

APPENDIX E

**NEWCASTLE COAL INFRASTRUCTURE GROUP
COAL EXPORT TERMINAL**



NEWCASTLE COAL INFRASTRUCTURE GROUP
COAL EXPORT TERMINAL

APPENDIX E
FLORA ASSESSMENT

JUNE 2006
Project No. NCIG-05-01
Document No. APPENDIX E-G.DOC

TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|---|-------------|
| E1 INTRODUCTION | E-1 |
| E1.1 PROJECT DESCRIPTION | E-1 |
| E1.2 ASSESSMENT OBJECTIVES | E-1 |
| E1.3 DESCRIPTION OF THE PROJECT SITE AND SURROUNDS | E-4 |
| E1.3.1 Landuse | E-4 |
| E1.3.2 History | E-4 |
| E1.3.3 Topography and Drainage | E-5 |
| E1.3.4 Geology and Soils | E-5 |
| E1.3.5 Climate | E-5 |
| E1.4 BOTANICAL/BIOGEOGRAPHICAL REGIONS | E-5 |
| E1.5 CONSERVATION STATUS OF THE REGIONAL FLORA | E-6 |
| E1.5.1 Conservation Reserves | E-6 |
| E2 METHODS | E-7 |
| E2.1 LITERATURE REVIEW | E-7 |
| E2.2 DATABASE SEARCHES | E-8 |
| E2.3 FIELD SURVEYS | E-9 |
| E2.3.1 Vegetation Survey | E-9 |
| E2.3.2 <i>Zannichellia palustris</i> | E-9 |
| E2.4 ASSESSMENT OF POTENTIAL IMPACTS | E-10 |
| E3 RESULTS | E-11 |
| E3.1 VEGETATION SURVEY | E-11 |
| E3.1.1 Wetlands Vegetation Communities | E-11 |
| E3.1.1.1 Freshwater Wetlands | E-11 |
| E3.1.1.2 Ephemeral Sedge Swamps | E-12 |
| E3.1.1.3 Estuarine Wetlands | E-12 |
| E3.1.2 Terrestrial Vegetation Community | E-12 |
| E3.2 TARGETED SURVEY FOR <i>ZANNICHELLIA PALUSTRIS</i> | E-13 |
| E3.3 PREVIOUS STUDIES UNDERTAKEN IN PROJECT SITE | E-13 |
| E3.4 THREATENED VEGETATION COMMUNITIES, POPULATIONS AND SPECIES | E-15 |
| E3.4.1 Endangered Ecological Communities | E-15 |
| E3.4.2 Threatened Populations | E-15 |
| E3.4.3 Threatened Flora Species | E-15 |
| E3.5 REGIONALLY SIGNIFICANT SPECIES | E-15 |
| E3.6 EVALUATION OF POTENTIAL IMPACTS | E-15 |
| E3.6.1 <i>Zannichellia palustris</i> | E-16 |
| E3.6.2 Coastal Saltmarsh in NSW North Coast, Sydney Basin and South East Corner Bioregions EEC. | E-17 |
| E3.6.3 Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC | E-19 |
| E3.7 SEPP – COASTAL WETLANDS | E-20 |
| E3.8 SEPP – LITTORAL RAINFOREST | E-20 |
| E3.9 MANGROVES | E-21 |
| E3.10 NOXIOUS WEEDS | E-21 |
| E4 DISCUSSION | E-23 |
| E4.1 POTENTIAL IMPACTS | E-23 |
| E4.2 MITIGATION MEASURES | E-24 |
| E4.3 COMPENSATORY MEASURES | E-25 |
| E4.4 ECOLOGICAL INITIATIVES | E-26 |
| E5 REFERENCES | E-27 |

TABLE OF CONTENTS (continued)

LIST OF TABLES

| | |
|-----------|--|
| Table E-1 | Threatened Flora Species Recorded in the Project Site and Surrounds |
| Table E-2 | Endangered Ecological Communities Recorded in the Project Site and Surrounds |

LIST OF FIGURES

| | |
|------------|-----------------------------|
| Figure E-1 | Project Location |
| Figure E-2 | Project General Arrangement |

LIST OF ATTACHMENTS

| | |
|----------------|---|
| Attachment E-A | Broad Habitat Types Across Study Site |
| Attachment E-B | Flora Species Recorded in the Project Site |
| Attachment E-C | Endangered Ecological Communities Across Study Site |
| Attachment E-D | Overview Vegetation Communities Across Study Site |
| Attachment E-E | Potential <i>Zannichellia palustris</i> Habitat Across Study Site |
| Attachment E-F | Records of <i>Zannichellia palustris</i> Across Study Site |

E1 INTRODUCTION

This document, Flora Assessment, assesses the potential impacts of the development of the proposed Coal Export Terminal (CET) (the Project) on flora. This Flora Assessment has been prepared in association with (i.e. co-authored by) Professor David Goldney. The Project is being developed by the Newcastle Coal Infrastructure Group (NCIG). As stipulated by the Project Environmental Assessment Requirements (EARs) (Section 1 of the Project Environmental Assessment [EA]) issued by the Director-General of the Department of Planning (DoP) on 26 April 2006, the Flora Assessment has been prepared in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). These guidelines identify important factors that must be considered when assessing potential impacts on threatened species, populations, or ecological communities, or their habitats for development applications assessed under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP & A Act) (DEC and DPI, 2005).

E1.1 PROJECT DESCRIPTION

The Project site is located on Kooragang Island in Newcastle, New South Wales (NSW) (Figure E-1). The Project involves the construction and operation of a 66 million tonne per annum (Mtpa) CET, including associated rail and coal handling infrastructure and wharf/ship loading facilities on the south arm of the Hunter River.

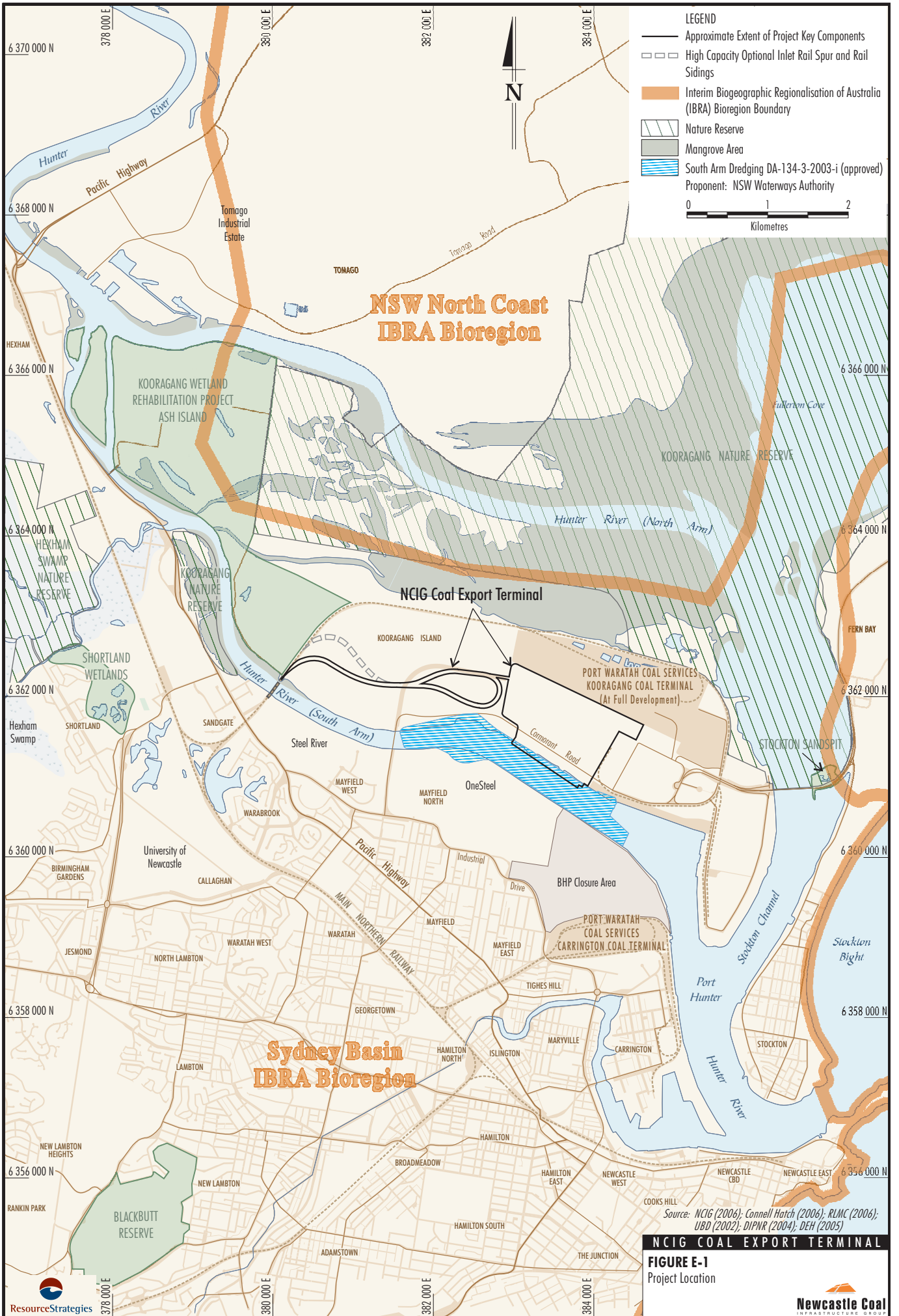
The Project general arrangement is shown on Figure E-2. A detailed description of the Project is provided in Section 2 of the Project EA.

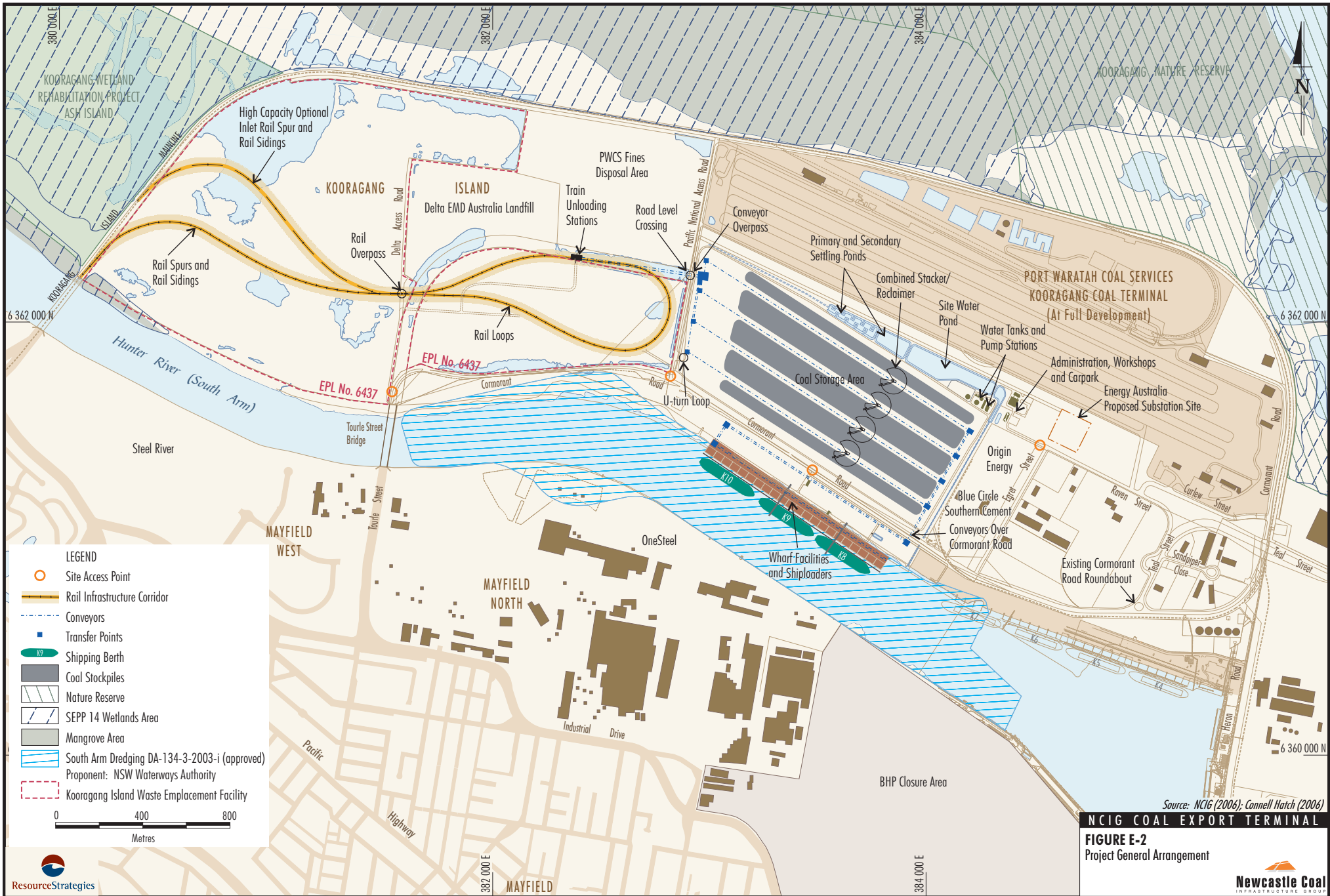
E1.2 ASSESSMENT OBJECTIVES

The specific objectives of the Flora Assessment were to:

- identify, describe and map the vegetation communities present across the Project site;
- compile a list of plant species occurring across the Project site;
- develop a list of threatened plant species and Endangered Ecological Communities (EECs) that occur in the Project site;
- conduct targeted searches for *Zannichellia palustris*, a threatened species, and map any occurrences;
- conduct detailed evaluations to determine whether the Project is likely to have a significant effect on relevant threatened flora species or EECs;
- identify the potential impacts of the Project on flora including threatened flora species and EECs; and
- provide measures to address the potential impacts of the Project on flora including threatened flora species and EECs.

The flora of the Project site and surrounds (including Kooragang Island and Kooragang Nature Reserve [NR]) has been well documented by numerous previous studies (Section E2.1). These studies, along with additional investigations undertaken specifically for this Project, form the basis for the assessment presented in this report.





E1.3 DESCRIPTION OF THE PROJECT SITE AND SURROUNDS

E1.3.1 Landuse

The Project is situated on Kooragang Island, approximately 6 kilometres (km) to the north-west of the Newcastle Central Business District (Figure E-1). Kooragang Island is characterised by a combination of port, marine and industrial landuses in the south and the Kooragang NR in the north.

The south arm of the Hunter River forms part of the southern boundary of the Project site. The Project is situated on land designated Zone 4(b) (Port and Industry), 5(a) (Special Uses Zone - Arterial Road) and an unzoned area (Hunter River) under the *Newcastle Local Environmental Plan, 2003* (Newcastle LEP). Landuses in the immediate proximity of the Project site include the Australian Rail Track Corporation rail easement to the north and west, the south arm of the Hunter River to the south and Blue Circle Southern Cement and Origin Energy to the east. Kooragang NR, Port Waratah Coal Services Kooragang Coal Terminal and fines disposal area, and Delta EMD Australia's licensed landfill are located to the north of the Project site. The Kooragang Wetland Rehabilitation Project at Ash Island is situated to the west.

The Project rail spurs and loops would be constructed on land which is part of the Kooragang Island Waste Emplacement Facility (KIWEF) which is owned by the Regional Land Management Corporation (RLMC). This site is currently licensed (EPL 6437) as a Solid Waste Class 2 landfill under the *Protection of the Environment Operations Act, 1997* (POEO Act).

E1.3.2 History

Kooragang Island was originally several low-lying deltaic islands at the mouth of the Hunter River formed from a deposition of river-borne sediments (Winning, 1996; Hamer, 1998). Much of the area of these islands was subjected to tidal influence and such areas were covered by saltmarsh, with mangroves restricted to the edges of the islands (Winning, 1996). Areas not subjected to tidal inundation (and with a high water table) would have originally supported a swamp forest of Swamp Oak (*Casuarina glauca*), *Melaleuca* spp. and Cabbage-tree Palm (*Livistona australis*) (*ibid.*). On higher land, *Livistona australis* and *Melaleuca quinquenervia* would have been prominent along with rainforest trees and shrubs, giving way to littoral rainforest at the western edge of Kooragang Island (*ibid.*).

The area has been used for agriculture (grazing and dairy farming) since the 1830s (Dames & Moore, 1999; Umwelt, 2003a). The deltaic islands were sporadically used for spoil disposal (mainly from dredging operations) which commenced in the late 1880s and continued up until the early 1950s. By 1954, almost all of the swamp forest and rainforest vegetation had been removed for agriculture (Winning, 1996).

The commencement of the *Newcastle Harbour Improvement Act, 1953* permitted the progressive reclamation of the deltaic islands for industrial use (i.e. formation of Kooragang Island). Fill material for the reclamation process was originally sourced from the dredging of the Hunter River and dredge material has continued to be used intermittently since 1953 (Dames & Moore, 1999).

Kooragang Island was zoned for heavy industrial use in the 1960s (Hamer, 1998). In 1972, BHP commenced operating a landfill at the Project site. Industrial waste materials (e.g. coal washery rejects, steel manufacturing waste and construction waste) were used to reclaim land in addition to dredge material.

Since the 1850s, there has been a gradual expansion of mangroves, often at the expense of saltmarsh (Winning, 1996). As a result, now only small patches of saltmarsh remain on Kooragang Island (*ibid.*).

Part of the Project site includes Big Pond which was originally part of an intertidal mangrove area which was cut off from tidal influence when Moscheto Creek was blocked by a railway and then bunded to create land suitable for industrial use (Straw, 1999). Shorebirds ceased to use Big Pond when water flows to the wetland were blocked by an extension of Port Waratah Coal Services (PWCS) in 1994 (*ibid.*). In order to make Big Pond attractive again to shorebirds, PWCS constructed a weir so that water levels could be manipulated but this was subsequently removed (*ibid.*).

E1.3.3 Topography and Drainage

The topography of Kooragang Island (including the Project site) is generally flat and low lying. Elevations within the Project site vary between 0.7 metres (m) to 12 m AHD across the site. There are a number of depressions that intermittently fill with surface runoff. The most notable of these depressions are Big Pond, which is located in the north-west of the Project coal storage area and Deep Pond, the southern end of which would be traversed by the northern Project rail spur.

E1.3.4 Geology and Soils

As stated above, dredge spoil and then other fill materials (e.g. coal washery rejects, steel manufacturing waste and other industrial wastes) were used to reclaim the land to form Kooragang Island. As a result of the reclamation and land filling activities, the majority of the Project site has been covered with fill (Dames & Moore, 1999; NCIG, 2005). The depth of the fill layer (depth above natural ground surface) varies from 0.5 to 3 m in the east and 0 to 10 m in the west of the Project site (Waterways Authority, 2003; 2004; RCA Australia, 2005).

The natural soil profile underlying the reclamation fill layer across the Project site generally consists of an upper clay layer, sandy layer, lower clay layer and soft and hard rock layers. As a result of the various fill materials and the historical flow paths of the Hunter River and its tributaries the depth of each of the soil layers varies significantly across the Project site.

The Project coal storage area (Figure E-2) was originally filled with dredged material from the mouth of the Hunter River approximately 45 years ago. Since then the area has been filled with miscellaneous waste materials (believed to be mainly demolition materials such as concrete, timber and rubble), additional dredge material (sourced from the Hunter River Mouth approximately 25 years ago and Throsby Creek in 1995) and a layer of blast furnace slag (Dames & Moore, 1999).

Waste disposal of by-products (e.g. coal washery rejects and other wastes associated with steel production) from the BHP steelworks at the KIWEF (along which the Project rail infrastructure corridor traverses) commenced in 1972 and ceased in late 1999. The composition and depth of the waste fill layer varies significantly across the site. The KIWEF is currently licensed as a Solid Waste Class 2 landfill and is managed by the RLMC in accordance with EPL 6437.

A comprehensive Land Contamination and Groundwater Assessment is presented as Appendix D of the Project EA.

E1.3.5 Climate

Generally the rainfall records for the Project site and surrounds indicate moderate seasonality, with higher rainfall totals being recorded in the late summer and autumn months and lower rainfall in the late winter and spring months.

Regional temperatures are warmest from November through March and coolest in the winter months of June, July and August. Average daily maximum temperatures peak in January (between 25.6°C and 29°C) while average daily minimum temperatures are lowest in July (between 6.3°C and 8.4°C).

E1.4 BOTANICAL/BIOGEOGRAPHICAL REGIONS

The Project site lies in the North Coast Botanical Division (Anderson, 1968; Harden, 1990). The North Coast Botanical Division is considered to be sub-tropical, with a fairly heavy annual rainfall (Anderson, 1968). Although the North Coast Botanical Division includes a wide range of soil and forest types, trees may be grouped under the following three categories: brush or rainforests, Eucalypt forests and vegetation on tidal areas or flats subject to flooding (*ibid.*).

The Project site is situated in the far north-eastern corner of the Sydney Basin Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion (DEH, 2005). The Project site is also close to the NSW North Coast IBRA Bioregion immediately to the north (*ibid.*). Due to its close proximity, the Project site is also likely to be influenced by the environmental characteristics of the NSW North Coast Bioregion (Figure E-1).

E1.5 CONSERVATION STATUS OF THE REGIONAL FLORA

E1.5.1 Conservation Reserves

The nearby Hunter Estuary Wetlands comprise the Kooragang and Hexham Swamp NRs, Shortland Wetlands (Figure E-1) and the State Environmental Planning Policy (SEPP) 14 listed wetlands associated with the lower Hunter River Estuary. The statements of significance for the listing of the Hunter Estuary Wetlands on the Register of the National Estate include recognition of their international significance as waterbird habitat (DEH, 2006a). The Hunter Estuary Wetlands are also listed as a Wetland of International Importance under the Ramsar Convention (Ramsar Convention, 2006).

The Project site is situated approximately 1 km to the south of the Kooragang NR (some 2,926 hectares [ha] in area [NPWS, 1998]) and approximately 2.5 km to the east of Hexham Swamp NR (some 900 ha in area [NPWS, 1998]) (Figure E-1).

Kooragang NR is largely an estuarine wetland with areas that have been modified for farmland (NPWS, 1998). Kooragang NR supports mangrove forests, saltmarsh, saline and freshwater pastures, swamp forests and rainforests (*ibid.*).

Hexham Swamp NR is predominantly a freshwater swamp but contains estuarine habitat in its north-eastern corner, adjacent to the Hunter River (NPWS, 1998). The vegetation of Hexham Swamp includes saltmarsh and mangroves, reed community, freshwater meadows and seasonal freshwater swamps and freshwater grassy swamps (*ibid.*).

E2 METHODS

The methods used to obtain information for this Flora Assessment included a literature review, database searches and field surveys (*viz* a vegetation survey and targeted field surveys for *Zannichellia palustris*). Detailed evaluations were also conducted to determine whether the Project is likely to have a significant effect on *Zannichellia palustris* and relevant EECs. The evaluations were based on information provided in the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). A description of the assessment methodology is provided below.

E2.1 LITERATURE REVIEW

There are numerous vegetation studies and flora assessments which have been undertaken in the Project site and surrounds in the past. A literature review was undertaken as part of the Flora Assessment and included relevant reports (e.g. Environmental Impact Statements [EISs], reports prepared for government departments and scientific literature). The reports reviewed for this assessment included (but were not limited to) the following:

- *Big Pond Habitat Offset Scheme Flora and Fauna Studies* (BPHOS Report) (Department of Commerce, 2005).
- *Proposed Cold Mill Facility Kooragang Island Environmental Impact Statement* (Protech Steel, 2001) including the *Flora and Fauna Assessment* (Appendix F).
- *Terrestrial Ecology Impact Assessment Report* (Umwelt, 2003b) (Appendix H of the *Proposed Extension of Shipping Channels, Port of Newcastle Environmental Impact Statement* [Waterways Authority, 2003]).
- *Western Kooragang Island Vegetation Study* (Winning, 1991).
- *Vegetation of Kooragang Nature Reserve and Hexham Swamp Nature Reserve and Adjoining Land* (Winning, 1996).
- *Flora and Fauna Assessment for Proposed Rehabilitation of Estuarine Wetlands at Tomago in the Hunter River Estuary, NSW* (Winning, 2000).
- *Flora and Fauna Assessment for Proposed Rehabilitation of Estuarine Wetlands at Tomago, NSW* (Winning, 1998).
- *Kooragang Port and Transport Corridor, Species Impact Statement* (RLMC, 2003).
- *Tomago - Fullerton Cove Vegetation Survey* (Winning, 1993).
- *Kooragang Coal Terminal Stage Three Expansion Environmental Impact Statement* (PWCS, 1996).
- *Ecological Assessment for Proposed Sandgate Rail Grade Separation Environmental Impact Statement* (Winning, 2004).

The flora assessments conducted for the BPHOS Report (Department of Commerce, 2005), the *Proposed Cold Mill Facility Kooragang Island Environmental Impact Statement* (Protech Steel, 2001) and the *Terrestrial Ecology Impact Assessment Report* (Umwelt, 2003b) included areas within the NCIG Project site. Subsequently, the vegetation communities and flora species identified by these reports were considered for the Flora Assessment.

All other reports listed above were reviewed to determine whether any of the flora species recorded in them were identified as threatened species, populations or EECs as listed under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and/or threatened species or EECs as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

E2.2 DATABASE SEARCHES

Database searches for the Project site and surrounds were undertaken using the following databases:

- The Department of Environment and Conservation (DEC) (2006) Atlas of NSW Wildlife (Newcastle [9232], Port Stephens [9332] and Lake Macquarie [9231] 1:100,000 map sheets).
- The Sydney Royal Botanic Gardens (2006) (using a search area of approximately 400 km² surrounding the Project site).

The searches were used to determine whether any previously recorded flora in the Project site and surrounds are threatened species or populations as listed under the TSC Act and/or EPBC Act. These threatened flora species are listed in Table E-1 and discussed in Section 3.4.3.

Table E-1
Threatened Flora Species Recorded in the Project Site and Surrounds

| Family Name | Scientific Name | Conservation Status | | Closest DEC Atlas of NSW Wildlife Record to the Project Site | DEC Atlas of NSW Wildlife ³ | Sydney Royal Botanic Gardens ⁴ |
|------------------------|--|----------------------|-----------------------|--|--|---|
| | | TSC Act ¹ | EPBC Act ² | | | |
| Asclepiadaceae | <i>Cynanchum elegans</i> | E | E | 18 km SW | • | |
| Asteraceae | <i>Senecio spathulatus</i> | E | - | 63 km NE | • | |
| | <i>Rutidosia heterogama</i> | V | V | 8 km S | • | • |
| Euphorbiaceae | <i>Chamaesyce psammogeton</i> | E | - | 18 km S | • | |
| Fabaceae (Mimosoideae) | <i>Acacia bynoeana</i> | E | V | 21 km NW | • | |
| Grammitaceae | <i>Grammitis stenophylla</i> | E | - | 102 km SW | • | |
| Lamiaceae | <i>Prostanthera densa</i> | V | V | 37 km NE | • | |
| Myrtaceae | <i>Angophora inopina</i> | V | V | 12 km SW | • | |
| | <i>Callistemon linearifolius</i> | V | - | 30 km SW | • | |
| | <i>Darwinia biflora</i> | V | V | 104 km SW | • | |
| | <i>Eucalyptus camfieldii</i> | V | V | 8 km NE | • | • |
| | <i>Eucalyptus glaucina</i> | V | V | 228 km NW | • | |
| | <i>Eucalyptus parramattensis subsp. decadens</i> | V | V | 4 km NE | • | • |
| | <i>Melaleuca groveana</i> | V | - | 37 km NE | • | |
| Orchidaceae | <i>Syzygium paniculatum</i> | V | V | 8 km S | • | |
| | <i>Caladenia tessellata</i> | E | V | 36 km S | • | |
| | <i>Diuris arenaria</i> | E | - | 18 km NE | • | |
| | <i>Diuris pedunculata</i> | E | E | 31 km NW | • | |
| | <i>Cryptostylis hunteriana</i> | V | V | 28 km SW | • | |
| Proteaceae | <i>Diuris praecox</i> | V | V | 7 km S | • | |
| | <i>Persoonia mollis subsp. Maxima</i> | E | E | 102 km SW | • | |
| | <i>Grevillea parviflora subsp. parviflora</i> | V | V | 21 km NW | • | |
| Rubiaceae | <i>Asperula asthenes</i> | V | V | 32 km NE | • | |
| Santalaceae | <i>Thesium australe</i> | V | V | 117 km SW | • | |
| Sterculiaceae | <i>Lasiopetalum joyceae</i> | V | V | 102 km SW | • | |
| | <i>Rulingia prostrata</i> | E | E | 8 km N | • | • |
| Tremandraceae | <i>Tetratheca glandulosa</i> | V | V | 26 km SW | • | |
| | <i>Tetratheca juncea</i> | V | V | 5 km SW | • | • |
| Zannichelliaceae | <i>Zannichellia palustris</i> | E | - | 2 km NW | • | • |

¹ NSW Threatened Species Conservation Act, 1995 (current as at 15 February 2006).

² Commonwealth Environment and Protection and Biodiversity Conservation Act, 1999 (current as at 28 January 2005).

³ NPWS Atlas of NSW Wildlife Records for the Newcastle (9232), Port Stephens (9332) and Lake Macquarie (9231) 1:100,000 map sheets (15 February 2006).

⁴ Sydney Royal Botanic Gardens using a search area of approximately 400 km² surrounding the Project site.

E Endangered

V Vulnerable

E2.3 FIELD SURVEYS

During preliminary ecological investigations of the Project site and surrounds undertaken by Connell Hatch in early 2005, a number of potential key ecological issues were identified as requiring further study (Connell Hatch, 2006a and b). This included recommendations for vegetation and habitat surveys as well as targeted surveys for *Zannichellia palustris* (*ibid.*).

Subsequently, field surveys conducted by Connell Hatch for the Project included a vegetation survey and targeted searches for *Zannichellia palustris* (a submerged aquatic plant listed as Endangered under the TSC Act). The methodologies used for the vegetation surveys and targeted survey for *Zannichellia palustris* are provided below.

E2.3.1 Vegetation Survey

The aim of the vegetation survey was to identify, describe and map vegetation communities present across the study site, to compile a list of flora species occurring in the study site and to determine the presence or likelihood of threatened flora species and/or EECs occurring within the study site (Connell Hatch, 2006a).

During vegetation mapping, the main wetland communities occurring across the study site were identified and classified as well as the extent of potential habitat for threatened species (Connell Hatch, 2006a). Vegetation mapping was also used to identify and map the extent and distribution of EECs across the study site (*ibid.*).

Vegetation mapping included air photograph interpretation (using 1:15,000 aerial photography dated 16 November 2002) to identify the main habitat types present in the study site (i.e. terrestrial, estuarine and freshwater) (Connell Hatch, 2006a). A one-day visit to the study site was made on 15 November 2005 to identify the main vegetation communities characterising the aquatic and terrestrial habitats (*ibid.*). Updated aerial photography (dated November 2005) was also used to identify vegetation communities (*ibid.*). Spot inspections of representative areas of the main vegetation communities occurring in the study area were used to extrapolate other areas of similar appearance on aerial photographs (*ibid.*).

Wetland vegetation across the study area was assigned to communities based on the dominant emergent species. For example, vegetation dominated by Common Reed (*Phragmites australis*) was assigned to 'Phragmites Reedland' (Connell Hatch, 2006a).

The vegetation across the study site was surveyed using a combination of sampling plots (quadrats), random meander traverses of 30 minutes duration and walking transects (e.g. to identify community boundaries) (Connell Hatch, 2006a). At least one quadrat (400 m² in size) was used to sample each of the main vegetation types present within the study area (*ibid.*). All flora species within each quadrat were recorded and identified to a species or subspecies level (*ibid.*).

The DEC Atlas of NSW Wildlife, Department of Environment and Heritage's (DEH's) Protected Matters Report and relevant literature was searched to identify threatened flora species occurring in the local area (Connell Hatch, 2006a). Only one species, *Zannichellia palustris*, was considered likely to occur as suitable habitat is present within the Project site (*ibid.*). A targeted survey for *Zannichellia palustris* was undertaken as described in Section E2.3.2.

E2.3.2 *Zannichellia palustris*

Zannichellia palustris was considered likely to occur on the basis that suitable habitat is present within the Project site (Connell Hatch, 2006a). Connell Hatch conducted field surveys targeting *Zannichellia palustris* between November 2005 and February 2006 (Connell Hatch, 2006b). The aims were to assess the suitability of the study site as habitat for *Zannichellia palustris* as well as to identify the presence or absence of *Zannichellia palustris* across the study site (*ibid.*).

As part of the habitat assessment for *Zannichellia palustris*, data on the physical attributes likely to influence the occurrence of this species was collected (e.g. wetland type, substrate type, depth of water) as well as information regarding the primary structural zones characterising the vegetation at each of the wetlands (including the height of the vegetation, relative cover abundance, foliage cover and dominant species for each zone) (Connell Hatch, 2006b).

During the targeted field surveys, relevant waterbodies were inspected. These waterbodies included those where *Zannichellia palustris* had previously been recorded by The University of Newcastle's M. Greenwood (Connell Hatch, 2006b). Targeted searches consisted of random meander traverses of 30 minutes duration (*ibid.*).

E2.4 ASSESSMENT OF POTENTIAL IMPACTS

This Flora Assessment considers the potential impacts of the Project on relevant threatened flora species and EECs, and their habitats in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

To assist in identifying whether the potential impacts of the Project are likely to have a significant effect on threatened flora species and EECs, evaluations were conducted. There were no threatened flora populations recorded in the Project site. The evaluations were based on the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and included consideration of the following items:

- How is the proposal likely to affect the lifecycle of a threatened species and/or population?
- How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
- Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
- How is the proposal likely to affect current disturbance regimes?
- How is the proposal likely to affect habitat connectivity?
- How is the proposal likely to affect critical habitat?

The evaluations are provided in Section E3.6.

E3 RESULTS

E3.1 VEGETATION SURVEY

The results of the vegetation survey indicate that the study site is characterised by wetland habitat types (Attachment E-A) varying from semi-natural to highly disturbed (Connell Hatch, 2006a). Very few native flora species were recorded in the study site as part of the flora surveys for the Project apart from native aquatic vegetation and landscape (amenity) plantings (Connell Hatch, 2006a). The predominant terrestrial habitat is grassland dominated by exotic pasture and landscaping species (*ibid.*).

A total of 96 vascular plant taxa were identified in the study site by the Project surveys and of these, 42 were native and 54 were exotic species (Connell Hatch, 2006a; Attachment E-B). A list of the plant species recorded in the study site is provided in Attachment E-B.

Within the study site, the following two EECs were identified (Connell Hatch, 2006a):

- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC (Freshwater Wetlands on Coastal Floodplains EEC) (Section E3.1.1.1; Attachment E-C).
- Coastal Saltmarsh in NSW North Coast, Sydney Basin and South East Corner Bioregions EEC (Coastal Saltmarsh EEC) (Section E3.1.1.3; Attachment E-C).

Sections E3.1.1 and E3.1.2 provide a description of each vegetation community mapped within the study site. These vegetation communities are mapped in Attachment E-D.

E3.1.1 Wetlands Vegetation Communities

The study site is dominated by ephemeral and semi-permanent wetlands subject to seasonal changes in vegetation and water levels (Connell Hatch, 2006a). The three main wetland types identified in the study area are (*ibid.*):

- Ephemeral freshwater wetlands dominated by Common Reed (*Phragmites australis*) and Cumbungi (*Typha orientalis*).
- Ephemeral sedge swamps dominated by Marsh Clubbrush (*Bulboschoenus fluvialis*).
- Estuarine wetlands dominated by Grey Mangrove (*Avicennia marina*), Samphire (*Sarcocornia quinqueflora*) and Sand Couch (*Sporobolus virginicus*).

These main wetland types are described in further detail in Sections E3.1.1.1, E3.1.1.2 and E3.1.1.3 below.

E3.1.1.1 Freshwater Wetlands

The freshwater wetlands occurring in the study site have been defined as Freshwater Wetlands on Coastal Floodplains EEC (Attachment E-C).

The dominant wetland habitat type across the study site is ephemeral freshwater swamp with the exception of Deep Pond which is perennial (Connell Hatch, 2006a). Typically, the ephemeral freshwater wetlands across the study site occur in low-lying parts of the study site which are periodically inundated with freshwater and are dominated by Common Reed (*Phragmites australis*) with Cumbungi (*Typha orientalis*) occurring either as a sub-dominant or not at all (*ibid.*). Bands or patches of Water Couch (*Paspalum distichum*) characterise the seasonally inundated margins of the ponds (*ibid.*).

The structure of this community varies from reedlands dominated by Common Reed (*Phragmites australis*) and (to a lesser extent by Cumbungi [*Typha orientalis*]) to sedgeland dominated by Marsh Clubrush (*Bulboschoenus fluvialis*) to swamp meadow less than 0.5 m tall dominated by Water Couch (*Paspalum distichum*) (Connell Hatch, 2006a).

Big Pond is characterised by wetland habitat types including open water, swamp meadow, reedbeds, saltmarsh and includes both ephemeral and semi-permanent waterbodies (Connell Hatch, 2006a). Although Big Pond appears to be isolated from the mangroves along the Hunter River by Cormorant Road and adjoining fill, it exhibits characteristics of a brackish estuarine wetland habitat (*ibid.*).

In the eastern section of Big Pond is an extensive saltmarsh community dominated by Samphire (*Sarcocornia quinqueflora*) and Water Buttons (*Cotula coronopifolia*) (Connell Hatch, 2006a). Big Pond is likely to have had limited deposition of fill, however, is likely to have been disturbed by land reclamation activities and previous landuses (Appendix D of the EA), perhaps explaining the disturbed nature of the saltmarsh community.

E3.1.1.2 Ephemeral Sedge Swamps

Extensive ephemeral sedge swamps dominated by Marsh Clubrush (*Bulboschoenus fluvialis*) occur at most of the ponds. This habitat type was generally dry during the survey period (Connell Hatch, 2006a).

E3.1.1.3 Estuarine Wetlands

Estuarine wetland habitat comprises small areas of mangrove swamp, interspersed with saltmarsh vegetation found in a narrow band between the Tourle Street bridge and the railway bridge (Attachment E-D). This area lies outside of the Project disturbance area. Mangrove swamp occurs on mudflat exposed to tidal inundation (Connell Hatch, 2006a). Grey Mangrove (*Avicennia marina* var. *australasica*) forms monospecific stands and, where present, the groundcover comprises saltmarsh species such as Samphire (*Sarcocornia quinqueflora*) and Sand Couch (*Sporobolus virginicus*) (*ibid.*).

The Coastal Saltmarsh found during the Project surveys was considered to be Coastal Saltmarsh EEC (Attachment E-C), although this may be better described as a relic community since it is essentially a monoculture. Across the study site, Coastal Saltmarsh generally occurs as a zone landward of mangrove stands and has been recorded a number of areas including sections of Big Pond, Ponds O, P, B, D, AB and R (Attachment E-C). Dense stands of tall reeds and clubrushes (e.g. Common Reed [*Phragmites australis*], *Bulboschoenus* spp., *Schoenoplectus* spp. and *Typha* spp.) occur as part of the community in brackish areas (*ibid.*).

The Coastal Saltmarsh was dominated by Samphire (*Sarcocornia quinqueflora*) in the more frequently flooded areas and Sand Couch (*Sporobolus virginicus*) in the mid saltmarsh which is slightly more elevated (Connell Hatch, 2006a). Weed species invading the Coastal Saltmarsh community include Spike Rush (*Juncus acutus*) and Pennywort (*Hydrocotyle bonariensis*) (*ibid.*).

E3.1.2 Terrestrial Vegetation Community

Terrestrial habitat across the study site is characterised by dense grassland and landscape plantings (Connell Hatch, 2006a). The grassland is dominated by landscape and pasture species including Red Natal Grass (*Rhynchelytrum repens*), Kikuyu (*Pennisetum clandestinum*), African Lovegrass (*Eragrostis curvula*), Common Couch (*Cynodon dactylon*), Fountain Grass (*Pennisetum setaceum*), Rhodes Grass (*Chloris gayana*) and Parramatta Grass (*Sporobolus africanus*) (*ibid.*).

Landscape plantings are dominated by Swamp Paperbark (*Melaleuca ericifolia*), eucalypts, Sickle Wattle (*Acacia falcata*), Coastal Wattle (*Acacia longifolia* var. *sophorae*), and Green Wattle (*Acacia irrorata*) (Connell Hatch, 2006a). Other than these landscape plantings, there were very few native terrestrial flora species present in the study site (*ibid.*). Indeed, most of the western area of the study site is dominated by introduced grasses and herbaceous weeds (*ibid.*).

E3.2 TARGETED SURVEY FOR *ZANNICHELLIA PALUSTRIS*

Many of the ponds across the study site offer potential habitat for *Zannichellia palustris* due in part to their ephemerality (Connell Hatch, 2006b; Attachment E-E). *Zannichellia palustris* was recorded in two waterbodies on the study site by the Project surveys, viz., Ponds A and H (Connell Hatch, 2006b; Attachment E-F). The specimens collected from Ponds A and H were taken from areas where the water levels had significantly receded and the submerged vegetation was decaying (Connell Hatch, 2006b).

The specimens were confirmed as being *Zannichellia palustris* by The University of Newcastle's M. Greenwood (Connell Hatch, 2006b). M. Greenwood has previously recorded *Zannichellia palustris* at Pond A as well as two other ponds, Pond I and L (*ibid.*).

The targeted surveys were conducted in a particularly hot summer. This is not the most ideal time to sample for this species because it dies back in summer (Winning, 1996; NSW Scientific Committee, 2004a; DEC, 2005a). Despite this, *Zannichellia palustris* was recorded by the Project surveys.

E3.3 PREVIOUS STUDIES UNDERTAKEN IN PROJECT SITE

The flora assessments conducted by Protech Steel Pty Ltd (Protech Steel) (2001), the BPHOS Report (Department of Commerce, 2005) and Umwelt (2003b) included areas located within the NCIG Project site. The vegetation communities and flora species identified by these previous studies are considered in this Flora Assessment.

Protech Steel (2001)

The eastern section of the Project site was the subject of field flora surveys by Protech Steel in 2001. A summary of the flora species and vegetation communities identified during the Protech Steel (2001) surveys is provided below.

The field investigations conducted by Protech Steel (2001) recorded 106 vascular plants within the site, of which over half were introduced species (Attachment E-B). There were four main communities in this area, viz., grassland, ephemeral aquatic environments, landscape plantings and mangrove open shrubland (Protech Steel, 2001). The last community, mangrove open shrubland, is not situated within the NCIG Project disturbance area.

The grassland community covered the majority of the Protech Steel (2001) site, with Sand Couch (*Sporobolus virginicus*) and Couch (*Cynodon dactylon*) the most dominant species of grass present. Other species, including Red Natal Grass (*Melinis repens*), dominated small patches (*ibid.*).

Common herbaceous species throughout the grassland included Plantain (*Plantago lanceolata*) and Pennywort (*Hydrocotyle bonariensis*) (Protech Steel, 2001). A large amount of exotic herbaceous species were found in some areas (including Ragweed [*Ambrosia artemisiifolia*] and Telegraph Weed [*Heterotheca grandifolia*]) (*ibid.*). The density of the grass ground cover varied depending on the hydrological regime present (e.g. wetter areas had more open space between tussocks and were dominated by the Spike Rush [*Juncus acutus*]) (*ibid.*).

Three areas of vegetated ephemeral aquatic environments within the site included two dense reed beds in the north-eastern and northern area of the Protech Steel (2001) site. These ephemeral aquatic environments were dominated by the Common Reed (*Phragmites australis*) with a dense understorey of Pennywort (*Hydrocotyle bonariensis*) (Protech Steel, 2001). The grassland-reed bed interface was dominated by introduced species including noxious weeds (e.g. Bitou Bush [*Chrysanthemoides monilifera* ssp. *rotundifolia*], Lantana [*Lantana camara*], Blue Morning Glory [*Ipomoea indica*], Blackberry [*Rubus discolor*] and Pampas Grass [*Cortaderia selloana*]) (*ibid.*). Other herbaceous species in the ephemeral aquatic environments included Kikuyu (*Pennisetum clandestinum*), Verbena (*Verbena rigida*) and Pitchforks (*Biddens pilosa*) (*ibid.*).

In areas adjacent to Cormorant Road, the Hunter River Foreshore as well as smaller areas within the grassland communities were landscape plantings of exotic as well as native species of trees and shrubs (many of which do not occur in the local area) (Protech Steel, 2001). These included River Red Gum (*Eucalyptus camaldulensis*), Drooping Sea Oak (*Allocasuarina verticillata*), Senna (*Senna pendula*) and Cluster Pine (*Pinus pinaster*).

The list of flora species recorded by the Protech Steel (2001) surveys is provided in Attachment E-B.

URS (2000)

During an ecological investigation conducted in the Project site, approximately 67 flora species within five vegetation communities were recorded (URS, 2000 in Protech Steel, 2001). Over half of the flora species were introduced (Attachment E-B). The five vegetation communities were: *Phragmites australis* (grassland/reedbed), exotic grassland, boundary landscape plantings (screen and roadside plantings), *Acacia saligna* cultivated strip woodland and *Avicennia marina* open scrub. URS (2000 in Protech Steel, 2001) concluded that this site has low conservation value.

The list of flora species recorded by URS (URS, 2000 in Protech Steel, 2001) surveys is provided in Attachment E-B.

The BPHOS Report (Department of Commerce, 2005)

The BPHOS Report included consideration of the flora species and vegetation communities present at Big Pond (which is located in the NCIG Project site). The BPHOS Report describes Big Pond as highly modified, consisting of an artificially raised section, and is completely cleared of woody vegetation (Department of Commerce, 2005). Four vegetation communities were identified in the Big Pond area by the BPHOS Report, viz., Phragmites/Typha reed marsh, *Bolboschoenus* marsh, bare ground and pasturelands (*ibid.*).

According to the BPHOS Report, the Phragmites/Typha Reed marsh and the *Bolboschoenus* marsh resembles the Freshwater Wetlands on Coastal Floodplains EEC (Department of Commerce, 2005).

The area that the Project vegetation surveys identified as the Coastal Saltmarsh EEC (Connell Hatch, 2006a) (Section E3.1.1.3) was identified as pasturelands by the BPHOS Report (Department of Commerce, 2005). The pasturelands community was comprised of introduced pasture grasses and weeds including Kikuyu (*Pennisetum clandestinum*), Red Natal Grass (*Melinis repens*), Rhodes Grass (*Chloris gayana*), Common Couch (*Cynodon dactylon*), Bitou Bush (*Chrysanthemoides monilifera* ssp. *rotundifolia*), Purple-top (*Verbena bonariensis*) and Plantain (*Plantago lanceolata*).

A total of 28 flora species were recorded in the Big Pond area and almost all were weeds (Department of Commerce, 2005; Attachment E-B). No rare or threatened species listed under State or Commonwealth legislation were recorded in the Big Pond area (*ibid.*). The list of flora species recorded by the BPHOS Report surveys is provided in Attachment E-B.

Umwelt (2003b)

The Project wharf and shiploading facilities area (i.e. the banks of the south arm of the Hunter River) consists of modified grassland and plantings of native species (Umwelt, 2003b). There are several scattered juvenile mangrove trees along the shoreline in this area (Umwelt, 2003b).

Any disturbance of mangroves in this area would be done as part of the dredging activities. This is discussed further in Section E3.9.

E3.4 THREATENED VEGETATION COMMUNITIES, POPULATIONS AND SPECIES

E3.4.1 Endangered Ecological Communities

Three EECs listed under the TSC Act and no EECs listed under the EPBC Act have been recorded in the Project site and surrounds (Table E-2).

**Table E-2
Endangered Ecological Communities Recorded in the Project Site and Surrounds**

| Endangered Ecological Community | Location |
|---|--|
| Coastal Saltmarsh in NSW North Coast, Sydney Basin and South East Corner Bioregions EEC. | <ul style="list-style-type: none"> Project site, including Big Pond (Connell Hatch, 2006a); Ash Island and Tomago (Department of Commerce, 2005); and Kooragang NR (NSW Scientific Committee, 2004b). |
| Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC. | <ul style="list-style-type: none"> Project site, including Big Pond (Connell Hatch, 2006a); Tomago and Big Pond (Department of Commerce, 2005); and Hexham Swamp and lower Hunter including along the proposed Sandgate Rail Grade Separation area (Winning, 2004). |
| Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC. | <ul style="list-style-type: none"> Hexham Swamp and lower Hunter including along the proposed Sandgate Rail Grade Separation area (Winning, 2004). |

E3.4.2 Threatened Populations

No threatened flora populations listed under the TSC Act have been recorded in the Project site and surrounds.

E3.4.3 Threatened Flora Species

Table E-1 shows threatened flora species listed in the schedules of the TSC Act and the EPBC Act that have been recorded in the Project site or surrounds. Included in the table is the closest DEC Atlas of NSW Wildlife record to the Project site for each species.

The only threatened flora species recorded in the Project site was *Zannichellia palustris* (Section E3.2). *Zannichellia palustris* was identified in Ponds A and H, I and L (RLMC, 2003; Connell Hatch, 2006b) and has also been found in Brackish ponds on Kooragang Island and in Ironbark Creek (Winning, 1996).

No threatened flora species listed under the TSC Act or EPBC Act were observed in the Ash Island, Tomago or Big Pond areas during GHD's survey in 2005 (Department of Commerce, 2005) nor during the Western Kooragang Island Vegetation Study (Winning, 1991). In addition, no threatened flora species were identified in the Project site or surrounds by Umwelt (2003b) or by Protech Steel (2001).

E3.5 REGIONALLY SIGNIFICANT SPECIES

Zannichellia palustris, recorded during the Project surveys (Section E3.2), is recognised as rare nationally (Briggs and Leigh, 1996).

E3.6 EVALUATION OF POTENTIAL IMPACTS

Detailed evaluations are presented below for each of the threatened flora species and EECs that were recorded in the Project site (*viz.* *Zannichellia palustris*, Freshwater Wetlands on Coastal Floodplains EEC and Coastal Saltmarsh EEC).

E3.6.1 *Zannichellia palustris*

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Zannichellia palustris is a submerged monoecious weakly rhizomatous aquatic annual or perennial plant which occurs in fresh to brackish waters which are still to slowly moving (NSW Scientific Committee, 2004a). *Zannichellia palustris* possess high fecundity which is unusual considering its very restricted distribution in Australia (Greenwood and DuBow, 2005). This has led to suggestions that this species is not native but a recent introduction to the Australian continent (*ibid.*).

In NSW, populations of *Zannichellia palustris* behave as annuals and die back in summer (NSW Scientific Committee, 2004a). The species germinates in winter, flowers in late spring to early summer, fruits and dies in mid to late summer (Winning, 1996). *Zannichellia palustris* requires a bare substrate for germination, which is provided either by the death of perennial plants due to the seasonal drying of ponds or the recent deposition of sediment from catchment erosion (*ibid.*). It is not surprising, therefore, that *Zannichellia palustris* is found in areas subject to considerable changes to their catchments (NSW Scientific Committee, 2004a).

The Atlas of NSW Wildlife (DEC, 2006) indicates *Zannichellia palustris* has been recorded at two locations in the region (i.e. Newcastle 1:100,000 map sheet), the closest of which was located 2 km NW of the Project site¹.

During recent targeted surveys within the Project site and surrounds, *Zannichellia palustris* was recorded at Ponds A and H (Connell Hatch, 2006b) (Attachment E-F). Earlier, M. Greenwood (The University of Newcastle) recorded *Zannichellia palustris* at Ponds A, I and L (Connell Hatch, 2006b) (Attachment E-F). In addition, RLMC (2003) recorded this species at Ponds I and L.

Ponds A, I and L would not be disturbed by the Project. However, the northern bank of Pond H would be disturbed by the Project. The disturbance (i.e. removal/modification) of a portion of known and potential habitat for *Zannichellia palustris* is unlikely to disrupt the lifecycle such that a local viable population of this species would be placed at risk given the:

- localised nature of the Project disturbance;
- non-disturbance of potential habitat in Ponds A, J, L, AD, C, T, F and I;
- implementation of the Project mitigation measures (Section E4.2 and Section 4 of the Project EA) which would minimise the potential for impacts on *Zannichellia palustris* beyond the limits of the Project disturbance area; and
- other nearby known and potential habitat to the Project site. Nearby occurrences of known *Zannichellia palustris* habitat include Ironbark Creek and tributaries at Shortland and Wallsend, in Black Creek at Cessnock and an area near Belmont (NSW Scientific Committee, 2004a).

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Zannichellia palustris occurs in fresh to brackish waters which are stationary or slowly flowing (NSW Scientific Committee, 2004a; DEC, 2005a). In the Hunter/Central Rivers Catchment Management Region, *Zannichellia palustris* is known to be associated with coastal freshwater lagoons, saltmarshes, waterbodies, rivers, lakes and streams (DEC, 2005a). None of the known sites for *Zannichellia palustris* in NSW are protected (NSW Scientific Committee, 2004a).

Potential habitat for *Zannichellia palustris* in the Project site and surrounds has recently been mapped by Connell Hatch (2006b). Known and potential habitat for *Zannichellia palustris* would be disturbed by the Project (i.e. habitat in Ponds H, K and Deep Pond [Attachment E-E]). However, potential habitat in Ponds A, J, L, AD, C, T, F and I would not be directly disturbed for the Project. Other nearby known and potential habitat for this species includes Ironbark Creek and tributaries at Shortland and Wallsend, in Black Creek at Cessnock and areas near Belmont (NSW Scientific Committee, 2004a).

¹ This record has an accuracy of 0.1 km (DEC, 2006a)

A number of mitigation measures are proposed as part of the Project in relation to the management of *Zannichellia palustris* habitat (Section E4.2). Based on the above (i.e. small amount of habitat disturbance, proximal habitat to the Project disturbance areas and mitigation measures), it is considered that the Project would not have a significant impact on the locally available habitat for *Zannichellia palustris*.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Although *Zannichellia palustris* has a cosmopolitan distribution (Greenwood and DuBow, 2005), the species is known in Australia only from the lower Hunter Region in NSW and the Murray River in South Australia (NSW Scientific Committee, 2004a). The distribution of *Zannichellia palustris* in the southern hemisphere is limited to coastal areas (Greenwood and DuBow, 2005).

Considering the above, the Project site is located within the known distribution of *Zannichellia palustris* and may represent the most northern distributional limit for this species.

4. How is the proposal likely to affect current disturbance regimes?

The Project is unlikely to affect any of the current disturbance regimes operating at the Project site and surrounds, including flooding flows and fire. As explained in Section E4.1, the potential for the Project to alter the natural flow regime in the area of the Project rail infrastructure (i.e. across the KIWEF site) would be minimised by the installation of culverts under the rail embankments at low points in the existing topography. Culverts would allow surface waters to continue to flow across the site in a similar manner to the existing conditions.

There is unlikely to be any change to the current fire regime due to the Project because several fire control measures would be implemented as described in Section E4.2.

5. How is the proposal likely to affect habitat connectivity?

The habitat requirements for *Zannichellia palustris* are described above. As previously established, known and potential habitat for this species occurs within the Project disturbance area and surrounds. Nearby occurrences of known *Zannichellia palustris* habitat include Ironbark Creek and tributaries at Shortland and Wallsend, in Black Creek at Cessnock and an area near Belmont (NSW Scientific Committee, 2004a).

In addition, a series of ponds which contain potential habitat for *Zannichellia palustris* would remain undisturbed in the immediate area surrounding the Project site (i.e. Ponds A, J, L, AD, C, T, F and I).

In consideration of the above, there is unlikely to be any significant change in habitat connectivity for *Zannichellia palustris* due to the Project.

6. How is the proposal likely to affect critical habitat?

There is no critical habitat as listed on the National Parks and Wildlife Service (NPWS) Critical Habitat Register (2006) or DEH Register of Critical Habitat (2006b) located in the Project site or surrounds.

E3.6.2 Coastal Saltmarsh in NSW North Coast, Sydney Basin and South East Corner Bioregions EEC.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

This question is not applicable because the subject of this evaluation is an EEC (i.e. not a threatened species or population).

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Coastal Saltmarsh in NSW North Coast, Sydney Basin and South East Corner Bioregions (Coastal Saltmarsh) EEC is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons along the NSW coast (NSW Scientific Committee, 2004b).

The total area of Coastal Saltmarsh in NSW was estimated to be approximately 5700 ha in 1985 (mostly in patches less than 100 ha) and since then further reductions have occurred (West *et al.*, 1985 in NSW Scientific Committee, 2004b). Kooragang Island has experienced a gradual expansion of mangrove forests, often at the expense of saltmarsh, so that by 1993 only patches of saltmarsh remain (Winning, 1996).

Coastal Saltmarsh EEC is present on Ash Island and in the Tomago area which is located to the north of the Project site (Department of Commerce, 2005). The Coastal Saltmarsh EEC occurs in a number of conservation reserves including Kooragang NR (NSW Scientific Committee, 2004b).

The occurrence of Coastal Saltmarsh EEC in the Project site and surrounds was recently assessed by Connell Hatch (2006a). The Coastal Saltmarsh EEC has been recorded in sections of Big Pond, Ponds O, P, B, D, AB and R.

It is estimated that a total of approximately 3 ha of Coastal Saltmarsh EEC would be disturbed by the Project (i.e. approximately 0.5 ha in Ponds O and P for the rail development and approximately 2.5 ha in Big Pond).

The BPHOS Report includes planned compensatory increases and/or enhancements in saltmarsh habitat at Ash Island and at Tomago (Department of Commerce, 2005). It is considered that the Coastal Saltmarsh EEC in the Big Pond area and Ponds P and O has low species diversity and is in moderate conservation condition.

Known and potential habitat for Coastal Saltmarsh EEC would be disturbed for the Project as described above. In relation to the regional distribution of known or potential habitat for this EEC, it is considered that the area to be disturbed for the Project does not constitute a significant area given the small scale of the habitat disturbance required for the Project and the greater quantity and quality of such habitat in the State. In addition, a number of mitigation and compensatory measures are proposed as part of the Project in relation to the management of Coastal Saltmarsh EEC habitat (Sections E4.2 and E4.3).

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Coastal Saltmarsh EEC has been recorded from NSW North Coast, Sydney Basin and South East Corner Bioregions (NSW Scientific Committee, 2004b).

Considering the Project site is located in the NSW Sydney Basin Bioregion, it can be concluded that the Project site is located within the middle of the distribution of the Coastal Saltmarsh EEC and therefore does not represent a distributional limit for this community.

4. How is the proposal likely to affect current disturbance regimes?

The Project is unlikely to affect any of the current disturbance regimes operating at the Project site and surrounds, including flooding flows and fire. As explained in Section E4.1, the potential for the Project to alter the natural flow regime in the area of the Project rail infrastructure (i.e. across the KIWEF site) would be minimised by the installation of culverts under the rail embankments at low points in the existing topography. Culverts would allow surface waters to continue to flow across the site in a similar manner to the existing conditions.

There is unlikely to be any change to the current fire regime due to the Project because several fire control measures would be implemented as described in Section E4.2.

5. How is the proposal likely to affect habitat connectivity?

The habitat requirements for the Coastal Saltmarsh EEC are described above. As previously established, known and potential habitat for this EEC occurs within the Project disturbance area and surrounds (i.e. Big Pond, Ponds O, P, B, D, AB and R).

Of the ponds containing potential habitat for Coastal Saltmarsh EEC, only Ponds O, P and Big Pond would be disturbed by the Project. A series of ponds which contain known habitat for Coastal Saltmarsh EEC (Ponds R, AB, B and D) would remain undisturbed by the Project.

In consideration of the above, there is unlikely to be any significant change of habitat connectivity for the Coastal Saltmarsh EEC for the Project.

6. How is the proposal likely to affect critical habitat?

There is no critical habitat as listed on the NPWS Critical Habitat Register (NPWS, 2006) or DEH Register of Critical Habitat (2006b) located in the Project site or surrounds.

E3.6.3 Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

This question is not applicable because the subject of this evaluation is an EEC (i.e. not a threatened species or population).

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Freshwater Wetlands on Coastal Floodplains) EEC is the name given to the ecological community associated with periodic or semi-permanent inundation by freshwater (minor saline influence may be present in some wetlands) (NSW Scientific Committee, 2005).

Freshwater Wetlands on Coastal Floodplains EEC generally occur on silts, muds or humic loams in depressions, drainage lines, flats, backswamps, lagoons and lakes associated with coastal floodplains (NSW Scientific Committee, 2005).

The occurrence of Freshwater Wetlands on Coastal Floodplains EEC in the study area was recently mapped by Connell Hatch (2006a). The Freshwater Wetlands on Coastal Floodplains EEC occurs across the study site (Connell Hatch, 2006a) (Attachment E-C).

It is estimated that a total of approximately 50 ha of Freshwater Wetlands on Coastal Floodplains EEC would be disturbed by the Project (i.e. approximately 6 ha for the rail development and approximately 44 ha for the coal storage area). The small amount of Freshwater Wetlands on Coastal Floodplains EEC to be disturbed for the Project is not considered significant in comparison to the total Freshwater Wetlands on Coastal Floodplains EEC in the lower Hunter – Central Hunter region (approximately 3,500 ha quantified in the 1990s [NSW Scientific Committee, 2005]).

According to the BPHOS Report, the loss of the Freshwater Wetlands on Coastal Floodplains EEC in the Big Pond area is not considered critical on a local or regional scale given, firstly, the isolated and small area of the EEC and, secondly, the planned compensatory increase in saltmarsh habitat at Ash Island and at Tomago detailed in the BPHOS Report (Department of Commerce, 2005).

Known habitat for Freshwater Wetlands on Coastal Floodplains EEC would be disturbed for the Project in Ponds H, K, P, Q, M and Big Pond and Deep Pond, and potentially on the western fringe of Pond A. However, Ponds AD, S, O, L, J, I, R, AA, AC, AB, AE, B, C, D, E, G, V, U, W, X, Y, Z, T and F would not be directly disturbed by the Project. In relation to the regional distribution of known or potential habitat for this species, it is considered that the area to be disturbed for the Project does not constitute a significant area given the small scale of the habitat disturbance required for the Project and the greater quantity and quality of such habitat in the lower Hunter-Central Hunter region.

In addition, a number of mitigation measures are proposed as part of the Project in relation to the management of the Freshwater Wetlands on Coastal Floodplains EEC (Section E4.2).

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Freshwater Wetlands on Coastal Floodplains EEC generally occurs below 20 m elevation in the NSW North Coast, Sydney Basin and South East corner bioregions (NSW Scientific Committee, 2005).

Considering the Project site is located in the NSW Sydney Basin Bioregion, it can be concluded that the Project site is located within the middle of the distribution of the Freshwater Wetlands on Coastal Floodplains EEC and therefore does not represent a distributional limit for this community.

4. How is the proposal likely to affect current disturbance regimes?

The Project is unlikely to affect any of the current disturbance regimes operating at the Project site and surrounds, including flooding flows and fire. As explained in Section E4.1, the potential for the Project to alter the natural flow regime in the area of the Project rail infrastructure (i.e. across the KIWEF site) would be minimised by the installation of culverts under the rail embankments at low points in the existing topography. Culverts would allow surface waters to continue to flow across the site in a similar manner to the existing conditions.

There is unlikely to be any change to the current fire regime due to the Project because several fire control measures would be implemented as described in Section E4.2.

5. How is the proposal likely to affect habitat connectivity?

The habitat requirements for Freshwater Wetlands on Coastal Floodplains EEC are described above. As previously established, known and potential habitat for this species occurs within the Project site and a portion would be disturbed for the Project (approximately 50 ha) (i.e. Ponds A, H, K, P, Q, M and Big Pond and Deep Pond).

However, a series of Ponds in the area surrounding the Project site would not be directly disturbed by the Project (i.e. Ponds AD, S, O, L, J, I, R, AA, AC, AB, AE, B, C, D, E, G, V, U, W, X, Y, Z, T and F). In consideration of the above, there is unlikely to be any significant change in habitat connectivity for the Freshwater Wetlands on Coastal Floodplains EEC for the Project.

6. How is the proposal likely to affect critical habitat?

There is no critical habitat as listed on the NPWS Critical Habitat Register (NPWS, 2006) or DEH Register of Critical Habitat (2006b) located in the Project site or surrounds.

E3.7 SEPP – COASTAL WETLANDS

The objective of SEPP 14 - Coastal Wetlands is to preserve and protect coastal wetlands for environmental and economic reasons. The policy identifies over 1,300 wetlands of high natural value. Land clearing, levee construction, drainage work or filling may not be conducted without the consent of the local council and concurrence of the Director of Planning.

There is one wetland identified in SEPP 14 which is adjacent to the south arm of the Hunter River and the Kooragang Island rail mainline. However, the Project would not directly disturb this SEPP 14 Wetland (Figure E-2).

E3.8 SEPP – LITTORAL RAINFOREST

The aim of SEPP 26 – Littoral Rainforests is to protect littoral rainforests (a type of rainforest adapted to harsh salt-laden and drying coastal winds). The Policy requires that the likely effects of a proposed development are thoroughly considered in an EIS. The policy applies to 'core' areas of littoral rainforest as well as a surrounding 100 m wide 'buffer' area except for residential land and areas to which SEPP 14 applies. Eighteen Local Government Areas are affected by SEPP 26, however, Newcastle Local Government is not listed as one of them. There is no littoral rainforest in the Project site so subsequently no littoral rainforest protected by SEPP 26 would be directly disturbed by the Project.

E3.9 MANGROVES

Mangroves are valuable as nursery grounds for fish and prawns (Queensland Museum, 1998). The removal of mangroves requires a permit from NSW Fisheries in accordance with S205 of the *Fisheries Management Act, 1994*.

Mangrove vegetation is currently expanding in area along much of the NSW coast, including the Hunter Estuary where between 1954 and 1994, the area of mangroves in the lower Hunter River and Kooragang Island increased by 31% and 20%, respectively (Williams *et al.*, 2000). Mangroves in the Hunter Estuary have been expanding at the expense of the Coastal Saltmarsh EEC and, in some areas (e.g. Ash Island), mangroves have been removed to enhance habitat for Coastal Saltmarsh EEC and shorebirds (Section 3.7.2 of the Project EA).

There are several scattered juvenile mangrove trees along the shoreline in the Project site. Any disturbance of mangroves in this area would be done as part of dredging activities. The NSW Maritime Authority holds a development consent (DA-134-3-2003-i) granted to it by the Minister on 9 August 2005 for the Extension of Shipping Channels within the Port of Newcastle (including dredging, excavation, treatment and disposal of sediments from the south arm of the Hunter River) (the Port Consent). The dredging of the south arm of the Hunter River adjoining to and on the Project site is not assessed in this EA and does not form part of this Project. This dredging is authorised for the purposes of the EP&A Act by the Port Consent (Section 3 of the Project EA).

According to these Consent Conditions:

"B2.38 A buffer of at least 50 metres shall be maintained between all plant and equipment associated with dredging/excavation works and mangrove areas that will not be removed as part of the development.

B2.39 Prior to the commencement of any phase of the dredging or excavation works, that will result in the removal of mangroves, wetland vegetation or saltmarsh communities, a compensatory habitat package shall be established in consultation with and to the satisfaction of the DEC and DPI. The package shall include one or more of the following compensatory measures:

- a) provision of no less than 15 hectares of compensatory habitat, whether new or restored, comprising Saltmarsh Endangered Ecological Community; or*
- b) equivalent financial contribution to a wetland rehabilitation project in the Lower Hunter Region; or*
- c) equivalent provision of new or maintained intertidal feeding areas and roosting habitats for waters in the Hunter River Estuary; or*
- d) any other form of compensatory habitat agreed by the DEC and DPI.*

Funding or works associated with the compensatory habitat package shall commence prior to the commencement of any phase of the dredging or excavation works, that will result in the removal of mangroves, wetland vegetation or saltmarsh communities. This condition does not apply with respect to dredging to supply materials to Stage 1B [refer to condition A2.1b)]."

E3.10 NOXIOUS WEEDS

Seven noxious weeds listed for Newcastle City Council (NCC) were recorded within the study site by the Project vegetation survey (Connell Hatch, 2006a):

- Crofton Weed (*Ageratina adenophora*);
- Burr Ragweed (*Ambrosia confertifolia*);
- Bitou Bush (*Chrysanthemoides monilifera* ssp. *rotunda*);
- Boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*);
- Pampas Grass (*Cortaderia selloana*);
- Lantana (*Lantana camara*); and
- Yellow Wood Sorrel (*Oxalis corniculata*).

Noxious weeds such as Bitou Bush and Pampas Grass occur throughout the study site, the latter being particularly problematic (Connell Hatch, 2006a).

The following additional noxious weeds listed for NCC were recorded in the Project site by previous studies (URS, 2000 in Protech Steel, 2001; Protech Steel, 2001; Department of Commerce, 2005):

- Ragweed (*Ambrosia artemisiifolia*);
- Mossman River Grass (*Cenchrus echinatus*);
- African Boxthorn (*Ligustrum sinense*);
- Prickly Pear (*Opuntia stricta*);
- *Oxalis perennans*; and
- Noogorra Burr (*Xanthium* sp.).

E4 DISCUSSION

Potential impacts of the Project on flora and proposed mitigation measures are outlined in Sections E4.1 and E4.2, respectively.

E4.1 POTENTIAL IMPACTS

The likelihood of the Project having a significant effect on relevant threatened flora and EECs is assessed in Section E3.6. Based on the evaluations presented in Section E3.6, it is considered that the Project is unlikely to have a significant effect on threatened species or EECs. Therefore, the impact of the Project on threatened flora and EECs is not considered to be significant from a local or regional perspective.

Presented below is an assessment of the potential impacts of the Project on flora. In considering these potential impacts, it is relevant to note the condition and context of the Project site.

- The Project site is situated on land zoned Zone 4(b) (Port and Industry), 5(a) (Special Uses Zone - Arterial Road) and an unzoned area (Hunter River) under the Newcastle LEP. The Kooragang NR located approximately 1 km to the north of the Project site provides protected habitat for threatened fauna, as it is on land zoned 8(a) (National Parks) by the Newcastle LEP.
- The Project rail infrastructure would be constructed on land which is part of the KIWEF which is owned by the RLMC. The KIWEF is licensed as a Solid Waste Class 2 landfill under EPL 6437, issued under the POEO Act.
- The ecosystem in the Project site can be considered to be dynamic as the landuse history of the site is such that much of the original vegetation has been covered by fill. Embankments, excavations and changed hydrological conditions have created the conditions for wetlands and marshes of varying conservation values.

Overall the ecosystem processes operating in the Project site are considered to be sub-optimal. However, the Project site provides habitat for a threatened flora species and two EECs.

Potential impacts of the Project on flora have been assessed in terms of threatening processes as follows.

Clearing of Native Vegetation - Vegetation Clearance is classified as a Key Threatening Process under the TSC Act. Alteration of habitat can result in direct loss of habitat as well as isolation of habitat through creation of barriers to movement between populations. There is considerable information about the value of vegetation corridors to flora and fauna in Australia (Saunders and Hobbs, 1991).

The majority of vegetation clearance would occur within the Big Pond area as part of the construction of the Project coal storage area. A corridor has been defined as a "*linear two-dimensional landscape element that connects two or more patches of wildlife habitat that have been connected in historical time*" (Soule and Gilpin, 1991). Vegetation clearance associated with the Project has the potential to fragment vegetation remnants and impact on the continuity of corridors.

Approximately 3 ha of Coastal Saltmarsh EEC and approximately 50 ha of Freshwater Wetlands on Coastal Floodplains EEC would be directly disturbed by the Project. Significant areas of these two EECs in the Project site and surrounds would not be directly disturbed by the Project (Section E3.6).

Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands - Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is also listed as a Key Threatening Process under the TSC Act. However, the Project site and immediate surrounds is now a highly modified floodplain (i.e. would not be described as a natural flow regime) with a series of contrived and more or less artificial wetlands with limited connectivity with surrounding wetland areas.

Big Pond would be directly infilled as a result of the Project. Smaller waterbodies within the Project site would be disturbed during construction of the rail infrastructure corridor. In addition, the southern area of Deep Pond would be traversed by the Project northern rail spur should it be required when the Project is fully developed to 66 Mtpa.

It should be noted that the existing flow regimes across the Project site are highly modified (i.e. not natural), however the potential for the Project to alter the existing flow regime in the area of the Project rail infrastructure corridor (i.e. across the KIWEF site) would be minimised by the installation of culverts under the rail embankments at low points in the existing topography. Culverts would allow surface waters to continue to flow across the site in a similar manner to the existing condition.

Coal Dust – Emissions associated operation of the Project would be primarily derived from coal dust emissions from transfer points, stacking/reclaiming, loading/unloading and wind blown emissions (particularly from the surfaces of coal stockpiles) (Appendix B of the Project EA).

Studies have shown that excessive dust generation can impact on the health and viability of surrounding vegetation. Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and allow penetration of phytotoxic gaseous pollutants (Eller, 1977; Farmer, 1993).

To meet stringent air quality assessment criteria, comprehensive air quality emission controls have been incorporated in the Project design and would be implemented as part of the Project development. The air quality assessment criteria are based on relevant human amenity and health criteria (Appendix B of the Project EA). All relevant air quality assessment criteria would be met by the Project (Section 4.4.3 and Appendix B of the Project EA). Based on this, the effect of dust caused by the Project on the health and viability of surrounding vegetation is expected to be minimal.

Fire – Coal stockpiles have the potential to self-heat, giving rise to smoldering fires (i.e. spontaneous combustion). In addition, accidental fires may occur (e.g. fires associated with the transport, storage and usage of fuels and chemicals). However, the frequency of fires would be reduced through the use of the Project controls described in Section E4.2. Therefore, it is considered unlikely that the Project would result in a significant change in the frequency of fires.

E4.2 MITIGATION MEASURES

Although the Project would avoid or minimise direct impacts on threatened species, EECs and associated habitats wherever possible, several measures have been developed to mitigate unavoidable impacts of the Project on flora including a flora and fauna management plan (FFMP) as described below.

Flora and Fauna Management Plan

The FFMP would be prepared prior to Project construction and would include management measures to be undertaken during construction and operation, including a vegetation clearance protocol, weed control and landscape plantings. The main components to be included in the FFMP are described below.

During construction, vegetation (including the Freshwater Wetlands on Coastal Floodplains EECs and the Coastal Saltmarsh EECs) immediately adjoining the Project disturbance areas would be delineated and clearly marked to minimise the potential for accidental damage during construction.

A weed management programme would be implemented to limit the spread and colonisation of weeds in the Project site during construction and operations.

Landscape (amenity) plantings would be established on available areas of land between the coal storage area and Cormorant Road (Figure E-2). These landscape plantings would comprise of locally indigenous species in order to provide some potential habitat for local fauna.

As previously discussed, dust controls would be employed, including watering of potential dust generating surfaces, to minimise dust emissions from the Project and associated potential impacts on surrounding vegetation.

The potential for a change in the frequency of fires due to the Project would be reduced through the use of water sprays and prudent stockpile management. A 2 ML fire services tank would also be installed for emergency fire fighting situations. An Emergency Response Plan and Spontaneous Combustion Management Plan would be prepared for the Project and would describe hazard (i.e. fire) preventative and mitigation measures (Section 5 of the Project EA).

The Project would include several measures to minimise disturbance to the marine environment in the south arm of the Hunter River including the water management strategies described in Section 2 of the Project EA. The primary design goal of the Project water management system is that of no discharge to the Hunter River during operation of the Project. Temporary erosion and sediment controls (e.g. silt fences and sediment control structures) would be installed prior to the commencement of construction activities. A silt curtain would be used during construction of the shipping berth batters, wharf structure and during piling operations.

E4.3 COMPENSATORY MEASURES

Existing Compensatory Habitat

Offsets have already been proposed by the NSW government for the development of Big Pond by the Department of Commerce as part of the BPHOS Report (Department of Commerce, 2005). The BPHOS Report proposes to enhance and create compensatory habitats in the Kooragang NR to offset the proposed development of Big Pond (Department of Commerce, 2005).

The proposed compensatory areas are at Ash Island (located on Kooragang Island) and at the Tomago Wetlands (located north of the Hunter River [North Arm]) (Figure E-1). The aim of the BPHOS Report is to modify land of low habitat value to create land with high values particularly for resident and migratory shorebirds.

Other offsets funded by the NSW government for potential impacts on Big Pond included the modifications of the Stockton Sand Spit, diurnal roost improvement at Smith Island and Sandy Island, the artificial roost at Fullerton Cove East, pond construction at Ash Island and reintroduction of tidal flows at Tomago (Straw, 1999, 2000).

In essence, Big Pond is a wetland area that was artificially created and has been manipulated as a foraging habitat for shorebirds (Straw, 1999). Originally, Big Pond was part of an intertidal mangrove area which was cut off from tidal influence when Moscheto Creek was blocked by a railway and then bunded to create land suitable for industrial use (Straw, 1999). Shorebirds ceased to use Big Pond when water flows to the wetland were blocked by an extension of PWCS in 1994 (*ibid.*). In order to make Big Pond attractive again to shorebirds, PWCS constructed a weir so that water levels could be manipulated but this was subsequently removed (*ibid.*).

No waterbirds or threatened avian species were observed during the survey at Big Pond during the Project surveys conducted during summer 2005-2006 (Avifauna Research and Services, 2006). This is most likely because Big Pond has since evolved from a brackish/saline open wetland with extensive mudflats and shallows to a largely freshwater wetland dominated by sedge and reeds as well as some open areas of mudflats or grass (Avifauna Research and Services, 2006).

The offsets funded by the NSW government address the potential impacts of the development of Big Pond.

Kooragang Wetland Rehabilitation Project Environmental Management Plan

A financial contribution would be made to Kooragang Wetland Rehabilitation Project (KWRP) towards updating its Environmental Management Plan (EMP) to incorporate the details of the proposed habitat creation initiatives outlined below, where relevant to lands managed by the KWRP. This would include a consultation programme and input from relevant independent experts.

Habitat Creation

Habitat creation for the Green and Golden Bell Frog and shorebirds/saltmarsh would be funded as part of the Project.

A financial contribution would be made towards current or future projects which involve habitat creation for the Green and Golden Bell Frog on RLMC-owned lands within the KWRP or alternate suitable lands in the Kooragang NR. Habitat creation would be located on the perimeter of existing habitat areas to provide suitable habitat into which the existing Green and Golden Bell Frog population can expand. This habitat creation would also create an opportunity to research the performance of alternative types of habitat enhancement.

Habitat creation initiatives for the Green and Golden Bell Frog would include construction of two habitat ponds of similar scale and detail to existing ponds where the Green and Golden Bell Frogs have been recorded on the KIWEF site (i.e. Pond C) (Appendix F of the Project EA). This is consistent with the recovery strategies (i.e. *habitat rehabilitation/restoration and/or regeneration and monitoring*) identified by the DEC to help recover the Green and Golden Bell Frog (DEC, 2005b).

Mangroves in the Hunter Estuary have been expanding at the expense of the Coastal Saltmarsh EEC and, in some areas (e.g. Ash Island), mangroves have been removed to enhance habitat for Coastal Saltmarsh EEC and shorebirds. A financial contribution would be made to an organisation such as the KWRP for the removal of up to 6 ha of mangroves from coastal saltmarsh habitat. A financial contribution would also be made towards the construction of a flow control structure to minimise the potential for mangrove propagules to enter areas reserved for saltmarsh. Alternatively, these initiatives may also be applied to lands within the Kooragang NR. These works are expected to enhance habitat for shorebirds as well as provide habitat for the Coastal Saltmarsh EEC.

In addition, habitat in the form of shallow areas for foraging shorebirds would be created during the construction of the northern rail spur embankment, if required to be installed when the Project is fully developed to 66 Mtpa, by modifying the design of the embankment batter slopes to have a gentle toe gradient (i.e. in the submerged zone of the batter slope). This would result in the creation of shallow areas suitable for shorebirds in Deep Pond. The specifications of this initiative would be detailed in the FFMP.

No habitat enhancement or creation works would be conducted on land subject to SEPP 74 (Newcastle Port and Employment Lands) (Section 3 of the Project EA).

E4.4 ECOLOGICAL INITIATIVES

Two additional ecological initiatives would be implemented for the Project including financial contributions towards research and exhibitions promoting conservation awareness.

Contribution to Research

A financial contribution would be given to the University of Newcastle, or other appropriate recognised research body, to fund research into the Green and Golden Bell Frog. The focus of research would be to expand existing knowledge of factors affecting the species which may be used to actively improve the strength of the population of Green and Golden Bell Frogs on Kooragang Island.

This is consistent with one of the recovery strategies (i.e. *research: general biological and ecological studies*) identified by the DEC to help recover the Green and Golden Bell Frog (DEC, 2005c).

Contribution to Hunter Wetlands Centre

A financial contribution would be given to the Hunter Wetlands Centre towards an annual exhibition regarding the Green and Golden Bell Frog and migratory shorebirds. The exhibition would include an update on the progress and the effectiveness of the habitat enhancement initiatives conducted as part of the compensatory measures of the Project. This would also provide an opportunity for a representative undertaking the university-based research described above to explain the progress/findings of the research to the interested public.

This is consistent with one of the recovery strategies (i.e. *community and land-holder liaison/awareness and/or education*) identified by the DEC to help recover the Green and Golden Bell Frog (DEC, 2005b).

E5 REFERENCES

- Anderson, R. H. (1968) *The Trees of New South Wales*. Fourth Edition. New South Wales Department of Agriculture, Sydney.
- Avifauna Research and Services (2006) *Shorebird Study and Habitat Assessment NCIG Project, Kooragang Island*. Final Report.
- Briggs, J. D. and Leigh, J. H. (1996) *Rare or Threatened Australian Plants*. Revised Edition. CSIRO Australia, Collingwood.
- Connell Hatch (2006a) *NCIG Kooragang Island Coal Export Terminal – Seasonal Ecological Investigations – Vegetation and Habitat Survey*. Revision 2.
- Connell Hatch (2006b) *NCIG Kooragang Island Coal Export Terminal – Seasonal Ecological Investigations – Zannichellia palustris Targeted Surveys*. Revision 1.
- Dames & Moore (1999) *Phase 2 Contamination Assessment Lot 203 Cormorant Road Kooragang Island*. Report prepared for the Department of Public Works and Services.
- Department of Commerce (2005) *Big Pond Habitat Offset Scheme Flora and Fauna Studies*. Prepared by GHD.
- Department of Environment and Conservation (DEC) (2005a) *Zannichellia palustris – Profile*.
- Department of Environment and Conservation (DEC) (2005b) *Green and Golden Bell Frog – Priority Actions*.
- Department of Environment and Conservation (DEC) (2006) *Atlas of NSW Wildlife – Records for the Newcastle, Port Stephens and Lake Macquarie 1:100,000 Map Sheets*. Data received 15 February 2006.
- Department of Environment and Conservation (DEC) and Department of Primary Industries (DPI) (2005) *Draft Guidelines for Threatened Species Assessment*.
- Department of the Environment and Heritage (DEH) (2005) *Interim Biogeographic Regionalisation for Australia – Version 6.1*. Provided by Bruce Cummings (DEH) 14 December 2005.
- Department of the Environment and Heritage (DEH) (2006a) *The Register of the National Estate*.
Website: <http://www.deh.gov.au/>
Date retrieved: 6 February 2006.
- Department of the Environment and Heritage (DEH) (2006b) *Register of Critical Habitat*.
Website: <http://www.deh.gov.au/>
Date retrieved: 7 June 2006.
- Eller, B.M. (1977) Road Dust Induced Increase of Leaf Temperature. *Environmental Pollution* 13: 99-107.
- Farmer, A. M. (1993) The Effects of Dust on Vegetation – A Review. *Environmental Pollution* 79: 63-75.
- Greenwood, M. E. and DuBow, P. J. (2005) Germination characteristics of *Zannichellia palustris* from New South Wales, Australia. *Aquatic Botany* 82: 1-11.
- Hamer, A. (1998) *Aspects of the Ecology of the Green and Golden Bell Frog (*Litoria aurea*) on Kooragang Island, New South Wales, Australia*.
- Hamer, A.J. (2002) *Ecology of the endangered green and golden bell frog *Litoria aurea*: roles of habitat determinants, spatial dynamics, population demography and threatening processes*. PhD thesis, The University of Newcastle.
- Harden, G. J. (Ed.) (1990) *Flora of New South Wales*. Volume 1. Royal Botanic Gardens, Sydney.

- Newcastle Coal Infrastructure Group (NCIG) (2005) *Newcastle Coal Infrastructure Group Coal Export Terminal – Kooragang Island Prefeasibility Study*.
- NSW National Parks and Wildlife Service (NPWS) (1998) *Kooragang Nature Reserve and Hexham Swamp Nature Reserve, Plan of Management*.
- NSW National Parks and Wildlife Service (NPWS) (2006) *NPWS Critical Habitat Register*.
Website: <http://www3.environment.nsw.gov.au/>
Date retrieved: 19 May 2006.
- NSW Scientific Committee (2004a) *Final Determination for Zannichellia palustris (a submerged aquatic plant)*.
- NSW Scientific Committee (2004b) *Final Determination for Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions*.
- NSW Scientific Committee (2005) *Final Determination for Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*.
- Port Waratah Coal Services (PWCS) (1996) *Kooragang Coal Terminal Stage Three Expansion Environmental Impact Statement*.
- Protech Steel (2001) *Proposed Cold Mill Facility Kooragang Island Environmental Impact Statement*.
- Queensland Museum (1998) *Wild Guide to Moreton Bay* Queensland Museum, South Brisbane.
- Ramsar Convention (2006) *The List of Wetlands of International Importance*.
Website: <http://www.ramsar.org/>
Date retrieved: 6 February 2006.
- RCA Australia (2005) *Geotechnical & Environmental Review, Kooragang Island*.
- Regional Land Management Corporation (RLMC) (2003) *Kooragang Port and Transport Corridor, Species Impact Statement*. Prepared by ERM.
- Saunders, D.A. and Hobbs, R.J. (Eds) (1991) *Nature Conservation 2: The Role of Corridors*. Surrey Beatty and Sons. Chipping Norton.
- Soule, M.E. and Gilpin, M.E. (1991) The Theory of Wildlife Corridor Capacity. In D.A. Saunders and R.J. Hobbs (Eds) *Nature Conservation 2: The Role of Corridors*. Surrey Beatty and Sons. Chipping Norton.
- Straw, P. (1999) *Hunter River Estuary Wader Habitat Investigation – Report to NSW National Parks and Wildlife Service*.
- Straw, P. (2000) *Hunter Estuary Wader Habitat Investigation Stage 2 - Report to NSW National Parks and Wildlife Service*.
- Sydney Royal Botanical Gardens Database (2006) *Database Records for the Search Area – 151°38' to 151°51'E by 32°46' to 32°57'S*. Data received 15 February 2006.
- Umwelt (2003a) *Aboriginal Cultural Heritage Assessment, Proposed Extension of Shipping Channels, Port of Newcastle*. Report prepared for New South Wales Waterways Authority.
- Umwelt (2003b) *Terrestrial Ecology Impact Assessment Report, Proposed Extension of Shipping Channels, Port of Newcastle Environmental Impact Statement*. Report prepared for New South Wales Waterways Authority.
- URS (2000) *Background Study – Flora and Fauna Survey – Kooragang Island Industrial Area, Newcastle, NSW*. Prepared for Bovis Lend Lease.

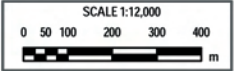
- Waterways Authority (2003) *Proposed Extension of Shipping Channels, Port of Newcastle, Environmental Impact Statement*.
- Waterways Authority (2004) *Supplementary Reports to the EIS for the proposed extension of shipping Channels, Port of Newcastle*.
- West, R., Thorogood, C. A., Walford, T. J. and Williams, R. J. (1985) *An Estuarine Inventory for New South Wales*. Department of Agriculture, NSW. Fisheries Bulletin 2, Sydney.
- Williams, R. J., Watford, F. A. and Balashov, V. (2000) *Kooragang Wetland Rehabilitation Project: History of changes to estuarine wetlands of the lower Hunter River*. Final Report to Kooragang Wetland Rehabilitation Project Steering Committee.
- Winning, G. (1991) *Western Kooragang Island Vegetation Study*.
- Winning, G. (1993) *Tomago - Fullerton Cove Vegetation Survey*.
- Winning, G. (1996) *Vegetation of Kooragang Nature Reserve and Hexham Swamp Nature Reserve and Adjoining Land*. Prepared for NSW National Parks & Wildlife Service.
- Winning, G. (1998) *Flora and Fauna Assessment for Proposed Rehabilitation of Estuarine Wetlands at Tomago, NSW*.
- Winning, G. (2000) *Flora and Fauna Assessment for Proposed Rehabilitation of Estuarine Wetlands at Tomago in the Hunter River Estuary, NSW*.
- Winning, G. (2004) *Ecological Assessment for Proposed Sandgate Rail Grade Separation Environmental Impact Statement*.

ATTACHMENT E-A
BROAD HABITAT TYPES ACROSS STUDY SITE



LEGEND

- Estuarine
- Freshwater Wetland
- Terrestrial



Proposed Coal Unloader
Kooragang Island
Seasonal Ecological Investigations



FIGURE 3.1
BROAD HABITAT TYPES
ACROSS STUDY SITE

ATTACHMENT E-B
FLORA SPECIES RECORDED IN THE PROJECT SITE

**Attachment E-B
Flora Species Recorded in the Project Site**

| Scientific Name | Common Name | Project Surveys ¹ | BPHOS ² | Protech Steel (2001) ³ | URS (2000) ⁴ |
|---|----------------------|------------------------------|--------------------|-----------------------------------|-------------------------|
| <i>Acacia falcata</i> | Sickle Wattle | • | | | |
| <i>Acacia irrorata</i> | Green Wattle | • | | | |
| <i>Acacia longifolia</i> | Sydney Golden Wattle | | • | • | |
| <i>Acacia longifolia var sophorae</i> | Coastal Wattle | • | | | |
| <i>Acacia saligna</i> | Golden Wreath Wattle | | | • | • |
| <i>Acacia sophre</i> | Coastal Wattle | | | • | • |
| <i>Acacia ulicifolia</i> | Prickly Moses | • | | | |
| * <i>Acetosa sagittata</i> | Rambling Dock | | | • | |
| * <i>Acetosella vulgaris</i> | Sorrel | | | | • |
| * <i>Ageratina adenophora</i> | Crofton Weed | • | | | |
| <i>Alloasuarina verticillate</i> | Drooping She Oak | | | • | |
| * <i>Ambrosia artemisiifolia</i> | Ragweed | | • | • | |
| * <i>Ambrosia confertifolia</i> | Burr Ragweed | • | | | |
| * <i>Ambrosia sp.</i> | Ragweed | | | | • |
| * <i>Anagallis arvensis</i> | Pimpernel | • | | • | • |
| * <i>Andropogon virginicus</i> | Whiskey Grass | • | | • | |
| * <i>Angellis arvensis</i> | | | • | | |
| * <i>Arctotheca calendula</i> | Capeweed | | | • | |
| <i>Aristida sp.</i> | Wire Grass | | | | • |
| * <i>Atriplex prostrata</i> | | | | • | |
| * <i>Avena fatua</i> | Wild Oat | • | • | | |
| * <i>Avena sp.</i> | Oat | | | | • |
| <i>Avicennia marina var. australasica</i> | Grey Mangrove | • | | • | • |
| * <i>Bambusa sp.</i> | Bamboo | • | | | |
| <i>Banksia ericifolia</i> | | | | • | |
| <i>Banksia integrifolia</i> | Coast Banksia | • | | • | • |
| * <i>Bidens pilosa</i> | Cobbler's Pegs | • | • | • | • |
| <i>Bolboschoenus caldwellii</i> | | | | • | |
| <i>Bolboschoenus fluviatilis</i> | | • | | | |
| * <i>Brassica fruticulosa</i> | | • | | | |
| * <i>Brassica tournefortii</i> | Mediterranean Turnip | | | • | |
| * <i>Briza maxima</i> | Quaking Grass | • | | | |
| * <i>Briza minor</i> | Shivery Grass | | | | • |
| * <i>Bromus brevis</i> | Short Brome | | | | • |
| * <i>Bromus catharticus</i> | Prairie Grass | • | | | • |
| <i>Callistemon citrinus</i> | Crimson Bottlebrush | | | • | |
| <i>Callistemon salignus</i> | Willow Bottlebrush | • | | | |
| <i>Callistemon sp.</i> | Bottlebrush | | | • | |
| <i>Calystegia sepium</i> | | | | • | |
| <i>Carex appressa</i> | Tall Sedge | • | | | |
| <i>Carex sp.</i> | | | | | • |
| <i>Carpobrotus glaucescens</i> | Pigface | • | • | • | |
| <i>Cassinia arcuata</i> | Sifton Bush | | | | • |
| <i>Cassinia uncata</i> | Bent Cassinia | • | | | |
| <i>Cassytha sp.</i> | | | • | | |

Attachment E-B (Continued)
Flora Species Recorded in the Project Site

| Scientific Name | Common Name | Project Surveys ¹ | BPHOS ² | Protech Steel (2001) ³ | URS (2000) ⁴ |
|--|-------------------------|------------------------------|--------------------|-----------------------------------|-------------------------|
| <i>Casuarina equisetifolia</i> | | | | • | • |
| <i>Casuarina glauca</i> | Swamp Oak | • | | • | • |
| <i>Cayratia clematidea</i> | Slender Grape | • | | | |
| * <i>Cenchrus echinatus</i> | Mossman River Grass | | | • | |
| * <i>Centaurium erythraea</i> | Pink Stars | • | | | |
| * <i>Chamaesyce prostrata</i> | | • | | | |
| * <i>Chloris gayana</i> | Rhodes Grass | • | • | • | • |
| <i>Chloris truncata</i> | Windmill Grass | • | | • | |
| * <i>Chloris virgata</i> | Feathertop Rhodes Grass | • | | • | |
| * <i>Chondrilla juncea</i> | | | • | | |
| * <i>Chrysanthemoides monilifera</i> | | | • | | |
| * <i>Chrysanthemoides monilifera</i> <i>ssp. monilifera</i> | Boneseed | | | | |
| * <i>Chrysanthemoides monilifera</i> <i>ssp. rotundata</i> | Bitou Bush | • | | • | • |
| * <i>Cinnamomum camphora</i> | Camphor Laurel | • | | | |
| * <i>Cirsium sp.</i> | Thistle | • | | | |
| * <i>Cirsium vulgare</i> | Spear Thistle | • | | • | • |
| <i>Commelina cyanea</i> | Wandering Jew | | | • | |
| * <i>Conyza bonariensis</i> | Flax-leaf Fleabane | • | | • | • |
| * <i>Cortaderia selloana</i> | Pampas Grass | • | | • | |
| * <i>Cotula coronopifolia</i> | Waterbuttons | • | | | |
| <i>Cupaniopsis anacardioides</i> | Tuckeroo | | | • | |
| * <i>Cupressus sp.</i> | | | | • | |
| <i>Cynodon dactylon</i> | Common Couch | • | • | • | • |
| * <i>Cyperus aggregatus</i> | | | | • | |
| * <i>Cyperus eragrostis</i> | | | • | | |
| <i>Cyperus polystachyos</i> | | • | | | |
| <i>Danthonia caespitosa</i> | Wallaby Grass | | | | • |
| * <i>Datura stramonium</i> | Common Thorn Apple | | | • | |
| <i>Dendrophthoe vitellina</i> | Mistletoe | | | • | |
| <i>Dianella sp.</i> | Flax Lily | | | | • |
| * <i>Eleusine indica</i> | Crowsfoot Grass | | | • | |
| <i>Elymus scaber</i> | Wheat Grass | | | | • |
| * <i>Epilobium sp.</i> | Willow Herb | | | | • |
| * <i>Eragrostis curvula</i> | African Lovegrass | • | • | | • |
| <i>Eucalyptus camaldulensis</i> | River Red Gum | | | • | • |
| <i>Eucalyptus gomphocephala</i> | Tuart | | | • | |
| <i>Eucalyptus sp.</i> | | • | | | |
| <i>Exocarpus cupressiformis</i> | Native Cherry | | | | • |
| * <i>Foeniculum vulgare</i> | Fennel | • | • | • | • |
| <i>Gahnia aspera</i> | Saw Sedge | • | | | |
| <i>Gahnia sp.</i> | | | | | • |
| * <i>Galenia pubescens</i> | Galenia | | | • | |
| <i>Galium sp.</i> | Bedstraw | • | | | |
| * <i>Gamochaeta americana</i> | Cudweed | • | | • | |

Attachment E-B (Continued)
Flora Species Recorded in the Project Site

| Scientific Name | Common Name | Project Surveys ¹ | BPHOS ² | Protech Steel (2001) ³ | URS (2000) ⁴ |
|--|-------------------------|------------------------------|--------------------|-----------------------------------|-------------------------|
| <i>Geranium sp.</i> | Native Geranium | | | | • |
| * <i>Glyceria maxima</i> | | | • | | |
| <i>Glycine clandestina</i> | Twining Glycine | • | | | |
| <i>Glycine sp.</i> | | | | | • |
| * <i>Gnaphalium calviceps</i> | | | | • | |
| * <i>Gnaphalium sp.</i> | | | | | • |
| * <i>Gomphocarpus fruticosus</i> | Narrow Leaf Cotton Bush | • | | | • |
| * <i>Gomphocarpus physocarpus</i> | Cotton Bush | • | | | |
| <i>Grevillea robusta</i> | Silky Oak | • | | | |
| <i>Hardenbergia violacea</i> | False Sarsaparilla | | | | • |
| * <i>Hebenstretia dentata</i> | | | | • | |
| * <i>Heterotheca grandiflora</i> | Telegraph Weed | • | | • | |
| * <i>Hydrocotyle bonariensis</i> | Kurnell Curse | • | • | • | |
| * <i>Hydrocotyle sp.</i> | Pennywort | | | | • |
| * <i>Hyparrhenia rufa ssp. altissima</i> | | | | • | |
| * <i>Hypochoeris glabra</i> | Smooth Catsear | | | • | • |
| * <i>Hypochoeris radicata</i> | Flatweed | • | | • | • |
| <i>Imperata cylindrica</i> | Blady Grass | | | • | |
| * <i>Ipomoea cairica</i> | Morning Glory | | | • | |
| * <i>Ipomoea indica</i> | Coastal Morning Glory | • | • | • | |
| <i>Isolepis nodosa</i> | | • | | | |
| * <i>Juncus acutus</i> | Sharp Rush | • | • | • | |
| <i>Juncus continuus</i> | | • | | • | |
| <i>Juncus usitatus</i> | Common Rush | • | | | |
| <i>Kennedia rubicunda</i> | Dusky Coral Pea | • | | | |
| * <i>Lagunaria patersona</i> | Norfolk Island Hibiscus | | | • | |
| * <i>Lantana camara</i> | Lantana | • | • | • | |
| * <i>Leontodon taraxcooides</i> | Lesser Hawkbit | | | • | |
| * <i>Lepidium africanum</i> | Peppergrass | • | | • | • |
| <i>Leptospermum laevigatum</i> | Coast Teatree | | | • | • |
| * <i>Ligustrum sinense</i> | African Boxthorn | | | | • |
| <i>Lomandra longifolia</i> | Spiny-headed Mat-rush | | | | • |
| <i>Lophostemon confertus</i> | Brush Box | • | | • | |
| * <i>Medicago polymorpha</i> | Burr Medic | • | | • | • |
| * <i>Medicago sativa</i> | Lucerne | • | | | |
| * <i>Medicago truncatula</i> | Barrel Medic | | | • | |
| <i>Melaleuca armillaris</i> | Honey Myrtle | | | • | |
| <i>Melaleuca ericifolia</i> | | • | | | |
| <i>Melaleuca nesophila</i> | | | | • | |
| <i>Melaleuca quinquenervia</i> | Broad-leaved Paperback | • | | • | |
| <i>Melaleuca styphelioides</i> | Prickle-leaved Tea Tree | | | • | |
| * <i>Mellilotus indicus</i> | Hexham Scent | • | | • | |
| * <i>Melinis repens</i> | Red Natal Grass | • | | • | |
| * <i>Nerium oleander</i> | Oleander | • | | | |
| * <i>Nicotiana glauca</i> | Tree Tobacco | • | | | |

Attachment E-B (Continued)
Flora Species Recorded in the Project Site

| Scientific Name | Common Name | Project Surveys ¹ | BPHOS ² | Protech Steel (2001) ³ | URS (2000) ⁴ |
|--|-------------------------|------------------------------|--------------------|-----------------------------------|-------------------------|
| <i>*Oenothera drummondii</i> | Beach Evening Primrose | • | | • | |
| <i>*Olea europaea ssp. africana</i> | African Olive | • | | | • |
| <i>*Opuntia stricta</i> | Prickly Pear | | • | • | |
| <i>*Oxalis corniculata</i> | Yellow Wood Sorrel | • | | | |
| <i>Oxalis perennans</i> | | | | | • |
| <i>*Panicum maximum var maximum</i> | Guinea Grass | • | | • | • |
| <i>Panicum sp.</i> | Panic | | | | • |
| <i>*Paspalum dilatatum</i> | Paspalum | • | • | • | • |
| <i>Paspalum distichum</i> | Water Couch | • | | | |
| <i>*Pennisetum clandestinum</i> | Kikuyu | • | | • | • |
| <i>Pennisetum setaceum</i> | Fountain Grass | • | | | |
| <i>*Petrohragia nanteuilii</i> | | • | | | |
| <i>*Phoenix canariensis</i> | Canary Island Date Palm | • | | • | |
| <i>Phragmites australis</i> | Common Reed | • | • | • | |
| <i>*Phytolacca octandra</i> | Inkweed | • | | | |
| <i>*Pinus pinaster</i> | Cluster Pine | | | • | |
| <i>*Pinus pinea</i> | Umbrella Pine | | | | • |
| <i>Pittosporum undulatum</i> | Sweet Pittosporum | • | | • | • |
| <i>*Plantago lanceolata</i> | Ribwort | • | • | • | |
| <i>*Plantago sp.</i> | | | | | • |
| <i>Poa affinis</i> | | • | | | |
| <i>*Poa annua</i> | Winter Grass | | | • | • |
| <i>Poa sieberiana ssp. sieberianna</i> | Snow Grass | | | | • |
| <i>Portulaca oleracea</i> | Pigweed | | | • | |
| <i>*Protasparagus aethiopicus</i> | Asparagus Fern | | | | • |
| <i>Pteridium esculentum</i> | Bracken | | | • | |
| <i>*Rhynchelytrum repens</i> | | | • | | |
| <i>*Ricinus communis</i> | Castor Oil Plant | • | • | • | |
| <i>Romulea rosea var. australis</i> | Onion Grass | • | | | |
| <i>*Rubus discolor</i> | Blackberry | | | • | |
| <i>Ruppia megacarpa</i> | Sea Tassel | • | | | |
| <i>Sarcocornia quinqueflora</i> | | | | • | |
| <i>Schoenoplectus litoralis</i> | | • | | | |
| <i>*Senecio madagascariensis</i> | Fireweed | • | | • | • |
| <i>*Senecio sp.</i> | | | | | • |
| <i>*Senna pendula</i> | | | | • | |
| <i>*Setaria gracilis</i> | Slender Pigeon Grass | • | | • | |
| <i>*Setaria pumila</i> | Pale Pigeon Grass | | | • | |
| <i>*Sida rhombifolia</i> | Paddy's Lucerne | • | | • | • |
| <i>*Sisymbrium irio</i> | London Rocket | | | • | |
| <i>*Solanum nigrum</i> | Black Nightshade | • | | • | |
| <i>*Solivia anthemifolia</i> | Button Burweed | | | • | |
| <i>*Sonchus oleraceus</i> | Common Sow-thistle | • | | • | • |
| <i>Sorghum leiocladum</i> | | • | | | |
| <i>*Sporobolus africanus</i> | Parramatta Grass | • | | | |
| <i>*Sporobolus virginicus</i> | Sand Couch | | | • | |

Attachment E-B (Continued)
Flora Species Recorded in the Project Site

| Scientific Name | Common Name | Project Surveys ¹ | BPHOS ² | Protech Steel (2001) ³ | URS (2000) ⁴ |
|----------------------------------|------------------|------------------------------|--------------------|-----------------------------------|-------------------------|
| * <i>Stenotaphrum secundatum</i> | Buffalo Grass | • | | • | |
| <i>Suaeda australis</i> | | | | • | |
| * <i>Tagetes minuta</i> | Stinking Roger | | | • | |
| * <i>Taraxacum officinale</i> | Dandelion | | | • | • |
| <i>Themeda australis</i> | Kangaroo Grass | | | | • |
| * <i>Trifolium repens</i> | White Clover | | • | • | |
| * <i>Trifolium sp.</i> | Clover | | | | • |
| <i>Typha orientalis</i> | Cumbungi | • | • | • | |
| * <i>Verbascum virgatum</i> | Twiggy Mullein | • | | • | |
| * <i>Verbena bonariensis</i> | Purpletop | • | • | | |
| * <i>Verbena brasiliensis</i> | Verbena | | | • | |
| * <i>Verbena rigida</i> | Veined Verbena | • | | | |
| * <i>Vicia sativa</i> | Vetch | | | • | • |
| * <i>Vulpia myuros</i> | Rats Tail Fescue | | | | • |
| <i>Westringia fruticosa</i> | Coastal Rosemary | | | • | • |
| * <i>Xanthium italicum</i> | Hunter Burr | | | • | |
| * <i>Xanthium sp.</i> | Noogorra Burr | | | | • |
| <i>Zannichellia palustris</i> | | • | | | |

¹ NCIG Kooragang Island Coal Export Terminal Seasonal Ecological Investigations – Vegetation and Habitat Survey.

² Department of Commerce (2005) *Big Pond Habitat Offset Scheme Flora and Fauna Studies*. Prepared by GHD.

³ Protech Steel (2001) *Protech Proposed Cold Mill Facility Kooragang Island EIS*.

⁴ URS (2000) in Protech Steel (2001)

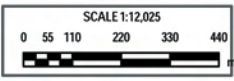
* Introduced species

ATTACHMENT E-C
ENDANGERED ECOLOGICAL COMMUNITIES ACROSS STUDY SITE



LEGEND

- Freshwater Wetland
- Saltmarsh

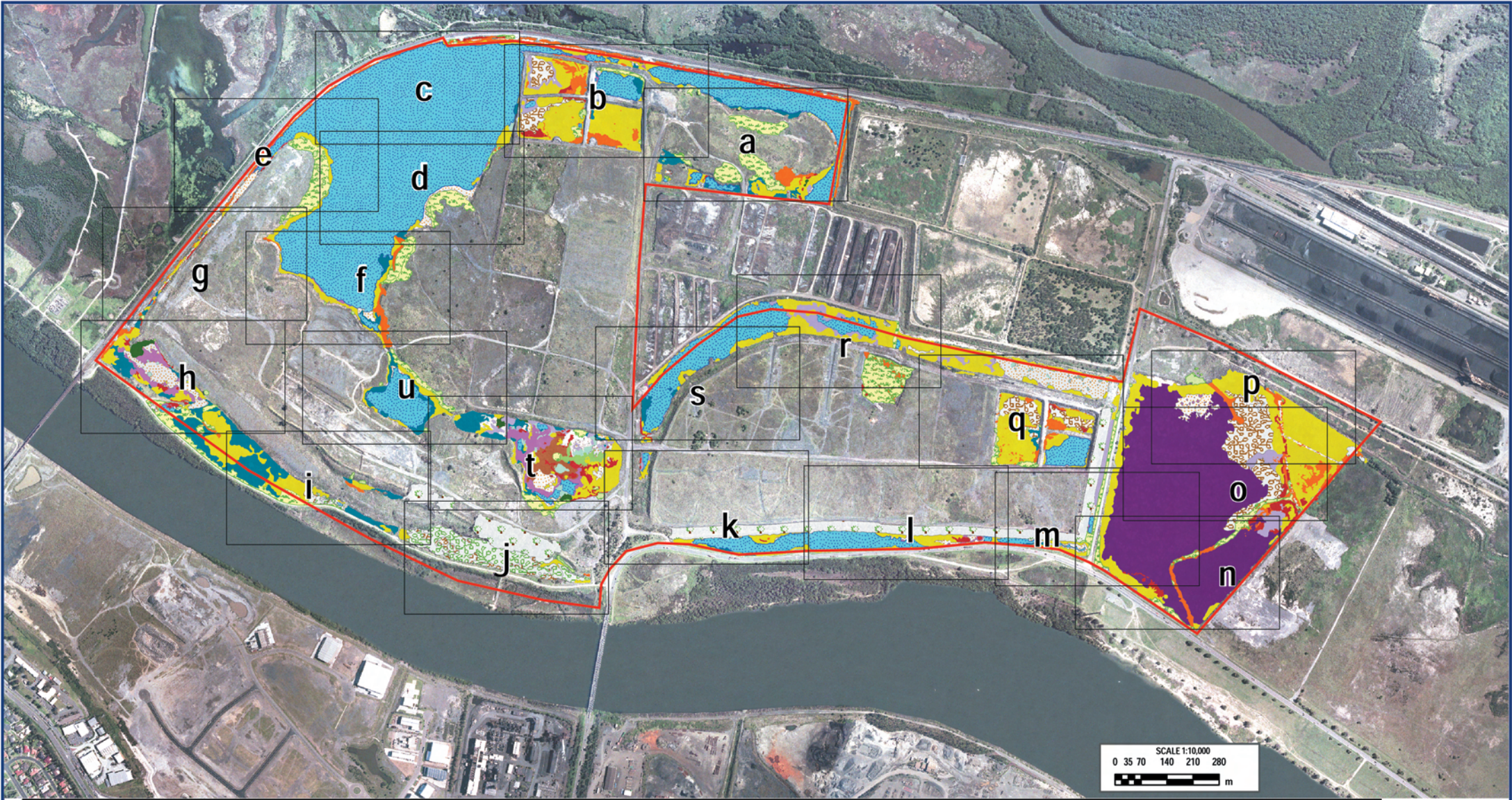


Proposed Coal Unloader
 Kooragang Island
 Seasonal Ecological Investigations



FIGURE 3.2
ENDANGERED ECOLOGICAL COMMUNITIES
ACROSS STUDY SITE

ATTACHMENT E-D
OVERVIEW VEGETATION COMMUNITIES ACROSS STUDY SITE



LEGEND

- | | | | | | | | | | |
|------------|-----------|---------------------|---------------------|----------------|---------------------|------------------------------|------------------------------|------------------------|---------------|
| Study Site | Mangrove | Grasses/Weeds | Landscape Plantings | Open Water | Phragmites Reedland | Mixed Reedland and Sedgeland | Schoenoplectus Sedgeland | Swamp Meadow | Mixed |
| Bare Mud | Saltmarsh | Native Trees/Shrubs | Azolla | Typha Reedland | Mixed Reedland | Bolboschoenus Sedgeland | Mixed Sedgeland/Swamp Meadow | Juncus acutus Rushland | Noxious Weeds |

NOTE: Non-mapped areas are either bare ground or exotic grasses/weeds as described in report



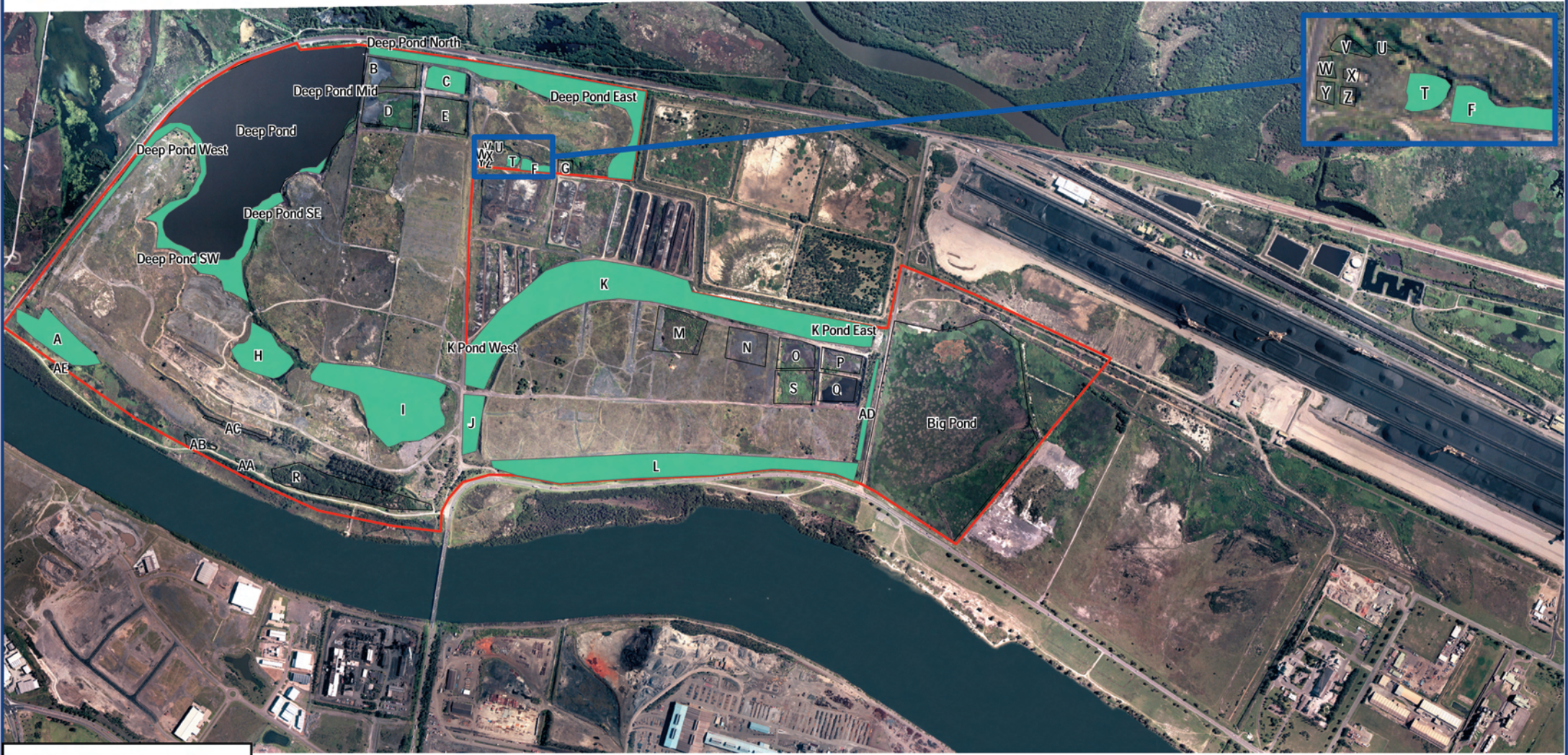
NOTE: Display at A3

Letters correspond to detailed maps

FIGURE 3.3 OVERVIEW VEGETATION COMMUNITIES ACROSS STUDY SITE

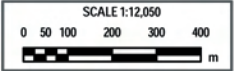
ATTACHMENT E-E

POTENTIAL *ZANNICHELLIA PALUSTRIS* HABITAT ACROSS STUDY SITE



LEGEND

- Study Site
- Ponds
- Potential *Zannichellia palustris* habitat



Proposed Coal Unloader
Kooragang Island
Seasonal Ecological Investigations



FIGURE 4.1:
POTENTIAL ZANNICHELLIA PALUSTRIS
HABITAT ACROSS STUDY SITE

ATTACHMENT E-F

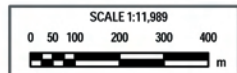
RECORDS OF *ZANNICHELLIA PALUSTRIS* ACROSS STUDY SITE



LEGEND

- Study Site
- Ponds
- Zannichellia palustris
- Likely *M. Greenwood*
- Recorded *M. Greenwood*
- Recorded *Connell Hatch*

M. Greenwood,
University of Newcastle,
pers. comm. 7/2/2006



NOTE: Display at A3

FIGURE 4.2:
RECORDS OF ZANNICHELLIA PALUSTRIS
ACROSS STUDY SITE