identify areas of suitable habitat for the Green and Golden Bell Frog. These areas would be targeted during the remaining survey effort using the methods described below. During habitat identification observations on habitat condition including the presence of predators were also recorded.

Dip Netting

Dip netting was performed in pools in an attempt to record Green and Golden Bell Frog tadpoles. Tadpoles caught during dip netting were identified using Tadpoles of South-eastern Australia – A Guide with Keys by (*Anstis* 2002).

Spotlighting and Active Searches

Spotlighting using head torches was undertaken while traversing the Study Area in an effort to detect eye shine from adult frogs. Torches were adjusted to the narrow spotlight setting and the beam was passed over suitable habitat areas. Sedges and rushes potentially housing adult frogs were searched for individuals. If a calling could not be identified by the call triangulation was used to locate the individual.

Call Detection

While traversing the Study Area ecologists listened for calls of frogs, in particular the distinctive call of the Green and Golden Bell Frog. When arriving at suitable vantage points over looking areas of suitable habitat, periods of up to 5 minutes were used to listen for frog calls.

Call Playback

Call playback involved playing recorded calls of the Green and Golden Bell Frog over a loudspeaker in an attempt to illicit a response from frogs in the Study Area. Suitable vantage points overlooking areas of suitable habitat were chosen, after an initial period of call detection the call of the Green and Golden Bell Frog was broadcast for approximately 2-3 minutes. This was then followed by a further 5 – 10 minutes of listening for a response. On some occasions the call was re-broadcast followed by another period of listening for a response.

Reference Site Survey

Two reference sites on Ash Island, within 2 km of the Study Area, were visited to determine whether the Green and golden Bell Frog was recordable from known sites during the time of survey. This method was used to assess the suitability of the survey timing.

4.2.2 *Birds*

Birds were opportunistically recorded during all survey periods, with particular emphasis placed on recording birds from the wetland areas adjacent to the Crawfords property.

4.2.3 *Groundwater Dependent Ecosystems*

Field surveys were undertaken by two ecologists over two days to validate vegetation mapping, identify dominant species with each vegetation community and assess the condition of each community in the Study Area. Vegetation communities were mapped using a combination of GPS waypoints and tracks and aerial imagery. Where access was difficult due to dense reed swamp vegetation, nearby vantage points were utilised to assist visual assessment of inaccessible areas.

4.2.4 *Aquatic Surveys*

Aquatic assessments were undertaken on 14 June 2012 where two ecologists sampled five sites in total. Four sampling techniques were employed at each site; real time *in-situ* water quality; laboratory analysis of water samples, macroinvertebrates and macrophytes.

Macroinvertebrates are animals with no backbone and can be seen with the naked eye. Aquatic macroinvertebrates live in water for all or part of their life cycle, therefore their survival is dependent on water quality. Different macroinvertebrates are sensitive to different physical and chemical conditions. The richness and composition of the macroinvertebrate community at a site can be used as an indicator of the water quality and ecosystem health. Macrophytes are aquatic plants and the abundance and diversity of these species can also provide indications of water quality and ecosystem health.

Water Quality

Using a real time water quality probe, *in-situ* temperature, salinity, conductivity, dissolved oxygen, pH and oxygen reduction potential were measured at each site. General observations on water quality such as colour, odour and presence of sheens were also recorded.

In addition to the *in-situ* water quality measurements, two 250 ml water samples were collected from each site. These samples were sent to ALS Laboratory for analysis of total nitrogen, nitrite (NO2), nitrate (NO3), ammonia (NH3) and total phosphorus.

Macrophytes

Macrophytes were recorded from within five metres of each sampling site and categorised as emergent or floating.

Macroinvertebrates

Macroinvertebrates were sampled at four sites. The method for sampling involved sweep netting for 30 seconds along the interface between macrophytes and open water over an area of approximately four metres. The net was run roughly along the edge of the vegetation to attempt to dislodge and capture organisms from within the vegetation. Due to the muddy substrate, the sweep was kept above the bottom.

Due to the lack of open water at site 3 (located in dense reed swamp), no macroinvertebrate sampling was undertaken as the sampling method employed at the other sites (sweep netting) was not possible.

4.1 LIMITATIONS

The survey for the Green and Golden Bell Frog is considered to have been undertaken outside optimal survey period and survey effort was not sufficient to meet the EPBC Act survey guidelines for the species.

Winter is not an ideal time for sampling aquatic macroinvertebrates since insect activity tends to be lower during the colder months; however, the project timing constraints prevented sampling at other times of the year. Nevertheless, comparison between sampling sites and the reference site is deemed to provide a relative indication of macroinvertebrate diversity and abundance to assist with the assessment of water quality.

5 RESULTS

5.1 DESKTOP ASSESSMENT

5.1.1 Database Searches

A total of 118 species listed under the TSC Act and/or EPBC Act were reported to have previously been recorded within 10 km of the Study Area. This includes 20 flora species and 98 fauna species. Species that are presumed extinct in NSW, are well outside their normal range, or are listed only as marine under the EPBC Act are not included in these results.

The Atlas of NSW Wildlife reported previous records of 18 flora species and 68 fauna species listed under the TSC Act in the search area. The Hunter Wetlands Centre reported records of seven bird species listed under the TSC Act in the search area, all of which were also report in the Atlas of NSW Wildlife.

A full list of threatened and migratory species known or with the potential to occur within 10 km of the Study Area is provided in *Table 5.1 and Table 5.2*. The locations of existing threatened species records reported by the NSW Wildlife Data Unit within 10 km of the Study Area are shown in *Figure 5.1* (flora) and *Figure 5.2* (fauna). Other database audits did not provide records of sufficient accuracy to be mapped.

The EPBC Protected Matters Search Tool reported the following Matters of NES that may occur in or may relate to the 10 km search radius surrounding the Study Area (for full results see *6.6A*):

- one wetland of international significance (Hunter Estuary Wetlands);
- one threatened ecological community (White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland);
- 18 threatened species; and
- 32 migratory species.

The full report from the EPBC Protected Matters Search Tool database for the search area is provided as *6.6A*.

Site Boundary

Legend

Ecological Boundaries

- Site Boundary
- Study Area

ThreatenedSpecies

- Eucalyptus parramattensis subsp. decadens
- Euphrasia arguta
- Grevillea shiressii
- Maundia triglochinoides
- Zannichellia palustris
- Arrow-head Vine, Tinospora tinosporoides
- Biconvex Paperbark, Melaleuca biconvexa
- Black-eyed Susan, Tetratheca juncea
- Camfield's Stringybark, Eucalyptus camfieldii
- Charmhaven Apple, Angophora inopina
- Coast Headland Pea, Pultenaea maritima
- Dwarf Kerrawang, Rulingia prostrata
- Heath Wrinklewort, Rutidosis heterogama
- Magenta Lilly Pilly, Syzygium paniculatum
- Netted Bottle Brush, Callistemon linearifolius
- Rough Doubletail, Diuris praecox
- Small-flower Grevillea, Grevillea parviflora subsp. parviflora
- Tall Knotweed, Persicaria elatior

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Figure 5.1- Threatened Flora Records within a 10km radius of the Study Area

Crawfords Freightlines Pty Ltd – Ecology Assessment

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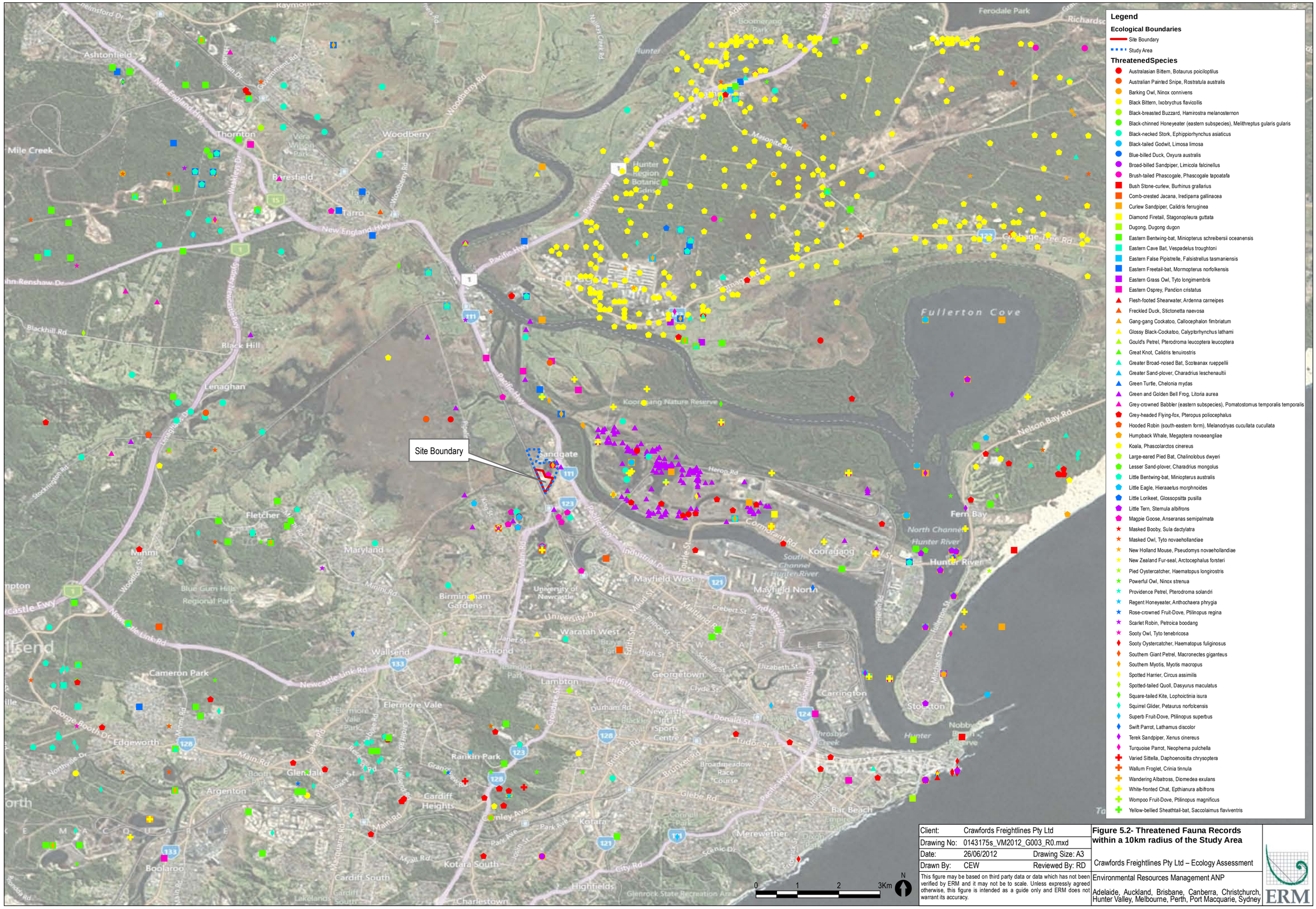

Client:	Crawfords Freightlines Pty Ltd		**Figure 5.2- Threatened Fauna Records within a 10km radius of the Study Area**
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Date:	26/06/2012	Drawing Size: A3	Crawfords Freightlines Pty Ltd – Ecology Assessment
Drawn By:	CEW	Reviewed By: RD	Environmental Resources Management ANP

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Table 5.1 Threatened species known or with the potential to occur within 10km of the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Atlas Search	EPBC Search
Fauna					
Amphibians					
Crinia tinnula	Wallum Froglet	V	-	Y	N
Litoria aurea	Green and Golden Bell Frog	E	V	Y	Y
Litoria littlejohni	Littlejohn's Tree Frog	V	V	N	Y
Birds					
Anseranas semipalmata	Magpie Goose	V		Y	N
Anthochaera phrygia	Regent Honeyeater	E	E	Y	Y
Ardenna carneipes	Flesh-footed Shearwater	V	MM	Y	N
Botaurus poiciloptilus	Australasian Bittern	E	E	Y	Y
Burhinus grallarius	Bush Stone-curlew	E	-	Y	N
Calidris ferruginea	Curlew Sandpiper	E	MW	Y	Y
Calidris tenuirostris	Great Knot	V	MW	Y	Y
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Y	N
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	E	Y	N
Charadrius leschenaultii	Greater Sand Plover	V	MW	Y	Y
Charadrius mongolus	Lesser Sand Plover	V	MW	Y	Y
Circus assimilis	Spotted Harrier	V	-	Y	N
Daphoenositta chrysoptera	Varied Sittella	V	-	Y	N
Dasyornis brachypterus	Eastern Bristlebird	E	E	N	Y
Diomedea exulans	Wandering Albatross	E	V, MM	Y	N
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Y	N
Epthianura albifrons	White-fronted Chat	V	-	Y	N
Glossopsitta pusilla	Little Lorikeet	V	-	Y	N
Haematopus fuliginosus	Sooty Oystercatcher	V	-	Y	N
Haematopus longirostris	Pied Oystercatcher	E	-	Y	N
Hamirostra melanosternon	Black-breasted Buzzard	V	-	Y	N
Hieraaetus morphnoides	Little Eagle	V	-	Y	N
Irediparra gallinacea	Comb-crested Jacana	V	-	Y	N
Ixobrychus flavicollis	Black Bittern	V	-	Y	N
Lathamus discolour	Swift Parrot	E	E	Y	Y
Limicola falcinellus	Broad-billed Sandpiper	V	MW	Y	Y
Limosa lapponica	Bar-tailed Godwit		MW	N	Y
Limosa limosa	Black-tailed Godwit	V	MW	Y	Y
Lophoictinia isura	Square-tailed Kite	V	-	Y	N
Macronectes giganteus	Southern Giant Petrel	E	E, MM	Y	N
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Y	N
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Y	N
Neophema pulchella	Turquoise Parrot	V	-	Y	N
Ninox connivens	Barking Owl	V	-	Y	N
Ninox strenua	Powerful Owl	V	-	Y	N
Oxyura australis	Blue-billed Duck	V	-	Y	N
Pandion cristatus	Eastern Osprey	V	-	Y	N

Scientific Name	Common Name	TSC Act	EPBC Act	Atlas Search	EPBC Search
Petroica boodang	Scarlet Robin	V	-	Y	N
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Y	N
Pterodroma leucoptera leucoptera	Gould's Petrel	V	-	Y	N
Pterodroma solandri	Providence Petrel	V	-	Y	N
Ptilinopus magnificus	Wompoo Fruit-Dove	V	-	Y	N
Ptilinopus regina	Rose-crowned Fruit-Dove	V	-	Y	N
Ptilinopus superbus	Superb Fruit-Dove	V	-	Y	N
Rostratula australis	Australian Painted Snipe	E	V	Y	Y
Rostratula benghalensis	Painted Snipe	-	V, MW	N	Y
Stagonopleura guttata	Diamond Firetail	V	-	Y	N
Sternula albifrons	Little Tern	E		Y	N
Sternula nereis nereis	Fairy Tern		V	N	Y
Stictonetta naevosa	Freckled Duck	V	-	Y	N
Sula dactylatra	Masked Booby	V	-	Y	N
Tyto longimembris	Eastern Grass Owl	V	-	Y	N
Tyto novaehollandiae	Masked Owl	V	-	Y	N
Tyto tenebricosa	Sooty Owl	V	-	Y	N
Xanthomyza phrygia	Regent Honeyeater	E	E, MT	N	Y
Xenus cinereus	Terek Sandpiper	V	MW	Y	Y
Mammals					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Y	Y
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Y	Y
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Y	N
Miniopterus australis	Little Bentwing-bat	V	-	Y	N
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Y	N
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Y	N
Myotis macropus	Southern Myotis	V	-	Y	N
Petaurus norfolcensis	Squirrel Glider	V	-	Y	N
Petrogale penicillata	Brush-tailed Rock-Wallaby	E	E	N	Y
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	Y	N
Phascolarctos cinereus	Koala	V	V	Y	Y
Potorous tridactylus tridactylus	Long-nosed Potoroo	E	V	N	Y
Pseudomys novaehollandiae	New Holland Mouse	-	V	Y	Y
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Y	Y
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Y	N
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Y	N
Vespadelus troughtoni	Eastern Cave Bat	V	-	Y	N
Flora					
Allocasuarina defungens	Dwarf Heath Casuarina	-	E	N	Y

Scientific Name	Common Name	TSC Act	EPBC Act	Atlas Search	EPBC Search
Angophora inopina	Charmhaven Apple	V	-	Y	N
Callistemon linearifolius	Netted Bottle Brush	V	-	Y	N
Diuris praecox	Rough Doubletail	V	-	Y	N
Eucalyptus camfieldii	Camfield's Stringybark	V	-	Y	N
Eucalyptus parramattensis subsp. *decadens*		V	-	Y	N
Euphrasia arguta		E	-	Y	N
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	Y	N
Grevillea shiressii		V	-	Y	N
Melaleuca biconvexa	Biconvex Paperbark	V	V	Y	Y
Maundia triglochinoides		V	-	Y	N
Persicaria elatior	Tall Knotweed	V	-	Y	N
Pterostylis gibbosa	Illawarra Greenhood	E	E	N	Y
Pultenaea maritima	Coast Headland Pea	V	-	Y	N
Rulingia prostrata	Dwarf Kerrawang	E	-	Y	N
Rutidosis heterogama	Heath Wrinklewort	V	-	Y	N
Syzygium paniculatum	Magenta Lilly Pilly	E	-	Y	N
Tetratheca juncea	Black-eyed Susan	V	V	Y	Y
Tinospora tinosporoides	Arrow-head Vine	V	-	Y	N
Zannichellia palustris		E	-	Y	N

Key: V = Vulnerable; E = Endangered; MM = Migratory Marine; MT = Migratory Terrestrial; MW = Migratory Wetland.

Table 5.2 Migratory species known or with the potential to occur within 10km of the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Atlas Search	EPBC Search
Actitis hypoleucos	Common Sandpiper	-	MW	N	Y
Apus pacificus	Fork-tailed Swift	-	MM	N	Y
Ardea modesta	Great Egret	-	MM, MW	N	Y
Ardea ibis	Cattle Egret	-	MM, MW	N	Y
Ardenna carneipes	Flesh-footed Shearwater	V	MM	Y	N
Arenaria interpres	Ruddy Turnstone	-	MW	N	Y
Calidris acuminata	Sharp-tailed Sandpiper	-	MW	N	Y
Calidris canutus	Red Knot	-	MW	N	Y
Calidris ferruginea	Curlew Sandpiper	E1	MW	Y	Y
Calidris ruficollis	Red-necked Stint	-	MW	N	Y
Calidris tenuirostris	Great Knot	V	MW	Y	Y
Charadrius bicinctus	Double-banded Plover	-	MW	N	Y
Charadrius leschenaultii	Greater Sand Plover	V	MW	Y	Y
Charadrius mongolus	Lesser Sand Plover	V	MW	Y	Y
Diomedea exulans	Wandering Albatross	E1	V, MM	Y	N

Scientific Name	Common Name	TSC Act	EPBC Act	Atlas Search	EPBC Search
Gallinago hardwickii	Latham's Snipe	-	MW	N	Y
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	MT	N	Y
Heteroscelus brevipes	Grey-tailed Tattler	-	MW	N	Y
Limicola falcinellus	Broad-billed Sandpiper	V	MW	Y	Y
Limosa lapponica	Bar-tailed Godwit		MW	N	Y
Limosa limosa	Black-tailed Godwit	V	MW	Y	Y
Macronectes giganteus	Southern Giant Petrel	E1	E, MM	Y	N
Merops ornatus	Rainbow Bee-eater	-	MT	N	Y
Monarcha melanopsis	Black-faced Monarch	-	MT	N	Y
Myiagra cyanoleuca	Satin Flycatcher	-	MT	N	Y
Numenius madagascariensis	Eastern Curlew	-	MW	N	Y
Numenius minutus	Little Curlew	-	MW	N	Y
Numenius phaeopus	Whimbrel	-	MW	N	Y
Pluvialus fulva	Pacific Golden Plover	-	MW	N	Y
Pluvialus squatarola	Grey Plover	-	MW	N	Y
Rhipidura rufifrons	Rufous Fantail	-	MT	N	Y
Rostratula benghalensis	Painted Snipe	-	V, MW	N	Y
Tringa stagnatilis	Marsh sandpiper		MW	N	Y
Xanthomyza phrygia	Regent Honeyeater	E1	E, MT	N	Y
Xenus cinereus	Terek Sandpiper	V	MW	Y	Y

Key: V = Vulnerable; E = Endangered; MM = Migratory Marine; MT = Migratory Terrestrial; MW = Migratory Wetland.

5.1.2 Literature Review

Existing Vegetation Mapping

HWR Ecological (2006) reported on the vegetation of the Study Area, describing areas previously cleared for agricultural activities now support dense areas of exotic weed species. Areas of lower elevations are periodically inundated and generally less disturbed supporting dense areas of Common Reed (*Phragmites australis)*.

Existing vegetation mapping of the Study Area (Hunter & Central Coast Regional Environmental Management Strategy (HCCREMS) 2003) identifies four distinct vegetation types including Paperbark Quandong Forest, Eucalypt Forest, exotic shrubs and grasses and wetland. Existing vegetation mapping is shown in *Figure 5.3* and discussed below.

Paperbark/ Hard Quandong Forest

Paperbark/ Hard Quandong Forest occurs along the eastern boundary of the Study Area on slopes surrounding the low lying wet areas. The vegetation community comprises a patchy closed canopy layer of Prickly-leaved Paperbark (*Melaleuca stypheloides*) and Hard Quandong (*Eleocarpus obovatus*), along with Whale Bone Tree (*Streblus brunonianus*), Flintwood (*Scolopia*

braunii), Sweet Pittosporum (Pittosporum undulates), Cheese Tree (G*lochidion ferdinandii*) and Mock Olive (*Notelaea longifolia*) (HWR Ecological 2005).

This vegetation community has affinities to the final determination of three endangered ecological communities (EEC's) listed under the TSC Act, including:

- Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion,
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions; and
- River-flat Eucalypt Forest of the North Coast, Sydney Basin and South East Corner Bioregions.

Eucalypt Forest

Eucalypt Forest occurs within the north-east corner of the Study Area on slopes surrounding low lying wetland areas. The vegetation community comprises of a patchy canopy layer of Forest Red Gum (*Eucalyptus tereticornis*), Grey Box (*Eucalyptus moluccana),* Spotted Gum (*Corymbia maculata*) and Grey Ironbark (*Eucalyptus paniculata*). The understorey consists of native species including Gorse Bitter-Pea (*Davesia ulicifolia*) and Blackthorn (*Bursaria spinosa).* However, majority of the understorey is disturbed with weed species including Lantana (*Lantana camara*), Kikuyu (*Pennisetum clandestinum*), Purple Top (*Verbena banariensis*), and Fireweed (*Senecio madagascariensis*) (HWR Ecological 2005).

Legend

- Site Boundary
- Study Area
- A. costata / C. gummifera / E. capitellata / E. umbra
- Avicennia marina subsp australasica / Sarcocornia quinqueflora subsp quinqueflora / Aegiceras corniculatum
- C. glauca / Melaleuca ericifolia / Baumea juncea
- C. maculata / E. umbra / E. siderophloia
- Ludwigia peploides subsp montevidensis / Paspalum distichum / Eleocharis sphacelata / Juncus usitatus
- Paperbark - Quandong Forest
- Exotic Shrubs and Grasses
- Eucalypt Forest
- Wetlands

N

0 150 300 450m

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Date:	26/06/2012	Drawing Size: A3	
Drawn By:	CEW	Reviewed By: RD	

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Figure 5.3- Existing Vegetation Mapping of the Study Area

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Environmental Resources Management ANP

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Exotic Shrubs and Grasses

Exotic shrubs and grasses occur within the eastern portion of the Study Area in areas that have previously been cleared for agricultural activities. The community is dominated by Kikuyu, Buffalo Grass (*Stenotaphrum secundatum*), Vasey Grass (*Paspalum urvillei*), Pampas Grass (*Cortadieria selloana*) and Rats-tail Grass (*Sporobolus indicus).* Additional species include Blackberry (*Rubus* sp.), Tobacco Bush (*Solanum mauritimum*), Lantana, Paddy's Lucerne *(Sida rhombifolia)* and Purple Top. Small fragments of native species remain within this community where conditions are suitable and include Cumbungi (*Typha orientalis*), Common Reed, Harsh Ground Fern (*Hypolepsis muelleri*) and River Buttercup (*Hydrocotyle inundatus*) (HWR Ecological 2005).

Wetland

The wetland community occur within the western portion of the site in areas of lower elevation that are regularly inundated. The community consists of islands of *Schoenoplectus littoralis* and *Panicum repens,* with some remnant mangroves, surrounded by open water with submerged macrophytes, such as *Myriophyllum* sp. and *Potamogeton* sp. The edge of the wetland community consists of reed swamp dominated by Common Reed with patches of Broad-leaf Cumbungi and dense *Panicum repens* (Cooper N & Winning G 2006).

Birds

A number of bird surveys have previously been undertaken within the vicinity of the Study Area (HWR Ecological 2005). The results of these studies identifies for four threatened bird species known or with the potential to occur within the Study Area, including:

- Latham's Snipe (*Gallinago hardwickii*);
- Australian Painted Snipe (Rostratula australis);
- Australasian Bittern (Botaurus poiciloptilus); and
- Magpie Goose (Anseranas semipalmata).

Latham's Snipe (*Gallinago hardwickii*) is listed as Migratory under the EPBC Act. The species roosts in shallowly inundated low grassland and sedgeland, and feeds in the same habitat or on exposed mud flats of freshwater wetlands. The study area provides habitat suitable for Latham's Snipe. However, previous surveys undertaken by HWR Ecological in July 2005 did not record the species.

Australian Painted Snipe (*Rostratula australis*) is listed as Vulnerable and Migratory under the EPBC Act and Endangered under the TSC Act. The species roost in shallowly inundated low grassland and sedgeland, and feed in the same habitat or on exposed mud flats of freshwater wetlands. The study area provides habitat suitable for Australian Painted Snipe. However,

previous surveys undertaken by HWR Ecological in July 2005 did not record the species.

The Australasian Bittern is listed as Endangered under the EPBC Act and TSC Act and is generally solitary, but sometimes occurs in pairs or dispersed aggregations of up to 12 birds. The species occurs in open areas and edge areas in reed swamps, utilising the reeds for shelter and feeding in shallow water along the edges (Marchant & Higgins 1990). The study area provides habitat suitable for Australasian Bittern and the species has previously been recorded within the Study Area (DECCW Atlas of Wildlife). However, previous surveys undertaken by HWR Ecological in July 2005 did not record the species.

The Magpie Goose (*Anseranas semipalmata*) is listed as Vulnerable under the TSC Act. The study area provides habitat suitable for the Magpie Goose and the species is known to roost in flocks at the Shortland Wetland Centre and has previously been recorded within the Study Area (DECCW Atlas of Wildlife). However, previous surveys undertaken by HWR Ecological in July 2005 did not record the species.

Green and Golden Bell Frog

The Green and Golden Bell Frog is listed as Endangered under Schedule 1 of the NSW TSC Act and Vulnerable under Schedule 1 Part 2 of the Commonwealth EPBC Act.

A core population of the Green and Golden Bell Frog was historically known from the 2HD Swamp area, with the open water and reed patches considered the primary breeding habitat and the surrounding areas of grasslands and swamps acting as secondary habitat. In the 2001/2002 breeding season, 100 Green and Golden Bell Frogs were captured in the 2HD Swamp (Cooper and Winning 2006). The species was last recorded in the 2HD Swamp complex during the 2003/2004 breeding season, over eight years ago.

Drought conditions, disease (chytrid fungus), salinity and Mosquitofish are potential causal factors for the decline of the population.

5.1.3 Groundwater Dependent Ecosystems

The NSW Office of Water has recently released risk assessment guidelines for GDEs (Serov *et al.* 2012). According to the classification system in the guidelines, two types of GDE were recorded in the Study Area.

Wetland Ecosystem

The wetlands surrounding the Crawfords property are considered to be GDEs. These wetlands are likely to be dependent on both surface water and groundwater for survival and impacts to groundwater such as pollution may impact these communities. Given the broad estuarine plain of the site and

surrounds, site hydrogeology is considered complex as the wetland maintains a permanent watertable which is generally less than 1 m below the ground surface and rises to the surface during wet seasons (*Soil Landscapes of the Newcastle 1:100 000 Geological Sheet 9232* (1995)).

Terrestrial Ecosystem

Stands of Swamp Oak in the Study Area are likely to be dependent on groundwater, although these stands are small and isolated and generally infested by exotic weeds species. These areas are likely to be subject to the same hydrological cycles as the adjacent wetland areas described above, but without having the groundwater reaching the surface.

The groundwater associated with the GDEs in the Study Area is part of a shallow alluvial aquifer system. These systems are often in direct connection with surface water bodies such as rivers and wetlands. The natural variability of these systems allows them to tolerate fluctuating water levels; however significant changes to water regimes, such as the operation of dams, can cause damage to the system and subsequently the dependent ecosystems (DLWC 2002). The Crawfords operations are not likely to result in significant changes to the water regime of the surrounding area, and significant impacts to GDEs are not expected.

5.2 FIELD ASSESSMENT

5.2.1 Vegetation Communities and Mapping

The existing mapping from HCCREMS (2003) has poor coverage of the Study Area well and is very broad in scale and low in detail. Previous ecological assessments provide more accurate and detailed mapping of some parts of the Study Area, however to develop coverage of the entire Study Area for this assessment and to maintain consistency, new mapping was developed during field surveys for this project.

The Study Area is dominated by exotic species in many areas, particularly around the edges of industrial properties and the Panicum repens wet grassland which dominated the 2HD Swamp area. Native reed swamps dominated by Broad-leaf Cumbungi and Common Reed are also present with a large stand extending from the north of the Crawfords property all the way to Ironbark Creek, this area also includes patches of Swamp Oak forest.

The vegetation communities recorded and mapped in the Study Area are shown in *Figure 5.4* and each community is described below.

Panicum repens Wet Grassland

The exotic grass *Panicum repens* dominates the margins of the 2HD Swamp in the east of the Study Area forming dense monocultures. Islands of the grass also occur in the open water areas. Floating macrophytes *Azolla filiculoides* and

Duckweed (*Spirodela sp.*) also occur on the edges of this community close to open water.

A portion of this community was recorded in the east of the Study Area where exotic species such as Blackberry, Camphor Laurel (*Cinnamomum camphora*) and Kikuyu were also abundant and this area is shown separately on the vegetation mapping in *Figure 5.4*.

Typha/Pragmites Reed Swamp

Stands of the native Broad-leaf Cumbungi and Common Reed form dense reed swamps across the Study Area.

The community is dominated by these species, with few other species present in abundance. Harsh Ground Fern (*Hypolepis muelleri*) is present within this dense community in some areas and *Panicum repens* also occurs infiltrates the community in some areas where the two communities meet. Pampas Grass occurs randomly within the large stand of reed swamp to the north of the Study Area and Swamp Oaks are also present in this area, forming islands of Swamp Oak Forest in some areas.

Exotic Shrubs and Grasses

Disturbed portions of the Study Area are dominated by exotic species. Some native species such as Swamp Oak and *Acacia longifolia* occur in these however the dominant species are exotics; species such as Castor Oil Plant (*Ricinis communis*) and Lantana dominate a shrubby upperstorey of this community. There is high diversity of exotic shrubs, climbers, forbs and grasses across the site, evidence of a history of high disturbance. Some of the more abundant weeds recorded during the vegetation mapping surveys were *Panicum repens*, Kikuyu, Pampas Grass, Red Natal Grass (*Melinis repens*), Blackberry, Camphor Laurel, S*enecio pterophorus*, *Vicia Sativa* and *Bidens pilosa* among many others.

Swamp Oak

Small stands of Swamp Oak are present in the Study Area along the northern edge of the Crawfords property, with some appearing to be have been planted (occur in rows). In these areas the understoreys are dominated by weeds such as Lantana and Kikuyu.

North of the Study Area and to the west of the rail line more extensive stands of Swamp Oak occurs. These areas are likely to be consistent with the Swamp Oak Floodplain Forest EEC listed under the TSC Act. The small stands of Swamp Oak in the Study Area around the industrial precinct are not considered to be consistent with the EEC due to their small area, lack of characteristic understorey species and because they are likely to have been planted there.

Buffalo Grass/*Juncus krausii* Wet Grassland

To the east of the 2HD Swamp an area of low, wet grassland occurs. This community is dominated by the introduced Buffalo Grass with stands of the native rush *Juncus kraussii* also occurring. Other exotic species including Purple Top and *Hydrocotyle bonariensis* are also present with Kikuyu abundant on the eastern fringe of this community adjacent to the new access road for the Newcastle inner-city bypass.

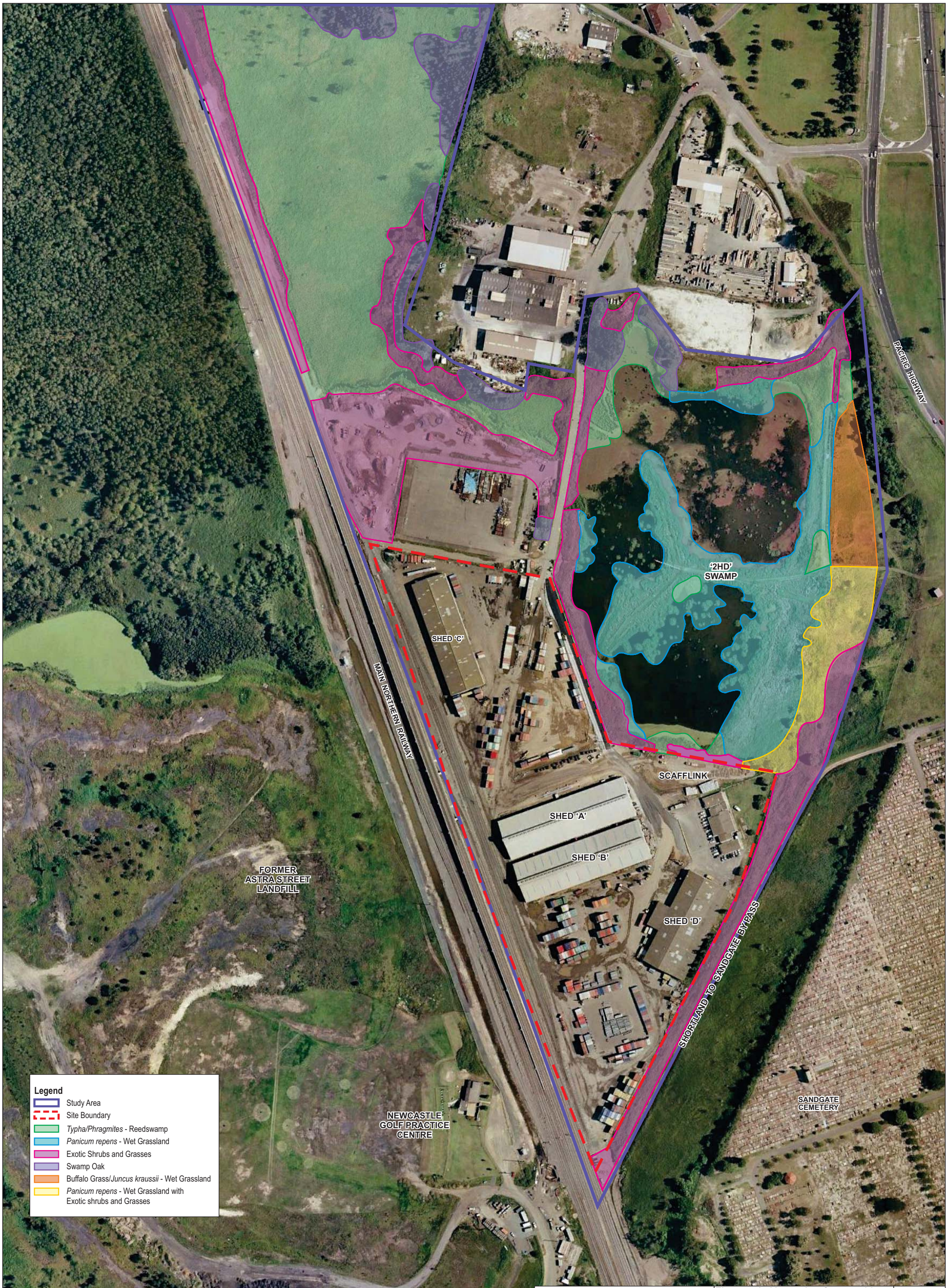

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Figure 5.4 - Vegetation Communities in The Study Area

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5.2.2 *Green and Golden Bell Frog*

No Green and Golden Bell Frogs were recorded in the Study Area during the surveys, but the results of habitat assessments and other survey methods are described in the sections below. The frog species recorded in the Study Area are shown in *Table 5.3*

Table 5.3 Frog Species and Abundance Recorded in the Study Area

Common Name	Scientific Name	14th March 2012	15th March 2012	19th March 2012
Eastern Dwarf Tree Frog	*Litoria fallax*	35, + AC	4, +AC	17, +AC
Striped Marsh Frog	*Limnodynastes peronii*	2, + AC	AC	AC
Peron's Tree Frog	*Litoria peronii*	1	-	-
Common Eastern Froglet	*Crinia signifiera*	-	-	1, AC

1. Numbers indicate individuals observed during each night survey.
2. AC - audible calls of that species were heard from individuals not observed.

Habitat Identification

Suitable areas of breeding habitat for the Green and Golden Bell Frog were identified in the Study Area; these areas were associated with the swamp complex to the east of the Crawfords property. Potential non-breeding habitat exists throughout the wetland areas and in adjacent vegetated areas. The introduced Mosquitofish was observed in all aquatic habitats within the Study Area. Studies have shown Mosquitofish predate on Green and Golden Bell Frog tadpoles (*Morgan and Buttemer* 1996) and have also suggested that presence of the Mosquitofish in permanent water bodies reduces their suitability as breeding sites (*Hamer* et al. 2002). The presence of Mosquitofish in very high abundance within water bodies of the Study Area is considered to significantly reduce its suitability for the Green and Golden Bell Frog.

Dip Netting

Dip netting was undertaken at two locations in the Study Area. Difficulty in safely accessing the edge of the open water areas due to floating mats of vegetation reduced the suitability of this technique in the Study Area. One net scoop was performed in the north of the Study Area where the drainage channel passes under the road and into the large wetland area. This scoop yielded no tadpoles and a large number (>50) Mosquitofish. A second scoop was undertaken on the flooded isthmus to the radio tower. This scoop recorded tadpoles of the Striped Marsh Frog.

Spotlighting and Active Searches

Spotlighting and active searches throughout the Study Area detected all four frog species that were recorded in the Study Area as listed in *Table 5.3* Call Detection

Three of the four frog species recorded in the Study Area were heard calling during the survey. Peron's Tree Frog was the only species recorded that was not heard calling in the Study Area.

Call Playback

Call playback was only attempted for the targeted Green and Golden Bell Frog. Call playback was broadcast at 5 locations in the Study Area. No response was recorded.

Reference Site Survey

No Green and Golden Bell Frogs were detected at the reference sites. Communication with the Newcastle University Frog Lab, who regularly survey the known sites for the Green and Golden Bell Frog, indicated that the species had not been calling since late February. Further surveys were not conducted at either the reference site or Study Area as this information indicated the survey window for the species had closed, and no significant conclusions were likely to result from additional survey effort during this season.

5.2.3 Birds

A total of 40 bird species were recorded in the Study Area during the field surveys. Two species listed as threatened under the TSC Act were recorded in the Study Area; the endangered Black-necked Stork and the vulnerable Magpie Goose. Eleven species listed as migratory under the EPBC Act were also recorded (see *Table 5.4*). Migratory species recorded comprised raptors from the families Falconidae and Accipitridae and waterfowl from the family Anatidae. Species from these families are listed as migratory under the EPBC Act as Australia is considered a range state for those species. The Eastern Great Egret (*Ardea modesta*) is also listed as a migratory species under the EPBC Act and was recorded in the Study Area. The bird species recorded in the Study Area are shown in *Table 5.4*.

Table 5.4 Bird Species Recorded During Field Surveys

Scientific Name	Common Name	TSC Act	EPBC Act
Accipiter novaehollandiae	Grey Goshawk	-	M
Acridotheres tristis	Indian Myna*	-	-
Anas castanea	Chestnut Teal	-	M
Anas superciliosa	Pacific Black Duck	-	M
Anseranas semipalmata	Magpie Goose	V	M
Ardea modesta	Eastern Great Egret	-	M
Ardea intermedia	Intermediate Egret	-	-
Aythya australis	Hardhead	-	M
	Yellow-tailed Black Cockatoo	-	-
Calyptorhynchus funereus	Swamp Harrier	-	M
Circus approximans	Golden-headed Cisticola	-	-
Cisticola exilis	Feral Pigeon*	-	-
Columbia livia	Australian Raven	-	-
Corvus coronoides	Black Swan	-	M
Cygnus atratus	Wandering Whistling Duck	-	M
Dendrocygna arcuata	Little Egret	-	-
Egretta garzetta	Black-shouldered Kite	-	M
Elanus axillaris	Black-fronted Dotterel	-	-
Elseyornis melanops	Black-necked Stork	E	-
Ephippiorhynchus asiaticus	Eurasian Coot	-	-
Fulica atra	Dusky Moorhen	-	-
Gallinula tenebrosa	Magpie Lark	-	-
Grallina cyanoleuca	Australian Magpie	-	-
Gymnorhina tibicen	White-bellied Sea Eagle	-	M
Haliaeetus leucogaster	Whistling Kite	-	M
Haliastur sphenurus	Welcome Swallow	-	-
Hirundo neoxena	Brown Honeyeater	-	-
Lichmera indistincta	Superb Fairywren	-	-
Malurus cyaneus	Noisy Miner	-	-
Manorina melanocephala	Australian Pelican	-	-
Pelecanus conspicillatus	Little Black Cormorant	-	-
Phalacrocorax sulcirostris	Purple Swamphen	-	-
Porphyrio porphyrio	Grey Fantail	-	-
Rhipidura albiscapa	Willie Wagtail	-	-
Rhipidura leucophrys	White-browed Scrubwren	-	-
Sericornis frontalis	Australasian Grebe	-	-
Tachybaptus novaehollandiae	Australian White Ibis	-	-
Threskiornis molucca	Straw-necked Ibis	-	-
Threskiornis spinicollis	Rainbow Lorikeet	-	-
Trichoglossus haematodus	Masked Lapwing	-	-
Vanellus miles			

1. V = vulnerable; E = endangered; M = migratory.
2. * = denotes an introduced species.

Black-Necked Stork

The Black-necked Stork has not previously been recorded in the Study Area but has been recorded in the locality. One adult male was observed foraging thoughout the 2HD Swamp complex on 12 June 2012.

Photograph 5.1 Black-necked Stork foraging in the Study Area

The Black-necked Stork is a distinctive, tall black-and-white waterbird, and the only species of stork found in Australia. Black-necked Storks are usually seen singly or in twos in NSW, occasionally in loose family groups (NSW DEC 2005). They mainly forage in shallow, still water, preferring open wetlands, and taking a variety of prey, including eels and other fish, frogs, turtles, snakes, and small invertebrates, such as crabs and small insects (NSW DEC 2005).

5.2.4 Water Quality

Water quality was sampled at five sites as shown in *Figure 5.5*. At each site *in-situ* water quality parameters were measured with a multiparameter probe and water samples were collected and sent for laboratory analysis. Site 1 is designated as a reference site because it is located upstream from the Project area according to the hydraulic study undertaken by BMT WBM.

Results of *in-situ* measurements of water quality at each sampling site are summarised in *Table 5.5* and each parameter is plotted for each sampling site in *Figures 5.6 – 5.10*.

Client:	Crawfords Freightlines Pty Ltd		
Drawing No:	0143175h_Ecol_A_C003_R0.cdr		
Date:	20/06/2012	Drawing size:	A4
Drawn by:	JD	Reviewed by:	TS

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 5.5 - Aquatic Sampling Locations

Crawfords Freightlines Pty Ltd - Ecology Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

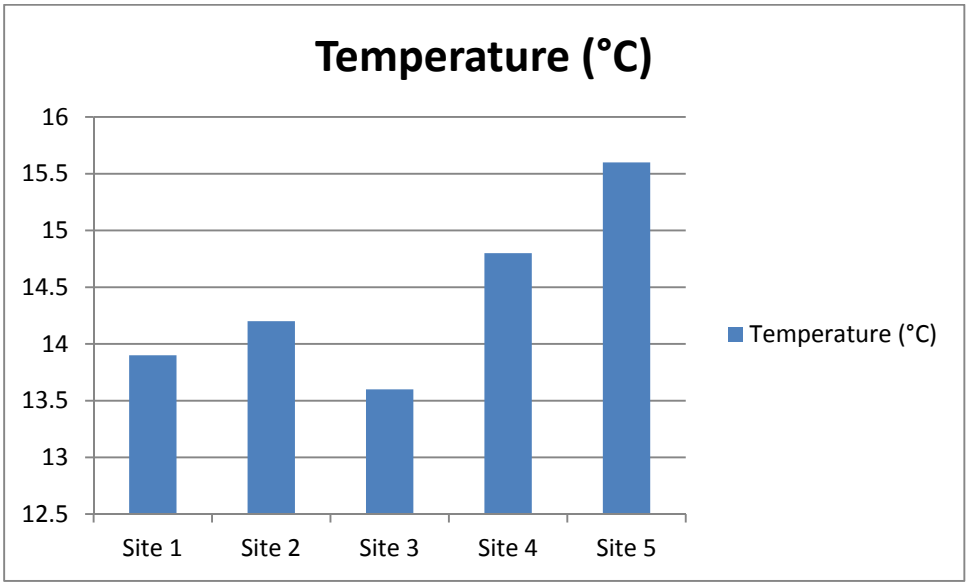
Table 5.5 ***In-situ Water Quality Measurement Results***

Site	Temperature (°C)	Salinity (µS/cm)	DO (%/mg/L)	pH	ORP (mV)
1	13.9	764.4	19/1.92	7.22	107.0
2	14.2	764.2	25.6/2.63	7.93	82.3
3	13.6	763.5	9.4/0.98	7.65	63.3
4	14.8	763.2	19.4/1.95	7.85	47.5
5	15.6	762.3	31.1/3.10	8.06	57.7

In-Situ Water Temperature

Water temperatures were variable between sampling sites within a range of 13.6 – 15.6 C. The variability in water temperature is likely to depend on a number of variables including the depth and movement of water, time of sampling and shading by local vegetation. The absence of distinct spatial patterns in water temperature at the five sampling sites indicates that there is no obvious impact of site activities on the temperature of surface water in the vicinity of the site.

Figure 5.6 ***In-situ Water Temperature Measurement for each Water Quality Sampling Site, June 2012***

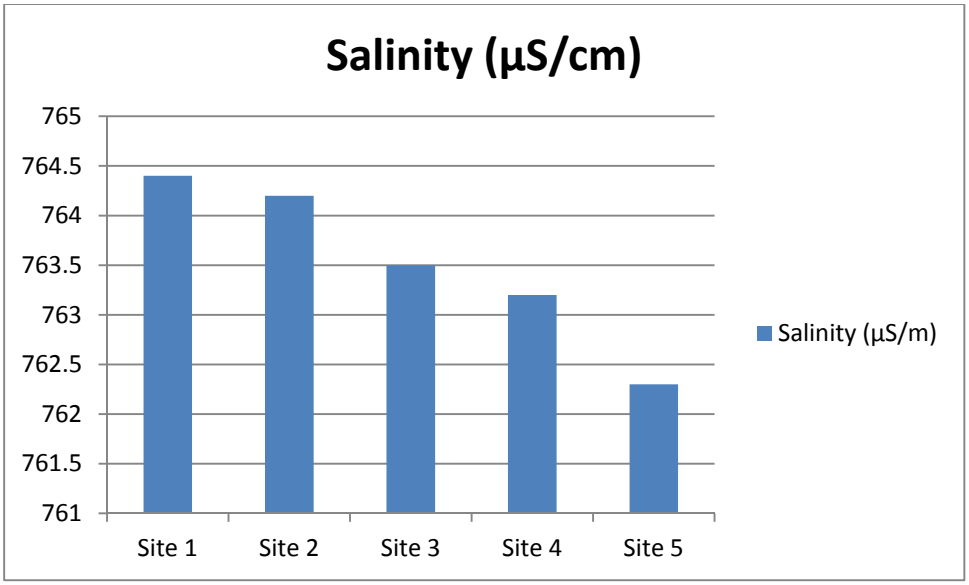


In-Situ Salinity

Salinity, measured as electrical conductivity, across the five sampling sites was within a narrow range of 762 – 764 µS/m indicating a similar level of dissolved salts within the water at each sampling site. Natural salinity of freshwater varies between regions and is related to the salt content of soils and the relative influence of fresh (or salt) water from within the catchment. The ANZECC (2000) guidelines indicate that NSW coastal rivers are typically in the range 200 – 300 µS/cm. Given the closeness of tidal waterways and the likelihood of regular tidal surges occurring in the immediate vicinity of the Study Area, it is not surprising that the electrical conductivity of the surface water is above what is expected for typical coastal rivers.

Importantly in this instance, the electrical conductivity at the reference location (Site 1) is similar to the measurements obtained at the other four sites (*Figure 5.7*). This suggests no obvious impact of site activities on the electrical conductivity of surface water in the vicinity of the site.

Figure 5.7 ***In-situ Salinity (as Electrical Conductivity) Measurement for each Water Quality Sampling Site, June 2012***



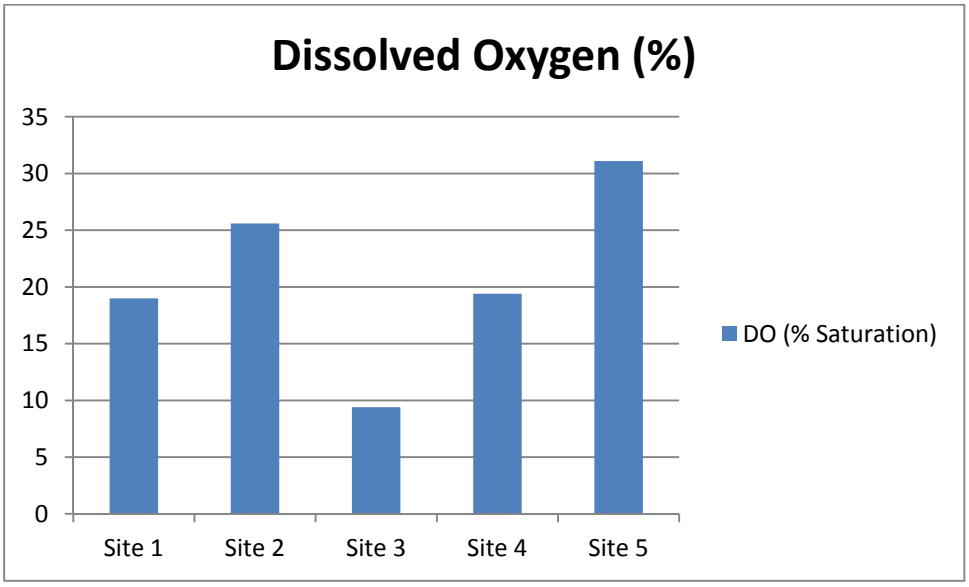
In-Situ Dissolved Oxygen

Dissolved oxygen (DO) refers to the concentration of oxygen dissolved in the water. A sufficient level of DO is essential for the health of aquatic species such as fish and invertebrates. DO concentrations can reduce below critical levels when excessive nutrients enter a water body causing a bloom in algae and/or aquatic plants that utilise DO for growth. Once DO levels fall below critical levels the aquatic fauna may become stressed and die.

DO concentrations varied between the sampling sites within a range of approximately 9 – 30% of saturation (1 – 3 mg/L) which are quite low for aquatic environments. The ANZECC (2000) guidelines state that NSW lowland rivers could be expected to have between 85 – 110% DO; however, non-flowing ponds and low flow drainage channels such as those sampled in this study would be expected to have significantly lower DO percentages.

Importantly for this study, the reference site (Site 1) has DO percentages in the middle range compared to DO at the other sampling sites (*Figure 5.8*), which suggests these low DO percentages are typical for surface waters in the vicinity of the Project area at the time of sampling.

Figure 5.8 ***In-situ Dissolved Oxygen (percent saturation) Measurements for each Water Quality Sampling Site, June 2012***

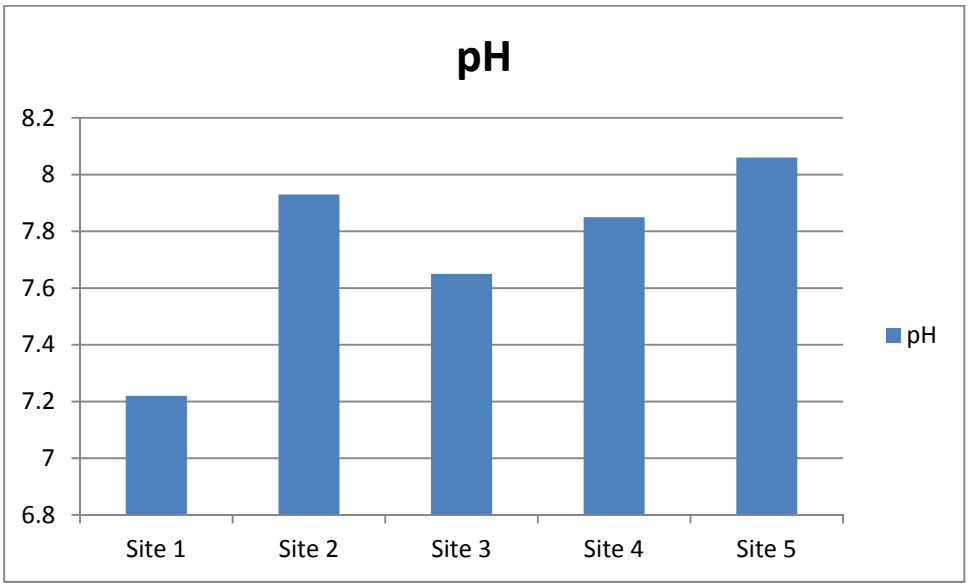


In-Situ pH

Water pH is an indicator of the acidity/alkalinity of the water. The typical pH range is approximately 6.5 to 8.0 and pH is usually maintained within this narrow range due to the buffering capacity of the salts and other chemicals naturally occurring in water.

The range of pH evident at the five sampling sites is within the expected range for lowland rivers and lakes according to ANZECC (2000). Interestingly, pH was noticeably lower at the reference site (Site 1) and similar at all other sites. These results indicate that the water at Sites 2 – 5 are more alkaline than the reference site which may indicate some form of contamination from human activities near to Sites 2 -5; however, as already stated, the range of pH across all five sites is considered to be within natural ranges.

Figure 5.9 In-situ pH Measurement for each Water Quality Sampling Site, June 2012



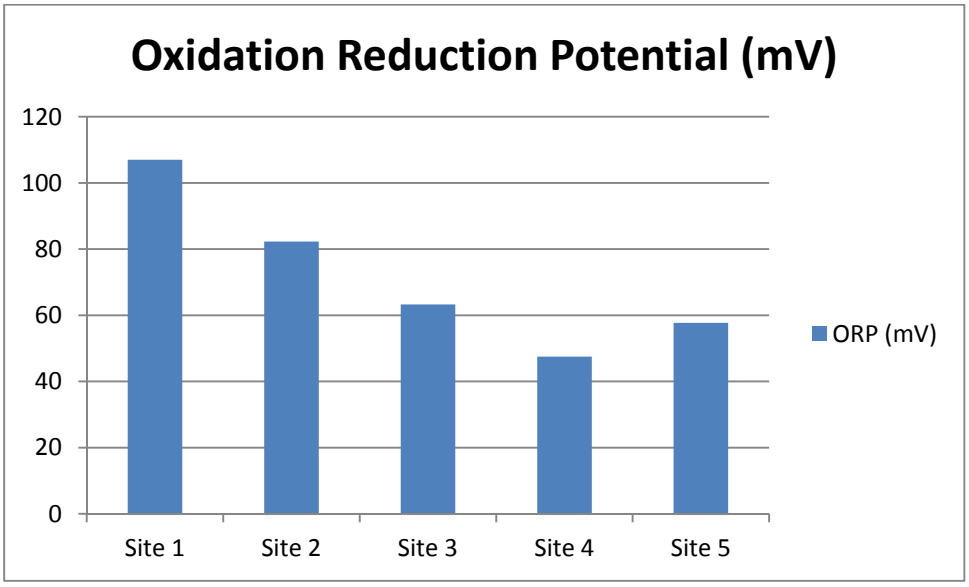
In-Situ Oxidation-Reduction Potential

Oxidation-reduction potential (ORP) of water is an indication of the ability of the water to oxidise contaminants and reflect the level of freely available oxygen in the water. The typical range of ORP readings for freshwater systems is between -100 and +300 mV. Where oxygen levels are low or utilisation through macrobenthic activity and microbial action is high, ORP readings are typically low. An ORP measurement below zero indicates that all freely available oxygen has been removed from the water and the environment is anoxic. Anaerobic decomposition of organic materials in the water body may create an oxygen demand and lower ORP levels.

ORP results for the five sampling sites indicate that the water at each site contains sufficient free oxygen for a healthy system and, at the time of sampling, the water was aerobic.

Importantly for the current study, the ORP level at the reference site (Site 1) was at least 20% higher than the ORP level at all other sampling sites (*Figure 5.10*). These results may indicate that there is a greater level of oxidation occurring at Sites 2 – 5 compared to Site 1, which may indicate some form of impact to the water at Sites 2 – 5. However, as mentioned above, the range of ORP evident at the five sampling sites is within the expected range for lowland aquatic environments.

Figure 5.10 ***In-situ Oxidation-Reduction Potential Measurement for each Water Quality Sampling Site, June 2012***



5.2.5 Laboratory Analysis Results

The results of the laboratory analysis of water quality samples are summarised in *Table 5.6* and the concentration of each parameter is plotted for each sampling site *in Figure 5.11* to *Figure 5.15*..

Table 5.6 ***Water Quality Laboratory Analysis Results***

Analyte	Units	Site 1	Site 2	Site 2-A	Site 3	site 4	Site 5
Ammonia as N	µg/L	80	120	30	30	40	30
Nitrite as N	µg/L	70	30	30	<10	20	20
Nitrate as N	µg/L	270	700	710	2520	380	520
Total Nitrogen as N	µg/L	1800	1600	1600	3900	1200	1300
Total Phosphorus as P	µg/L	70	300	320	220	300	250

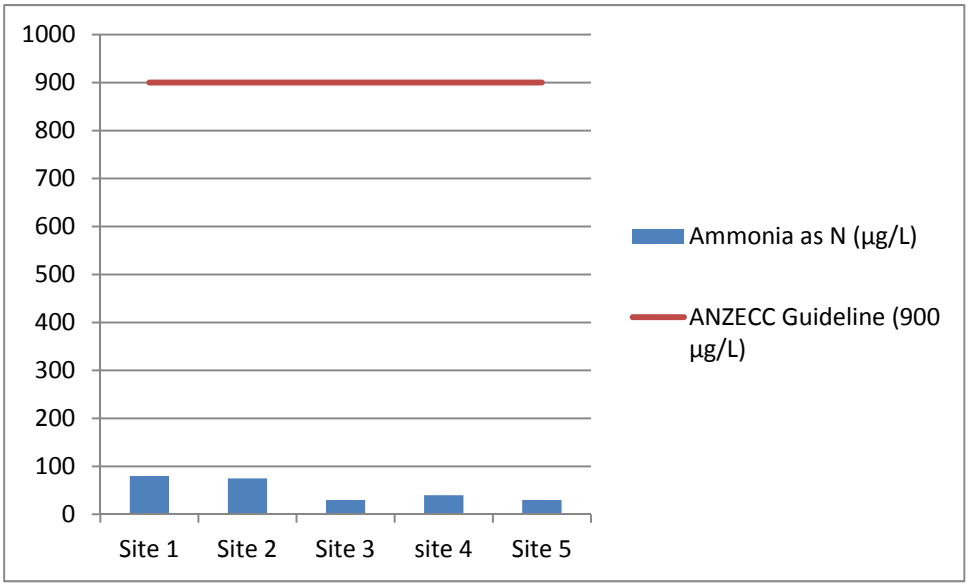
Ammonia

Ammonia (as N) concentrations in water collected from each sampling site ranged between 30 and 120 µg/L (*Figure 5.11*). The highest ammonia concentration was reported in water from Site 2, which was 40 µg/L (or 50%) higher than reported for the reference site (Site 1); however ammonia concentrations at Sites 3 – 5 were between 30 and 40 µg/L or about half the concentration reported at the reference site. All results are within one order of magnitude of each other and no sites are significantly higher than any others or the reference site.

Ammonia concentrations were well below the 900 µg/L ANZECC (2000) guideline trigger value for the protection of 95% of freshwater species (for slightly - moderately disturbed systems), as shown in (*Figure 5.11*).

This indicates that despite spatial differences evident across the survey area, there is low risk of the ammonia concentrations evident in water at the time of sampling to impact most freshwater species.

Figure 5.11 Ammonia Concentrations at each Water Quality Sampling Site, June 2012

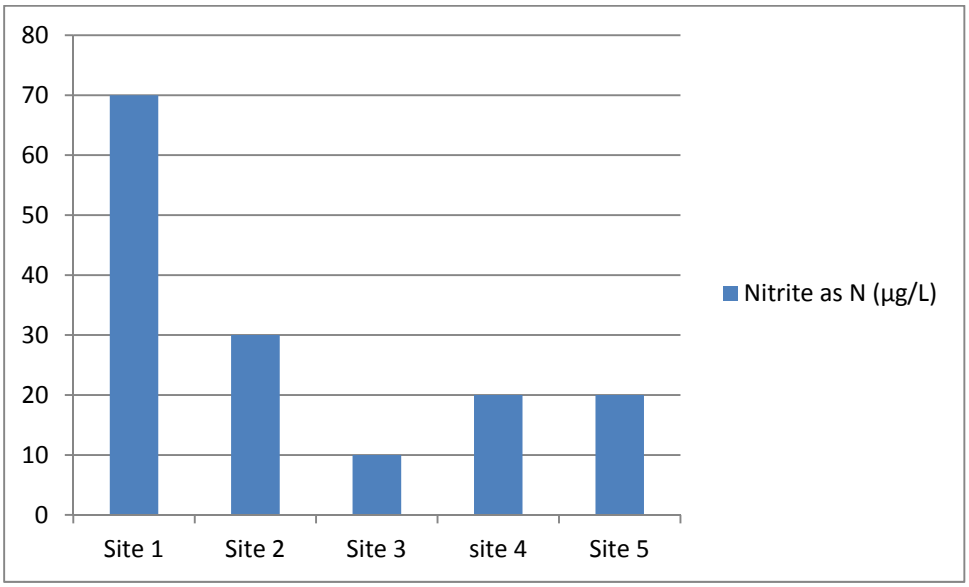


Nitrite

Nitrite concentrations in water collected from the five sampling sites ranged from <10 to 70 µg/L (*Figure 5.12*). The highest nitrite concentration was reported for the water sample collected from the reference site (Site 1) which was more than double the concentrations measured at all other sites. Assuming the concentration at Site 1 is close to background, these results indicate that there is no nitrite contamination evident at the sampling sites at the time of sampling.

ANZECC (2000) does not specify trigger values for nitrite.

Figure 5.12 Nitrite Concentrations at each Water Quality Sampling Site, June 2012



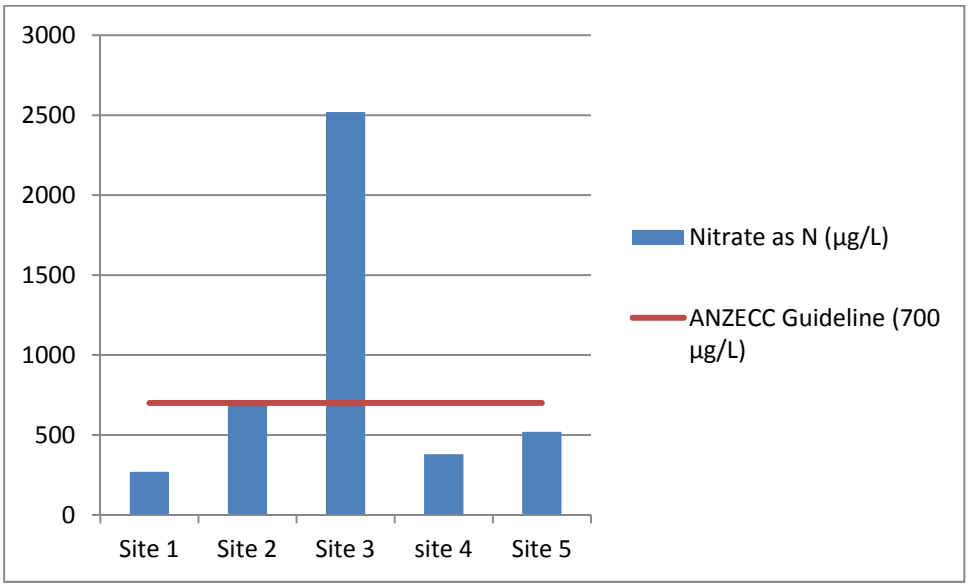
Nitrate

Nitrate concentrations in water collected from the five sampling sites ranged from 270 to 2,520 µg/L (*Figure 5.13*). The highest nitrate concentration was reported for the water sample collected at Site 3 which was 1,800 µg/L or 257% higher than the next highest concentration (Site 2). This significantly higher nitrate concentration at Site 3 indicates a strong signature of nitrate contamination at that site. Interestingly, Site 3 is furthest away from the Project site and its location may suggest cumulative impacts from several upstream sources. However, the high nitrate content does indicate potential impacts from a nitrate source.

Nitrate concentration was lowest at the reference site (Site 1) which is likely to indicate natural background levels for the local area, and nitrate concentrations at the other sampling sites vary between 380 and 705 µg/L which are between 140% and 260% higher than the reference site. These results do indicate a distinct elevation of nitrates in surface waters adjacent to the Project site.

Nitrate concentrations at Sites 4 and 5 are below the 700 µg/L ANZECC (2000) guideline trigger value for the protection of 95% of freshwater species (for slightly - moderately disturbed systems), as shown in (*Figure 5.13*) and the nitrate concentration at Site 2 (mean of two samples) is marginally above the ANZECC trigger value.

Figure 5.13 Nitrate Concentrations at each Water Quality Sampling Site, June 2012



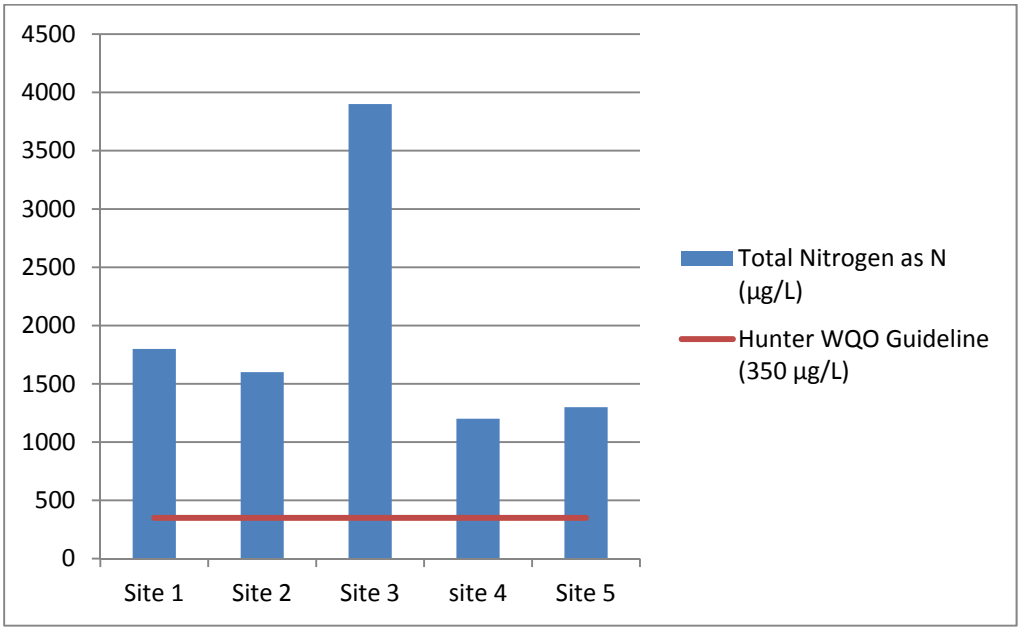
Total Nitrogen

Total nitrogen concentrations in water collected from the five sampling sites ranged from 1,200 to 3,900 µg/L (*Figure 5.14*). The highest total nitrogen concentration was reported for the water sample collected at Site 3 which was higher than the next highest concentration (Site 1) by 2,100 µg/L (or 117%).

Total nitrogen is the sum of all nitrogen products, including ammonia, nitrite and nitrate, so it is not surprising that the trend in total nitrogen concentrations often reflects any significantly high concentrations of any of the other nitrogen compounds. In this case, the high nitrate concentration evident at Site 3 adds significantly to the total nitrogen concentration at that site.

The ANZECC (2000) default trigger level for total nitrogen in slightly disturbed lowland river ecosystems is 500 µg/L and the trigger value specified under the Hunter River water quality objectives is 350 µg/L. All total nitrogen concentrations from the survey area are well above both these trigger values and therefore the local aquatic environment would appear to have a significantly higher total nitrogen loading than expected.

Figure 5.14 ***Total Nitrogen Concentrations at each Water Quality Sampling Site, June 2012***

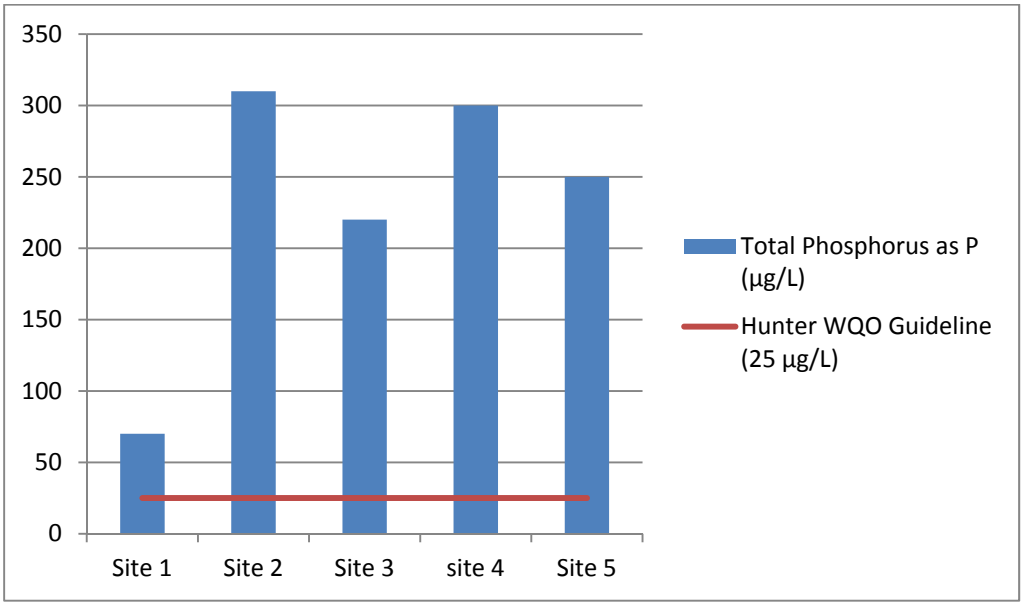


Total Phosphorus

Total phosphorus concentrations in water collected from the five sampling sites ranged from 70 to 310 µg/L (*Figure 5.15*). The highest total phosphorus concentration was reported for the water sample collected at Site 2 (mean of two samples). Compared to the total phosphorus concentration at the reference site, total phosphorus concentrations at all other sites were between 214% and 440% higher which indicates possible phosphorus contamination of the surface waters adjacent to the Project site.

The ANZECC (2000) default trigger level for total phosphorus in slightly disturbed lowland river ecosystems is 50 µg/L and the trigger value specified under the Hunter River water quality objectives is 25 µg/L. All total phosphorus concentrations from the survey area are well above both these trigger values and therefore the local aquatic environment would appear to have a significantly higher total phosphorus loading than expected.

Figure 5.15 ***Total Phosphorus Concentrations at each Water Quality Sampling Site, June 2012***



5.2.6 Aquatic Macroinvertebrates

Assessment of macroinvertebrates in a waterway can provide an indication of water quality. Different macroinvertebrates have different tolerances to pollution and diversity of macroinvertebrates is also an indicator ecosystem health.

The range of macroinvertebrates recorded during the field surveys are listed in *Table 5.7*.

Table 5.7 ***Aquatic Macroinvertebrates Recorded in the Study Area, June 2012***

Common Name [1]	*Order*	Sub Order	Family
Water Boatmen	*Hemiptera*	*Heteroptera*	*Corixidae*
Water Flea	*Cladocera*		
Freshwater Mite	*Acarina*		
Non-biting Midges	*Diptera*		*Chironomidae*
Diving Beetle	*Coleoptera*	*Dytiscidae*	
Dragonfly	*Odonata*	*Epiproctophora*	
Damselfly 1	*Odonata*	*Zygoptera*	*Coenagrionidae*
Damselfly 2	*Odonata*	*Zygoptera*	*Synlestidae*
Snail	*Gastropoda*		*Planorbidae*
Mosquito	*Diptera*	*Nematocera*	*Culicidae*
Flatworm (*Platyhelminthes*)			

1. Naming in accordance with Gooderham & Tsyrlin (2005)

The abundance of aquatic macroinvertebrates varied between the different species at the sampling sites (*Table 5.7*). The most abundant macroinvertebrates were water fleas (Order Cladocera), water boatmen (Family Corixidae), non-biting midges (Family Chironomidae) and freshwater mites (Order Acarina), with only a few individuals of the other seven invertebrate groups.

Table 5.8 Abundance of Aquatic Macroinvertebrates Recorded at each Site in the Study Area, June 2012

Common Name	Site 1	Site 2	Site 3	Site 4	Site 5
Water Boatmen	100	>500	ns [1]	>300	>400
Water Flea	>1000	50	ns	>1000	>1000
Freshwater Mite	20	40	ns	>400	70
Non-biting Midges	20	>1000	ns	20	>250
Diving Beetle	2	0	ns	0	0
Dragonfly	0	0	ns	1	0
Damselfly 1	1	4	ns	8	8
Damselfly 2	0	0	ns	1	0
Snail	0	0	ns	1	0
Mosquito	0	0	ns	1	0
Flatworm (*Platyhelminthes*)	0	1	ns	0	1

1. ns = not sampled

SIGNAL 2 (Chessman 2003) is a simple scoring system for macroinvertebrate sampling in Australian rivers. Combining SIGNAL score calculations and consideration of diversity can give an indication of water quality and levels of pollution in a river system. The applicability of SIGNAL 2 to wetlands has not been tested and most of the macroinvertebrate orders that have the highest SIGNAL 2 sensitivity grades are naturally rare in wetlands such as stoneflies and mayflies and as such wetlands are likely to have naturally lower scores than streams in the same region. Therefore, SIGNAL 2 calculations were not undertaken for this assessment however grades for each macroinvertebrate group were recorded to help develop an understanding of the sensitivity of the species which were recorded in the Study Area.

Macroinvertebrates are rated according to their sensitivity to pollution. Pollution rating numbers from 1 to 10 are assigned to different groups based on their sensitivity.

There are four grades within the rating system:

- Very sensitive – 9-10;
- Sensitive – 6-8;
- Tolerant – 3-5; and
- Very tolerant – 1-2.

Macroinvertebrates recorded in the survey and their SIGNAL 2 ratings are shown in

Table 5.9.

Table 5.9 Macroinvertebrates Recorded in the Study Area and SIGNAL 2 Rating

Site	Common Name	*Order*	*Sub Order*	*Family*	SIGNAL 2 Grade
4	Damselfly	*Odonata*	*Zygoptera*	*Synlestidae*	7
1,2,4,5	Freshwater Mite	*Acarina*			6
4	Dragonfly	*Odonata*	*Epiproctophora*		3
1,2,4,5	Non-biting Midges	*Diptera*		*Chironomidae*	3
1,2,4,5	Damselfly	*Odonata*	*Zygoptera*	*Coenagrionidae*	2
1,2,4,5	Water Boatmen	*Hemiptera*	*Heteroptera*	*Corixidae*	2
1	Diving Beetle	*Coleoptera*		*Dytiscidae*	2
4	Snail	*Gastropoda*		*Planorbidae*	2
4	Mosquito	*Diptera*	*Nematocera*	*Culicidae*	1
1,2,4,5	Water Flea	*Cladocera*			NR
2,5	Flatworm (Platyhelminthes)				NR

1. SIGNAL 2 Grade – Chessman 2003.
2. NR = not rated.

Two macroinvertebrates recorded (freshwater mite and a damselfly (Synlestidae)) are included in the sensitive category. The freshwater mite species was recorded at all sites and in reasonable abundance, while the Synlestid damselfly was recorded as one individual only at site 4. These results indicate that the water quality in the Study Area is of sufficient quality to support sensitive species. Diversity of macroinvertebrates at all sites was generally quite low (11 different macroinvertebrates in total), this may reflect the time of year that the aquatic samples were undertaken (winter) and or a result of the uniform habitat of the sampling sites which were all dominated by dense *Panicum repens*.

5.2.7 Macrophytes

Macrophytes were surveyed at the five aquatic sampling locations. Species recorded at each site are shown in *Table 5.10* below.

Table 5.10 Macrophytes Recorded at Each Water Sampling Location

Species	Common Name	Site 1	Site 2	Site 3	Site 4	Site 5
*Panicum repens**		E	E	-	E	E
Typha orientalis	Broad-leaf Cumbungi	-	-	E	-	-
Phragmites australis	Common Reed	E	-	E	-	-
Azolla filiculoides		-	F	-	F	F
Spirodela sp.	Duckweed	-	F	F	F	F

1. F = floating; E = emergent.

Panicum repens was dominant at all sites with the exception of Site 3 which was located in a dense reed swamp and not adjacent to open water; at this site Broad-leaf Cumbungi was dominant. Duckweed and *Azolla filiculoides* are abundant among mats of *Panicum repens* adjacent to open water areas of the 2HD Swamp No submerged macrophytes were recorded during the sweep surveys for macroinvertebrates.

6 CONCLUSION

As the Crawfords property is located in the Hunter River Floodplain, it is suggested that flood mitigation is incorporated in any proposal. This would help safeguard the surrounding environment from the impacts if a flood event occurred at the property. In addition, improving run-off control measures and sediment capture techniques will reduce inflow of pollutants from the site to the wetland areas as a result of rainfall events.

6.1 GREEN AND GOLDEN BELL FROG

The Green and Golden Bell Frog was not recorded in the Study Area during this study. It is possible the species may no longer be extant in the 2HD swamp complex as the species has not been recorded there for over eight years and Mosquitofish (a known predator) are abundant at the site. Surveys coinciding with confirmed calling at nearby reference sites would improve confidence on this conclusion. The continuing operation of Crawfords business activities on the site is not considered likely to impact quality of habitat for the Green and Golden Bell Frog in the adjacent wetland areas beyond impacts which have already occurred associated with storage of ammonium nitrate and other fertilisers and chemicals on the site for a number of years.

6.2 THREATENED SPECIES

Wetland habitats surrounding the Crawfords property provide potential habitat for a number of threatened species, including the Magpie Goose and Black-necked Stork which were both recorded during the field surveys. Suitable habitat for other threatened bird species including the Australasian Bittern, Black Bittern (I*xobrychus flavicollis*), Latham's Snipe and Australian Painted Snipe. The continuation of activities on the Crawfords property is unlikely to significantly impact these habitat areas. All activities are restricted to already developed industrial land and the adjacent wetland habitats which provide habitat for threatened species will not be cleared.

6.3 GROUNDWATER DEPENDENT ECOSYSTEMS

The Crawfords property is generally surrounded by wetland GDEs, particularly the Typha/Phragmites Reedswamp to the north and 2HD swamp to the east. Northwest of the Crawfords property on the western side of the rail corridor a large stand of Swamp Oak Floodplain Forest, which is likely to classify as Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC, also occurs. Operations involving the storage of ammonium nitrate on the Crawfords property have been undertaken for approximately 10 years.

This study did not record any evidence that the operations are having a significant adverse impact on these communities.

The opening of the Hexham floodgates is reintroducing more saline water into the lowest lying wetland areas surrounding the site (HCRCMA 2012). Some areas of Swamp Oak forest, north of the Study Area near Ironbark Creek and west of the Study Area just north of the old Astra Street landfill site, appear to be dying back possibly as a result of this increased salinity. Over time it is possible that saline influence will spread further and result in more significant changes to the freshwater wetlands of the Study Area and surrounds.

6.4 WATER QUALITY

The assessment of surface water quality at sites adjacent to the Crawfords site identified elevated concentrations of nitrates and total phosphorus in 2HD Swamp and at a location downstream from the swamp (north-west of the Crawford's site). In the absence of true pre-development baseline data, the water quality in 2HD Swamp was compared to water quality at a ponded area upstream of the Crawford's site, nominated as a reference site that approximated the environment of 2HD Swamp.

In-situ water quality was relatively similar between the reference site and all other sampling sites, with the exception of pH which was markedly higher at the 2HD sites indicating alkaline waters of the swamp (and downstream). Dissolved oxygen was lowest at Site 3 which probably reflects the stagnant, vegetation-choked nature of the site.

Nitrate concentrations in water samples from 2HD Swamp and downstream of 2HD Swamp (Site 3), were between 140 and 260% higher than at the reference site, which indicates a significant elevation of nitrate in surface waters adjacent to the Crawford's site. Interestingly, the highest nitrate concentration was reported at Site 3 which is furthest from the Crawford's site but is downstream of several industrial activities. Nitrate concentration at Site 3 was well above the ANZECC (2000) guideline trigger value for the protection of 95% of freshwater species (for slightly - moderately disturbed systems) and nitrate concentration at Site 2 (immediately adjacent to the Crawford's site) was marginally above the ANZECC trigger value.

Total phosphorus concentrations in water samples from 2HD Swamp and downstream of the swamp (Site 3) were between 214% and 440% higher than at the reference site, which indicates possible phosphorus contamination of the surface waters adjacent to the Crawford site. Interestingly, total phosphorus concentrations at all sites, including the reference site, were above both the ANZECC (2000) default trigger level for slightly disturbed lowland river ecosystems and the Hunter River water quality objectives but nonetheless, total phosphorus concentrations were significantly higher in 2HD Swamp (and downstream) compared to the reference site.

6.5 AQUATIC ECOLOGY

A total of 11 different macroinvertebrates were recorded from four sampling locations. Analysis of the sensitivity of the macroinvertebrates recorded using SIGNAL 2 ratings indicated that two types of sensitive macroinvertebrates were recorded in relatively high abundances. This result suggests that water quality in the wetlands of the Study Area is sufficient to support these species. The majority of macroinvertebrates recorded however are from groups considered tolerant or very tolerant to low water quality and pollutants.

A low diversity of macrophytes was recorded in the Study Area; this may be associated with the occurrence of *Panicum repens* which dominates almost all vegetated areas adjacent to open water. This exotic species may be outcompeting native macrophytes.

2HD Swamp is an artificial aquatic ecosystem and is unlikely to function as a natural ecosystem in terms of water flows, water quality and the availability of a range of aquatic habitats. In addition, the swamp supports a variety of introduced species including aquatic fauna (eg Mosquitofish) and a variety of weed species that are widespread in and around the swamp.

6.6 SUMMARY

The Crawfords operation is generally surrounded by wetland habitats which although disturbed, provide known and potential habitat for threatened fauna species. The proposed development is a continuation of existing activities on the industrial site. Impacts associated with weeds and water quality were recorded in the surrounding habitats, however continuing current operations is not expected to significantly impact features of ecological significance.

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Annex A

EPBC Protected Matters Search Tool Results

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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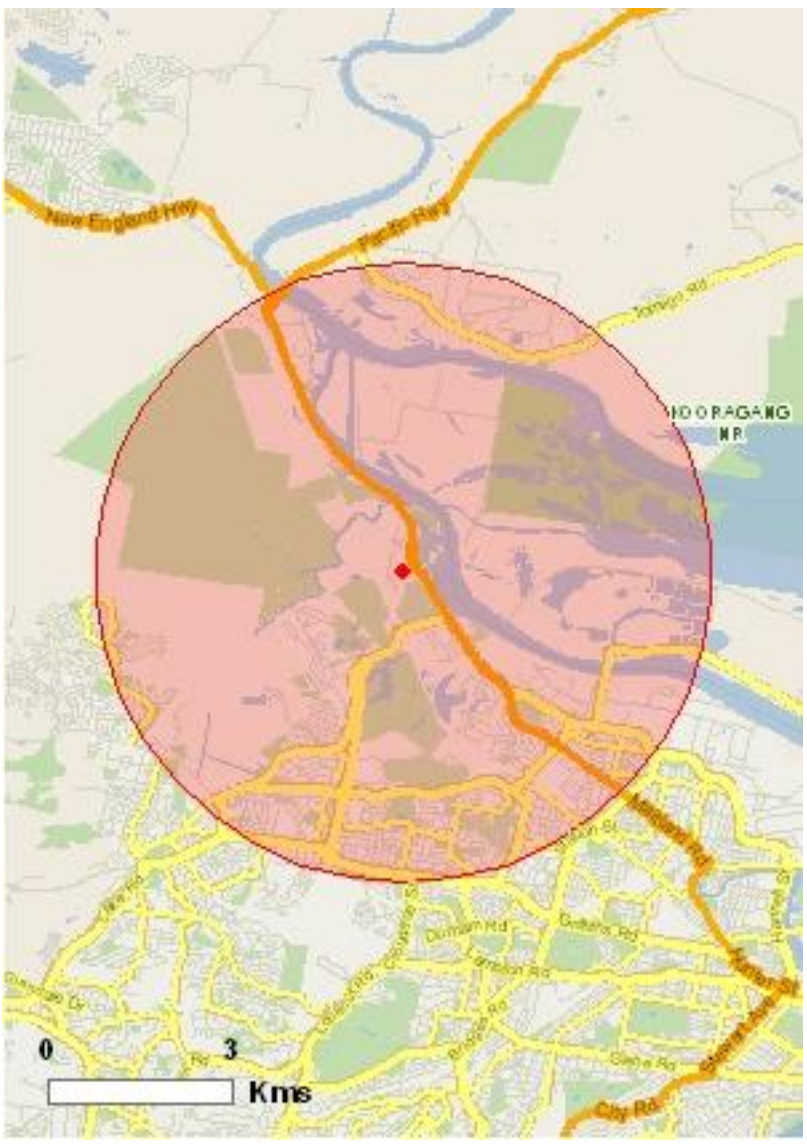
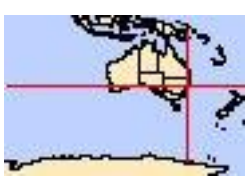


This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 5.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	1
Threatened Species:	24
Migratory Species:	40

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	7
Commonwealth Heritage Places:	None
Listed Marine Species:	44
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

Place on the RNE:	2
State and Territory Reserves:	1
Regional Forest Agreements:	1
Invasive Species:	15
Nationally Important Wetlands:	3

Details

Matters of National Environmental Significance

Wetlands of International Significance (RAMSAR)	[Resource Information]
Name	Proximity
Hunter estuary wetlands	Within Ramsar site

Threatened Ecological Communities	[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
White Box-Yellow Box-Blakely's Red Gum Grassy	Critically Endangered	Community may occur

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Woodland and Derived Native Grassland		within area

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
Anthochaera phrygia		
Regent Honeyeater [82338]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Dasyornis brachypterus		
Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Lathamus discolor		
Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Vulnerable	Species or species habitat likely to occur within area
Sternula nereis nereis		
Fairy Tern (Australian) [82950]	Vulnerable	Species or species habitat may occur within area
FISH		
Epinephelus daemelii		
Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
FROGS		
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Litoria littlejohni		
Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
MAMMALS		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys novaehollandiae		
New Holland Mouse [96]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
[Pteropus poliocephalus](#)		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
PLANTS		
[Allocasuarina defungens](#)		
Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat likely to occur within area
[Melaleuca biconvexa](#)		
Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area
[Pterostylis gibbosa](#)		
Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area
[Tetratheca juncea](#)		
Black-eyed Susan [21407]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
[Caretta caretta](#)		
Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
[Chelonia mydas](#)		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
[Dermochelys coriacea](#)		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
[Eretmochelys imbricata](#)		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area

Migratory Species	[Resource Information]	
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#)		
Fork-tailed Swift [678]		Species or species habitat may occur within area
[Ardea alba](#)		
Great Egret, White Egret [59541]		Breeding likely to occur within area
[Ardea ibis](#)		
Cattle Egret [59542]		Breeding likely to occur within area
Migratory Marine Species		
[Caretta caretta](#)		
Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
[Chelonia mydas](#)		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
[Dermochelys coriacea](#)		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
[Eretmochelys imbricata](#)		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area
[Lamna nasus](#)		
Porbeagle, Mackerel Shark [83288]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Terrestrial Species		
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus](#) White-throated Needletail [682]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Breeding likely to occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Breeding may occur within area
[Xanthomyza phrygia](#) Regent Honeyeater [430]	Endangered*	Species or species habitat likely to occur within area
Migratory Wetlands Species		
[Actitis hypoleucos](#) Common Sandpiper [59309]		Roosting known to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Breeding likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Breeding likely to occur within area
[Arenaria interpres](#) Ruddy Turnstone [872]		Roosting known to occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Roosting known to occur within area
[Calidris canutus](#) Red Knot, Knot [855]		Roosting known to occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]		Roosting known to occur within area
[Calidris ruficollis](#) Red-necked Stint [860]		Roosting known to occur within area
[Calidris tenuirostris](#) Great Knot [862]		Roosting known to occur within area
[Charadrius bicinctus](#) Double-banded Plover [895]		Roosting known to occur within area
[Charadrius leschenaultii](#) Greater Sand Plover, Large Sand Plover [877]		Roosting known to occur within area
[Charadrius mongolus](#) Lesser Sand Plover, Mongolian Plover [879]		Roosting known to occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
[Heteroscelus brevipes](#) Grey-tailed Tattler [59311]		Roosting known to occur within area

Name	Threatened	Type of Presence
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Roosting known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew [847]		Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of War Service Homes

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Roosting known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding likely to occur within area
Ardea ibis Cattle Egret [59542]		Breeding likely to occur within area

Name	Threatened	Type of Presence
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]		Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]		Roosting known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Roosting known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]		Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]		Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Roosting known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding likely to occur within area
Numenius madagascariensis Eastern Curlew [847]		Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Breeding may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area

Extra Information

Places on the RNE	[Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status

Name	State	Status
Natural		
Hunter Estuary Wetlands	NSW	Registered
Historic		
Tomago House Chapel	NSW	Registered

State and Territory Reserves [Resource Information]

Name	State
Hunter Wetlands	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit,

Name	Status	Type of Presence
Frogs		
Bufo marinus Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Hexham Swamp	NSW
Kooragang Nature Reserve	NSW
Shortland Wetlands Centre	NSW

Coordinates

-32.86436 151.70351

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales

-Department of Sustainability and Environment, Victoria

-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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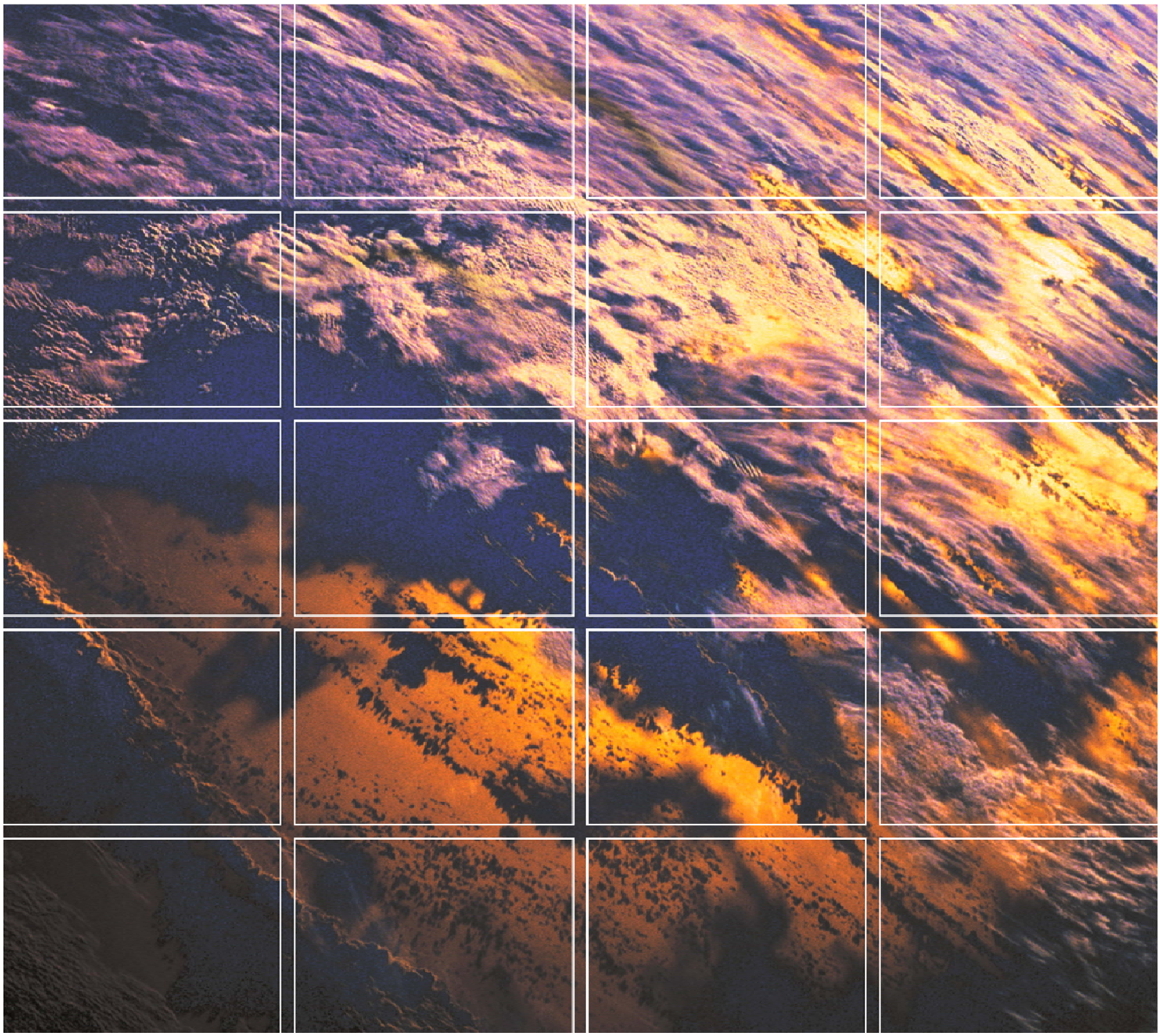
Annex H

Greenhouse Gas Assessment



Ammonium Nitrate Storage and Distribution Facility

Greenhouse Gas Emissions Assessment

For Crawfords Freightlines Pty Ltd

July 2012

0143175

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ERM

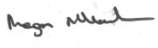
Delivering sustainable solutions in a more competitive world

Ammonium Nitrate Storage and Distribution Facility

Greenhouse Gas Emissions Assessment

Crawfords Freightlines Pty Ltd

July 2012

Approved by:	*Megan McLachlan*
Position:	Project Manager
Signed:	
Date:	*5 July 2012*
Approved by:	*Steve O'Connor*
Position:	Partner Director
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Date:	*5 July 2012*

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FINAL REPORT

Crawfords Freightlines Pty Ltd

Ammonium Nitrate Storage and Distribution Facility *Greenhouse Gas Emissions Assessment*

July 2012

Reference: 0143175rp1

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) has been commissioned by Crawfords Freightlines Pty Ltd (Crawfords) to prepare a Greenhouse Gas Emissions (GHG) Assessment for their ammonium nitrate storage and distribution operation in Sandgate, NSW.

The site receives shipments of ammonium nitrate chemical in sealed containers by rail from Sydney and in 1.2-1.25 tonne bulka bags brought to the site by truck from the Port of Newcastle or from Orica, Kooragang Island. The site distributes this chemical via truck several times per day mainly to mine sites in the Hunter Valley. A maximum of 13,500 tonnes per annum is stored on site at any one time and an estimated 75,000 tonnes are handled through the site per annum.

Total greenhouse gas emissions (Scope 1, 2 and 3) for a single year of operations have been estimated at 7,606t CO_2-e.

Scope 1 and 2 greenhouse gas emissions (those under direct management control of the proposed development) are estimated at 7,003t CO_2-e/ annum.

Total lifetime emissions (Scope 1 and 2), based on a nominal 25 year operating period, are estimated at 175,075t CO_2-e.

Comparison to the Australia's National Greenhouse Accounts, 2010 report indicates emissions from the development (Scope 1 and 2) represent approximately 0.0044% of the reported total annual NSW emissions and 0.0012% of the total annual national emissions reported in 2010. Comparison to the transport sector fuel usage emissions (Scope 1) indicates the development contributes approximately 0.034% to the reported total annual NSW emissions.

The main contribution of emissions was identified to be from the transport of product to and from the site, therefore a number of mitigation measures were proposed aimed at this component of site operations to reduce the GHG intensity of the development.

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) has been commissioned by Crawfords Freightlines Pty Ltd (Crawfords) to prepare a Greenhouse Gas Emissions (GHG) Assessment for their ammonium nitrate storage and distribution operation in Sandgate, NSW ('the site'). The site is located in the part industrial and residential locality of Sandgate approximately 9.8km northwest of the Newcastle CBD, within the Newcastle City Council (NCC) Local Government Area (LGA) in the Hunter region of New South Wales (NSW).

The site receives shipments of ammonium nitrate chemical in sealed containers by rail from Sydney and in 1.2-1.25 tonne bulka bags brought to the site by truck from the Port of Newcastle or from Orica, Kooragang Island. The site distributes this chemical via truck several times per day mainly to mine sites in the Hunter Valley. A maximum of 13,500 tonnes per annum is stored on site at any one time and an estimated 75,000 tonnes are handled through the site per annum.

1.2 SCOPE OF WORKS

ERM undertook the following scope of work to complete the GHG assessment in line with the Director General's Requirements (DGRs) issued in relation to an environmental impact statement (EIS) which is required in support of proposed development:

- define the energy and GHG boundary of the facility to ensure that all activities that are part of the operations, which is the subject of the approval, are included;
- review each of the key process steps undertaken at the facility and identify the predicted GHG emissions likely to be generated for each year of operations. Emissions are broken down into the following:
  - direct (scope 1 as defined by the Greenhouse Gas Protocol);
  - indirect (scope 2); and
  - upstream and downstream emissions (scope 3) GHG emissions;
- estimate the volume of emissions likely to be generated from the facility and also from each emission source;

- provide a breakdown of emissions on a:
    - tonnes per unit production basis;
    - total annual emissions basis; and
    - total project lifetime basis;
- evaluate and report on the feasibility of measures to reduce emissions associated with the project.

2 ASSESSMENT METHODOLOGY

The GHG assessment was prepared in accordance with the general principles of:

- the recognised international standard – The *Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard* developed by the World Business Council for Sustainable Development (GHG Protocol);
- the Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts (NGA) Factors 2011* ; and
- the DCCEE *National Greenhouse and Energy Reporting (Measurement) 2008 (the Determination).*

These reference documents are those required to be used for calculating GHG emissions and energy data under the *National Greenhouse and Energy Reporting (NGER) Act 2007* and represent best practice in Australia.

2.1.1 Emission Scopes

Emissions of GHGs from the development can be categorised as 'direct' and 'indirect' emissions.

The National Greenhouse Account (NGA) Factors 2011 adopt the emissions categories of the international reporting framework of GHG Protocol. These emission categories are as follows:

- *Scope 1* - covers direct emissions from sources within the boundary of an organisation such as fuel combustion;
- *Scope 2* - covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another facility. Scope 2 emissions result from the combustion of fuel to generate the electricity, steam or heat and do not include emissions associated with the production of the fuel. Scopes 1 and 2 are carefully defined to ensure that two or more organisations do not report the same emissions in the same scope; and
- *Scope 3* - includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned, or controlled, by the organisation (i.e. produced by third-party organisations outside of the proposed development).

2.1.2 *Boundary of Assessment*

The boundary for this GHG assessment has been defined as those emissions directly attributable to the operational activities at the 'site'. Emissions from construction activities were not considered as part of this assessment as the site is currently leased by the proponent and the construction of the site was completed in the 1990's. In addition, emissions from this source are considered to be insignificant in terms of the overall operational emissions.

The largest source of Scope 1 or, direct emissions for the proposed development, are emissions associated with diesel and petrol use in on-site plant and vehicles and the trucks used to transport product to and from the site.

Scope 2 emissions result from electricity consumption for on-site activities including machinery, ancillary plant and administration facilities.

In addition to Scope 1 and Scope 2 emissions, this assessment has also considered any significant (upstream and downstream) indirect Scope 3 emissions associated with the development as required by the DGR's. Potential Scope 3 emissions included within the boundary of this assessment are those related to transport of the ammonium nitrate to the site and transport of the ammonium nitrate to their final destination. The transport to and from the site of the ammonium product is primarily via Crawford Freightlines trucks, which are covered under Scope 2 emissions. Approximately 8 tonnes of ammonium nitrate is transported to the site by rail from Sydney weekly and therefore is included as a Scope 3 emission within the boundary of this assessment. The reason this has been included is because it is considered the development has some level of control (albeit limited) over the transport distances of the product, primarily through the selection of transport type. Other Scope 3 emissions related to embodied energy of the ammonium nitrate raw materials were excluded as the development has no control over the emissions associated with the production of these materials.

Total project lifetime emissions were based on a nominal operating period of 25 years. However, it is noted that the proposed development is not an extractive industry and thus not subject to a known quantity of resource and therefore it is difficult to determine an exact end point to production. Similarly, it is difficult to anticipate fluctuations in demand for ammonium nitrate overtime. Therefore as a conservative (worst case scenario) approach, it is assumed that the development operates at 75,000 tpa for a nominal 25 year period.

2.1.3 *Data Collection and Calculation Procedures*

Baseline energy consumption data was sourced from the 2011 usage information supplied by the client. This data was used to calculate Scope 1 and 2 emissions using relevant emission factors from the NGA Factors 2011.

This approach was taken with the assumption that there will be a consistency of operations, machinery and fuel used for all years of operation.

Energy consumption associated with fuel used for transportation of ammonium nitrate to the site by train from Sydney was calculated from the average weekly tonnages transported to the site as well as the approximate haulage distance. This data was used to calculate Scope 3 emissions using typical diesel consumption rates for rail freight (168.159km/litre (tonnes)) taken from *Association of American Railroads USA 2007* and applying relevant emission factors from NGA Factors 2011.

Estimates with high accuracy were used wherever possible to calculate GHG emissions. For example, electricity consumption estimates can be multiplied by the NGA emission factors to calculate GHG emissions with a high degree of accuracy. When data was unavailable, assumptions and approximations were made in order to obtain a reasonable estimate. Recognised international standards, such as the World Business Council *Greenhouse Gas Protocol (2004),* were used to assist in these estimations whenever appropriate.

Emission factors that are used in the greenhouse footprint calculations are outlined in *Annex A.*

All energy consumption and emissions data has been converted into quantities of carbon dioxide equivalent (CO_2-e), as shown in *Annex A*. The emission values have been summed to reach an estimate of the total annual GHG emissions.

2.1.4 Exclusions and Assumptions

The life cycle stages, emissions sources and energy consumption that have been omitted from the study are identified below:

- emissions associated with construction activities. This is due to the site being leased by the proponent and construction being completed before the proponent occupied the site. In addition, the construction period would have been short in duration and emissions associated with the activities involved are considered to be insignificant compared to operational emissions;

- emissions associated with decommissioning of the facilities, including the end of life disposal and vehicles and machinery required for decommissioning. Emissions associated with decommissioning of the facility are considered to be a very small proportion of the annual operating emissions;

- emissions associated with support services for the facility including off-site office activities, marketing and promotional materials, staff business travel and/or visitors travelling to and from the site by any means of transport;

- emissions associated with the production of ammonium nitrate as this does not take place on-site and was considered outside the scope of Scope 3 emissions for the proposed development; and

- fugitive emissions of refrigerants from refrigeration and air conditioning systems. These are negligible compared to emissions from other sources.

The materiality of the omitted emission sources is difficult to accurately establish. However, these emissions are unlikely to be significant compared to the major direct operational emission sources, such as fuel use and electricity consumption on-site. The discrepancies in the total emissions inventory due to the exclusions and limitations of the assessment are therefore anticipated to be non-material.

Table 2.1 summarises the GHG emission sources included and excluded in this assessment.

Table 2.1 Greenhouse Gas Emission Sources Included and Excluded in this Assessment

	Scope 1 – Direct Emissions	**Scope 2 –Indirect Emissions from Purchased Energy**	**Scope 3 – Other Indirect Emissions**
Emission Sources Included	Fuel use on-site for operational activities (i.e. diesel, LPG and petrol used in mobile plant, vehicles and other equipment on site). Fuel usage of trucks used to transport ammonium nitrate to and from the site	Electricity usage on-site for operational activities (i.e. machinery, ancillary plant and administration facilities).	Transport of ammonium nitrate to site by freight train.
Emission Sources Excluded	Fuel use on-site for construction activities (i.e. diesel and petrol used in mobile plant to erect sheds) Fuel used for decommissioning of the facilities, including the end of life disposal and vehicles and machinery required for decommissioning.	Electricity usage on site for construction activities (i.e. electric tools used to erect sheds.) Electricity usage for decommissioning of the facilities.	Embodied energy of ammonium nitrate. Emissions associated with support services for the facility (i.e. marketing and promotional materials, staff business travel and/or visitors travelling to and from the site by any means of transport). Fugitive emissions of refrigerants from refrigeration and air conditioning systems.

Of the emissions sources identified in *Table 2.1* it is important to note that Scope 1 and 2 sources are those under direct management control of the proponent. That is, site management can implement measures which will directly affect emissions associated with these sources - in the case of electricity usage, through reducing consumption.

Scope 3 sources are not under direct management control and therefore the opportunity to reduce emissions from these sources is less direct.

3 GREENHOUSE GAS EMISSIONS ESTIMATION RESULTS

*Table 3.1*provides details on the annual Scope 1 emission estimates for the project

Table 3.1 Annual Scope 1 Source Emission Estimates

Source	Assumed Consumption (kL/annum)[1]	Assumed Consumption (GJ/annum)[2]	Scope 1 Emission Factor (kg CO2-e/GJ)[3]	Estimated Emissions (t CO_2-e)
Diesel Consumption from transfer of materials to and from the site (transport)	2,520.00	97,272.00	69.20	6,799.31
Petrol Consumption from on-site operational activities (transport)	12.50	427.50	69.20	29.75
			Total	**6,829.06**

1- Assumed consumption calculated on consumption figures supplied by client
2- Calculated based on relevant Energy Content Factor taken from '*NGA Factors, July 2011'*
3- Scope 1 emission factors taken from relevant tables in '*NGA Factors, July 2011''*.

As highlighted in *Table 3.1,* emissions associated with consumption of Diesel for transport of ammonium nitrate to and from the site represent the largest source of Scope 1 emissions from the site operations.

Table 3.2 details the emission estimates for Scope 2 sources.

Table 3.2 Annual Scope 2 Source Emission Estimates

Source	Consumption (kWh/annum)[1]	Emission Factor (kg $CO_{2\text{-}e}$/kWh)[2]	Estimated Emissions (t CO_2.e/ annum)
Energy from consumption of grid electricity.	195,000	0.89	173.55
		Total	**173.55**

1. Consumption calculated on 2011 consumption figure supplied by client
2. Current (2011) *Scope 2* NSW emission factor for consumption of purchased electricity from Table 5; '*NGA Factors, June 2011'*.

Table 3.3 details the emission estimates for Scope 3 sources.

Table 3.3 Annual Scope 3 Source Emission Estimates

Source	Activity Level[1]	Estimated Diesel Consumption (kL/annum)[2]	Total Energy Consumption (GJ)[3]	Emission Factor (kg/CO_2-e per GJ)[4]	Estimated Emissions (t CO_2-e /annum)
Transport of ammonium nitrate to site by rail (from Sydney Port)	155km journey to site – 8 tonnes per week. 50 deliveries / annum.	2.95	38.6	5.3	603.43
				Total	**603.43**

1. Journey distance was sourced from Transport for NSW website. Expected number and volume of deliveries provided by Crawfords Freightlines.
2. Calculated based on rate from *Association of American Railroads USA 2007.*
3. Based on Energy Content Factor for Transport Purposes taken from Table 4 of *NGAF, July 2011.*
4. Based on Scope 3 Emission Factors – liquid fuels and certain petroleum based products taken from Table 38 of *NGAF, July 2011.*

3.1.1 Summary of Emissions

Figure 3.1 illustrates the percentage contributions of annual Scope 1, 2 and 3 emissions sources for the proposed development.

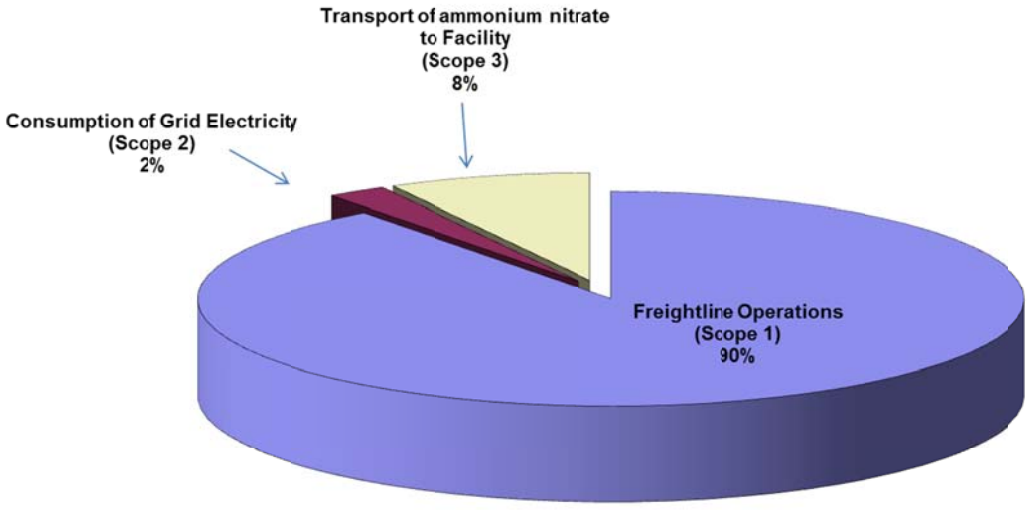

Figure 3.1 Greenhouse Emissions Sources – Scopes 1, 2 and 3

Scope 1 direct emissions associated with operational activities are estimated at 6,829t CO_2-e/annum, representing approximately 90% of annual emissions from the development. The majority of Scope 1 emissions are sourced from diesel usage by trucks used to transport ammonium nitrate to and from the site.

Scope 2 emissions associated with consumption of grid electricity are estimated at 174t CO_2-e/annum, representing approximately 2%of overall annual emissions.

Scope 3 emissions associated with transportation of raw material to the site (upstream) via rail are estimated at approximately 603t CO_2-e/annum. This equates to approximately 8% of the annual greenhouse gas emissions associated with the development.

Table 3.4 summarises the total estimated annual Scope 1, 2 and 3 emissions resulting from the proposed development.

Table 3.4 Summary of Annual Greenhouse Gas Emissions

Source	Estimated Total Annual Emissions (t CO_{2-e}/annum)
Scope 1	
Fuel used for transport purposes – i.e. diesel used for trucks and other mobile plant.	6,799
Fuel used for small vehicles	30
Total Scope 1	**6,829**
Scope 2	
Energy from consumption of grid electricity.	174
Total Scope 1 + 2	**7,003**
Scope 3	
Transport of ammonium nitrate by rail to site (from Sydney Port).	603
Total Scope 3	**603**
Annual Total for Scopes 1,2 and 3	**7,606**

3.2 *IMPACT ASSESSMENT*

Total greenhouse gas emissions (Scope 1, 2 and 3) for a single year of operations have been estimated at 7,606t CO_2-e.

Scope 1 and 2 greenhouse gas emissions (those under direct management control of the proposed development) are estimated at 7,003t CO_2-e/ annum, meaning that the greenhouse intensity of the development equates to approximately 0.093t CO_2-e for each tonne of ammonium nitrate transported through the site.

Total lifetime emissions (Scope 1 and 2), based on a nominal 25 year operating period, are estimated at 175,075t CO_2-e. Scope 3 (transportation) emissions are not included in the estimation as it is not known with any degree of certainty where the raw materials will be sourced from over the 25 year period.

3.2.1 *Comparison with National, NSW and Industry Emissions*

The Department of Climate Change and Energy Efficiency (DCCEE) publishes Australia's National Greenhouse Accounts, which outline Australia's GHG emissions as a nation, by state and by industry. *Table 3.5* below summarises the annual GHG emissions in comparison with the development emissions.

Table 3.5 Contribution to National and State Emissions 2010

Source	Emissions (t CO_2-e per annum)[1]
Project Scope 1 & 2 Emissions	7003
Project Scope 1 Emissions (fuel usage – transport)	6829
2010 Scope 1 & Scope 2 Emissions - National	560,773,280
2010 Scope 1 & Scope 2 Emissions - NSW	157,435,910
2010 Scope 1 Emissions (Transport Sector Fuel Usage) - National	71,474,970
2010 Scope 1 Emissions (Transport Sector Fuel Usage) - NSW	19,851,280

1. Source: *Australian Greenhouse Emissions Information System (AGEIS), 2010* the most recent reporting year Kyoto Protocol Accounting Framework)

Therefore, emissions from the development (Scope 1 and 2) represent approximately 0.0044% of the total annual NSW emissions and 0.0012% of the total annual national emissions. Comparison to the transport sector fuel usage emissions (Scope 1) indicates the development contributes approximately 0.034% to the total annual NSW emissions.

3.2.2 *Comparison with Similar Facilities*

Due to a lack of published data in Australia in regards to emissions intensity of transport facilities, a reliable comparison for the Crawford Freightlines site was unable to be made.

Usually rail freight is the least emission intensive transport mode compared to road transport. The emissions intensity for the various modes of transport are summarised in *Table 3.6* below:

Table 3.6 Emissions Intensity of Alternative Modes of Transport

Transport Mode	Emission Intensity (g/CO_2-e per tonne/km)[1]
Road Transport	
Light Commercial Vehicles	1294
Rigid Trucks	183
Articulated Trucks	60
Rail	
Government	20
Private	5.4
Coastal Shipping	13

1. Source: AGO, 2007 p 71.

3.3 MINIMISING ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

3.3.1 Reducing Direct Emissions

As the main contribution of emissions is from the transport of product to and from the site, reduction in emissions is best achieved by managing this component. The following mitigation measures have been identified as opportunities to reduce the greenhouse gas intensity of the development:

Maximising Vehicle Efficiency

- the efficiency of all upgraded mobile and fixed equipment be considered during procurement for fuel-powered equipment;
- investigate opportunities for low emission transportation of ammonium nitrate (i.e. utilise transport trucks that use biodiesel as opposed to regular diesel);
- investigate opportunities for using increased quantities of biodiesel in on-site plant;
- select vehicle size for purchase based on task i.e. larger vehicles generally have a lower emissions intensity than smaller vehicles;
- site management will ensure that equipment is maintained to retain energy efficiency;
- site management to check current vehicle fleet and consider the installation of aerodynamic features to reduce fuel consumption

Optimal freight loading

- minimise running of empty trucks where possible i.e. look at back loading vehicles
- optimise freight loads so that all trucks are full; and
- reduce packaging and packaging weight to maximise use of productive space and minimise waste i.e. bulk product in place of bulka bags.

Driving behaviour

- slow acceleration to the average driving speed
- selection of route to optimise driving at speeds that optimise fuel efficiency;
- driving at speeds that avoid the need for heavy braking;
- leaving adequate distance between vehicles to avoid the need for heavy braking; and
- using roads at times of least congestion to prevent idling time and stop/start driving; and
- minimise idling loses by turning vehicles off when not driving. Cab comfort can be maintained through the use of generators allowing engines to be switched off.

Other Mitigation Measures

Although electricity consumption contributed 2% to the final emissions, the following additional mitigation measures have been identified:

- energy audits be held when practicable to ensure that the site is using current practice techniques to minimise energy use and is operating at optimum energy levels; and
- investigate opportunities for purchasing part or all of electricity consumption from renewable sources.

4 CONCLUSION

This report has provided an assessment of the greenhouse gas impact from activities associated with the development. The impact assessment has presented estimates of direct emissions, and indirect emissions beyond the operational control of the development.

Total annual emissions have been calculated as being 7,606t CO_2–e / annum. Scope 1 and 2 emissions (those under direct control of the Proponent) are estimated to be approximately 7,003 tonnes CO_2-e / annum meaning that the greenhouse intensity of the proposed development will equate to approximately 0.093t CO_2-e for each tonne of material that passes through the site.

Scope 1 and 2 emissions from the development are anticipated to contribute approximately 0.0044 % of emissions to the NSW annual and 0.0012% of the total annual national emissions. Comparison to the transport sector fuel usage emissions (Scope 1) indicates the development contributes approximately 0.034% to the total annual NSW emissions.

Comparison to similar 'best practice' facilities was unable to be made, due to lack of published data in Australia.

A number of mitigation measures, some which will be investigated further and some that will be undertaken by site management have been recommended to reduce the greenhouse gas intensity of the development. Implementation of these measures will enable the development to reduce the greenhouse gas intensity of its operations beyond that presented in this assessment.

5 REFERENCES

Australian Greenhouse Office (AGO), Department of the Environment and Water Resources, 2007, *National Greenhouse Gas Inventory: Analysis of recent trends and greenhouse indicators 1990 to 2005,* p 71.

Department of Climate Change and Energy Efficiency (DCCEE) (2012), *Australian National Greenhouse Accounts: National Inventory by Economic Sector 2009/2010.*

Department of Climate Change and Energy Efficiency (DCCEE) (2009), *National Greenhouse Gas Inventory - Kyoto Protocol Accounting Framework: NSW 2009,* http://ageis.climatechange.gov.au/ Accessed 1 June 2012.

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World Business Council for Sustainable Development (WBCSD) (2004) *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard - Revised Edition*, WBCSD World Resources Institute, March 2004.

Annex A

Greenhouse Gas Emissions Inventory

Summary:

• This spreadsheet details the greenhouse gas emissions inventory for Crawford Frieghtlines Operations.

• Greenhouse gas emissions estimates are based upon an output of 200,000 tonnes per annum.

• Emissions estimates are provided for the following project components:

Expected Storage Capacity

13,500 tonnes/annum ammonium nitrate

Project Lifetime (Nominal)

25 years

Summary of Greenhouse Gas Emissions/Annum

Scope 1 - Direct Emissions

Greenhouse gas emissions from site operational activities (Table 1)	6,829	t CO_2-e/annum

Scope 2 - Electricity Consumption

Consumption of grid electricity per annum (Table 2)	174	t CO_2-e/annum

Scope 3 - Indirect Emissions

Emissions associated with transportation of raw materials to site	603	t CO_2-e/annum

Project Lifetime Emissions

Total Project Lifetime Emissions (Scope 1 and 2)	175,065	t CO2-e

Emissions Intensity

Freightline Operations (Scopes 1 & 2)	0.093	t CO_2-e/t precast item
Freightline Operations and Transportation (Scopes 1,2,3)	0.101	t CO_2-e/t precast item

Contribution to NSW Emissions

Percentage Contributin to NSW Emissions from Operations	0.0044	%

Version History

Date:	Filename:	Author	Description:	ERM Reviewer	Client Reviewer
1-Feb-12	0143175_GHG Inventory_v1.xls	Megan McLachlan	Original Inventory - Requires technical review.	Iain Cowan	-

Scope 1 - Emissions Inventory for Operational Emissions

TABLE 1. TOTAL ANNUAL EMISSIONS FROM OPERATIONAL ACTIVITIES

Source	Consumption per annum (kL/annum)	Energy Content Factor (GJ/kL)	Consumption (GJ annum)	Emission Factor (kg CO2/GJ)	Emission Factor (kg CO2-e/GJ) of CH4	Emission Factor (kg CO2-e/GJ) of N2O	Total Emissions tCO2/annum
LPG CONSUMPTION FROM OPERATIONAL ACTIVITIES (NON TRANSPORT)	0	34.4	-	59.6	0.1	0.2	-
DIESEL CONSUMPTION FROM OPERATIONAL ACTIVITIES (NON TRANSPORT)	0	38.6	-	69.2	0.1	0.2	-
DIESEL CONSUMPTION FROM OPERATIONAL ACTIVITIES (TRANSPORT)	2520	38.6	97,272.00	69.2	0.2	0.5	6,799.31
PETROL CONSUMPTION FROM OPERATIONAL ACTIVITIES (TRANSPORT)	12.5	34.2	427.50	66.7	0.6	2.3	29.75
ETHONAL (E10) CONSUMPTION FROM OPERATIONAL ACTIVITIES (TRANSPORT)	0	23.4	-	-	1.2	2.2	-
BIODIESEL CONSUMPTION FROM OPERATIONAL ACTIVITIES (TRANSPORT)	0	34.6	-	-	1.2	2.2	-
TOTAL:							**6,829.07**

NOTES:

1 Consumption based on estimates supplied by Crawfords Freightlines - 15,000 tonnes per week of ammonium nitrate, Diesel = 210,000L/month and 5 vehicles using 50litres per week each of unleaded petrol
2 Energy Content Factor for Stationary Energy taken from NGAF, July 2011, Table 3. Energy Content Factor for Transport Purposes taken from NGAF, July 2011, Table 4.
3 Emission Factors for Stationary Energy taken from NGAF, July 2011, Table 3. Emission Factors for Transport Purposes taken from NGAF, July 2011, Table 4.

Total Scope 1 Annual Operational Emissions (t CO_2-e):	**6,829**

Scope 2 - Emission Inventory for Grid Electricity Consumption

TABLE 2. EMISSIONS ASSOCIATED WITH CONSUMPTION OF GRID ELECTRICITY ON SITE

Consumption per annum (kWh/annum)	Emission Factor for Electricity in NSW (kg CO_2-e/kWh)	Total Emissions per annum (t CO_2-e)
195,000	0.89	174
TOTAL:		***173.55***

NOTES:

1 Consumption based on 2011 usage provided by CWF
2 Emission Factors taken from NGAF, July 2011, Table 5.

Total Annual Scope 2 Emissions from Electricity Co	**174**

Scope 3 - Emissions Inventory for Transport Upstream and Downstream of Site Operations

TABLE 3. EMISSIONS ASSOCIATED WITH TRANSPORTATION OF RAW MATERIALS TO SITE (UPSTREAM)

Material	Number of Trucks/Annum	Distance of Haulage (km)	Total km Travelled/Annum	Diesel fuel consumption rate (L/km)	Total Diesel Consumption kL/Annum	Energy Content Factor GJ/KL	Total Energy Use (GJ)	Emission Factor - kg/CO2-e per GJ	Total Emissions (t CO2-e)
Ammonium Nitrate (Newcastle Port)	0		-	0.546	-	38.6	-	69.90	-
Ammonium Nitrate (Orica)	0		-	0.546	-	38.6	-	69.90	-
Ammonium Nitrate - pick ups	0		-	0.546	-	38.6	-	69.90	-
TOTAL:									**-**

NOTES: All trucks bringing material to site and dleivering from site CWF therefore included in Scope 2 emissions

1 Number of trucks based on 15 deliveries per day x 5 days per week for 50 weeks per year.

2 Diesel Consumption rate taken from AGO Factors and Methods Workbook 2006 Table 4: Fuel consumption rates for 'Heavy Trucks'. Heavy Trucks are assumed to be 'articulated trucks' by the workbook. This workbook was used for the purposes of this assessment given that updated versions no longer provide an emissions factor.

3 Energy Content Factor for Transport Purposes taken from NGAF, July 2011, Table 4.

4 Emission Factors for Transport Purposes taken from NGAF, July 2011, Table 4.

Total Annual Scope 3 Emissions from Transport:	**603**

Emission Inventory - 'Project Lifetime'

TABLE 4. PROJECT LIFETIME EMISSIONS

Emission Scope	Annual Emissions (t CO2-e)	Project Lifetime (years)	Total Project Lifetime Emissions (t CO2-e)
Project Scope 1 & 2 emissions (t CO2-e/annum)	7,003	25	175,065

Notes:

1 Total lifetime emissions based on nominal 25 year operating period.

Emission Inventory - 'Emissions Intensity'

TABLE 5. EMISSION INTENSITY

Emission Scope	t CO2-e/ t Product
Direct Emissions and Electricity Consumption (Scopes 1 & 2)	0.093
Emissions Intensity - Direct, Electricity Consumption, and Indirect Emissions (Scopes 1,2 & 3)	0.101

Notes:

1 Emissions intensity based on 75,000 tpa production rate.

Emission Inventory - 'Contribution to NSW Emissions Totals'

TABLE 6. CONTRIBUTION TO NSW EMISSION TOTALS

Source	
Project Scope 1 & 2 emissions (t CO2-e/annum)	7,002.62
2010 Estimated NSW Emissions (t CO_2-e)	157,435,910.00
Contribution to NSW Total (%)	0.0044

Notes:

1 2010 Estimated NSW Emissions sourced from Australian Greenhouse Emissions Information System for Reporting year 2010 under the Kyoto Protocol Framework. http://www.ageis.greenhouse.gov.au/

TOTAL PROJECT EMISSIONS

Period	Freightline Operations (Scope 1)	Consumption of Grid Electricity (Scope 2)	Transport of ammonium nitrate to Facility (Scope 3)	Total
Annual	6,829	174	603	7,606
%	90%	2%	8%	100%

DIRECT EMISSIONS (SCOPES 1 & 2)

Period	Transport of Material (Scope 1) (t CO2-e)	Power Generation (Scope 2) (t CO2-e)	Total Emissions (Scopes 1 & 2) (t CO2-e)
Annual	6,829	174	7,003