



Flora & Fauna Assessment

For
Proposed Waste Emplacement Site

HDC Land
at
Kooragang Island

Prepared for
SBHP Billiton
PO Box 196B
Newcastle NSW 2300



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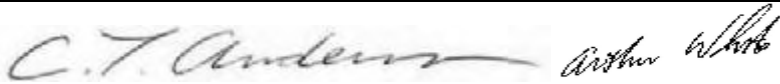
PLANNING > SURVEYING > ECOLOGY

A member of **RPS** Group Plc

Job Reference 25123 - December 2008



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PROJECT: FLORA & FAUNA ASSESSMENT – EMPLACEMENT SITE – KOORAGANG ISLAND	
CLIENT:	BHP BILLITON
OUR REFERENCE:	25123
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EXECUTIVE SUMMARY

RPS Harper Somers O'Sullivan (RPS HSO) has been engaged by BHP Billiton (BHPB) to undertake a Flora and Fauna Assessment, as part of the wider project environmental impact assessment for the Stage 2 approval to proceed application to be lodged with the Department of Planning (DoP). This Assessment specifically addresses the potential for ecological impacts and the appropriate management measures for treated sediment emplacement activities on Kooragang Island (west of Area C) that are proposed as part of BHPB's Hunter River Remediation Project (HRRP).

Biosphere Environmental Consultants (BEC) who have extensive project experience in assessing ecological matters on Kooragang Island, including for the neighbouring Newcastle Coal Infrastructure Group (NCIG), has been engaged to contribute to the ecological assessment.

Kooragang Island is a natural delta that historically exhibited a combination of estuarine wetlands and freshwater wetlands. The site which is the subject of this proposal is a highly disturbed and modified site. The site was used for grazing and dairy farming from the 1830's and the site was used for soil disposal in the late 1880's through until the 1950's. Within the last 40 years, the site which is the subject of the proposed treated sediment emplacement activities has been used as waste disposal grounds for a range of heavy industrial wastes generated from the operation of the former Newcastle Steelworks. This latter activity ceased prior to the closure of the Steelworks in 1999, however, the site is still licensed to receive particular types of wastes.

This assessment aims to examine the likelihood of the proposal to have a significant effect on any threatened species, populations or ecological communities listed within the *Threatened Species Conservation Act 1995* (TSC Act 1995). The report recognises the relevant requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) as amended by the *Environmental Planning and Assessment Amendment Act 1997* (EP&AA Act 1997).

Ecological investigations included field studies (both diurnal and nocturnal) and desktop assessments over the site and its vicinity as conducted by RPS HSO and BEC. Desktop investigations represented the results of other previous ecological investigations for the area as contained in the NSW NPWS Atlas of NSW Wildlife, Hunter Bird Observers Club (HBOC) records and anecdotal records from other ecological investigations from the area.

Six vegetation communities were found to occur within the site, being, Grassy Waste Emplacement Lands, Planted Vegetation, Freshwater Wetland Complex, Coastal Saltmarsh, Swamp Oak Floodplain Forest and Mangrove-Estuarine Complex.

One threatened flora species (*Zannichellia palustris*), eight threatened fauna species (Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe, Red-backed Button Quail, Grass Owl, Magpie Goose, Blue Billed Duck and Freckled Duck) and three EECs (Freshwater Wetland, Swamp Oak Floodplain Forest and Coastal Saltmarsh) were recorded or considered to have at least a moderate chance of occurring within the site.

Whilst the proposal will result in the removal of known or potential habitat for a small number of threatened species, including small areas of core and larger adjacent areas of foraging and shelter habitat for the Green and Golden Bell Frog, for most species such habitat is well represented in the immediate locality, including within existing conservation reserve areas.

The design of the emplacement cell has continually evolved over a period of years via input from ecologists, the Department of Environment and Climate Change (DECC), community interest and research groups and project environmental and engineering design teams, such that direct impacts on core habitat areas for Green and Golden Bell Frog (and other species / communities) has now been significantly reduced (by over 80% from the original emplacement design).

This substantial redesign of the emplacement facility and related disturbance areas has come at a cost of millions of dollars to BHPB and has delayed finalisation of the project emplacement design (for a critical project schedule) by more than 3 months, demonstrating BHPB's firm commitment to significantly reducing its potential for ecological impacts as part of the HRRP.

Further to this, BHPB has committed to strictly implementing a number of mitigation measures during construction and adhering to recommendations outlined within this report to reduce ecological impacts.

In addition, BHPB is committed to providing an ecological offsets package in accordance with the principles outlined by DECC to ensure that an overall holistic balanced outcome is achieved for the related threatened species ecology of the Lower Hunter estuary.

On the basis of the avoidance, mitigation and offset measures committed to, the proposed development is not predicted to have a significant impact on the threatened species found or suspected to occur at this site.

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1 INTRODUCTION

RPS Harper Somers O'Sullivan (RPS HSO) have been engaged by BHP Billiton (BHPB) to undertake a Flora and Fauna Assessment over lands in the vicinity of and to the west of Area C of the Kooragang Island Waste Emplacement Facility (KIWEF) on Hunter Development Corporation (HDC) Lands, Kooragang Island, as shown in Figure 1-1 (hereafter referred to as the "site"). The purpose of the flora and fauna assessment is to assess the site's potential for providing suitable habitat for threatened species and Endangered Ecological Communities (EEC's) known to occur within the Kooragang / Ash Island and Lower Hunter River Estuary areas.

Expert advice regarding Green and Golden Bell Frog (*Litoria aurea*) from Dr Arthur White of Biosphere Environmental Consultants (BEC) has been incorporated into this report, including site inspection, habitat mapping and assessment review.

This assessment aims to examine the likelihood of the proposal to have a significant impact on any threatened species, populations or ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act 1995). The report recognises the relevant requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) as amended by the *Environmental Planning and Assessment Amendment Act 1997* (EP&AA Act 1997).

1.1 Site Particulars

Locality – HDC KIWEF Lands, Kooragang Island

LGA – Newcastle

Area – emplacement footprint 36.3ha

Boundaries – The site is bounded on all sides by filled land

Current Land Use – The land is currently managed by HDC to be ultimately developed for light industrial purposes

Topography – The land and adjacent areas is dominated by large areas of land fill more or less arranged as a network of roads forming a grid of high areas separating waste emplacement cells. Some areas due to previous fill works are uniformly elevated, while others are low due to their unfilled status.

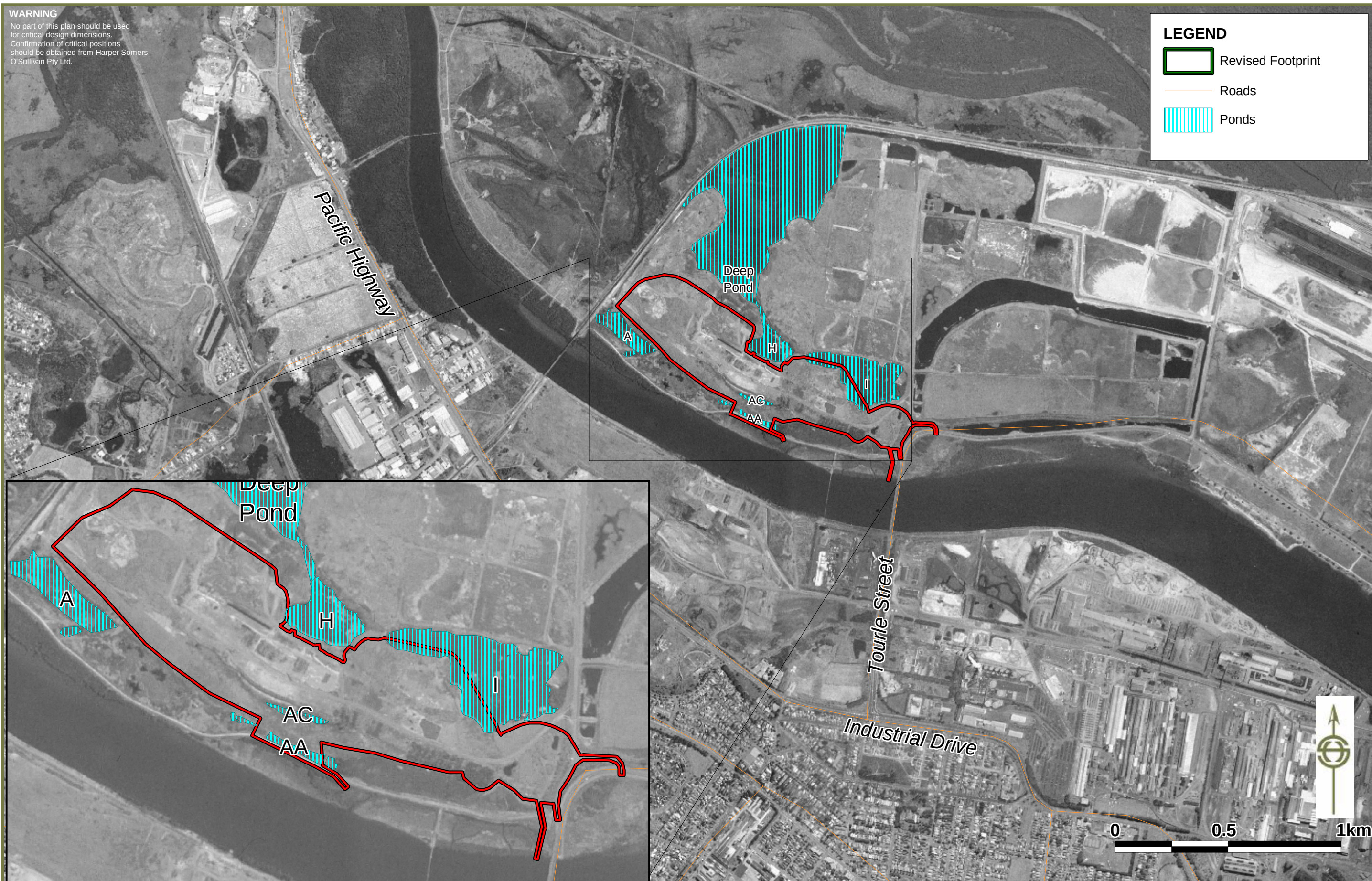
Vegetation – Vegetation communities extant within the site were delineated and mapped using existing regional vegetation community mapping (NPWS 2002), Aerial Photograph Interpretation (API) and ground-truthing as required. Six vegetation communities were found to occur within the site, being, Grassy Waste Emplacement Lands, Planted Vegetation, Freshwater Wetland Complex, Coastal Saltmarsh, Swamp Oak Floodplain Forest and Mangrove-Estuarine Complex.

Site History – Kooragang Island is a natural delta that historically exhibited a combination of estuarine wetlands and freshwater wetlands. The site was used for grazing and dairy farming from the 1830's (Dames & Moore, 1999; Umwelt, 2003) and the site was used for soil disposal in the late 1880's through until the 1950's.

The *Newcastle Harbour Improvement Act, 1953* saw the deltaic islands being used for industrial purposes. Kooragang Island was zoned as heavy Industrial in 1960 and in 1972 BHPB commenced operating the KIWEF at the site. The site was used as a waste emplacement for BHPB until the close of the steelworks in 1999.

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- LEGEND**
-  Revised Footprint
 -  Roads
 -  Ponds



TITLE: Figure 1-1 Site Location
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DATUM: MGA Zone 56 (GDA 94) **DATE:** 31/10/2008
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1.2 Background

The proposed consent application is for a waste emplacement area to receive treated river sediments, as part of BHPB's Hunter River Remediation Project (HRRP). The HRRP will remediate sediments recovered from the South Arm of the Hunter River that have been contaminated by the activities of the BHP-owned former Newcastle Steelworks site at Mayfield, Newcastle.

The HRRP has been approved on the basis that the project be undertaken in a staged manner. The original Environmental Impact Statement (EIS) (GHD, 2003) discussed in detail the potential impacts of the project on the terrestrial ecology of the northern bank of the Hunter River as a result of the project. The original EIS also discussed disposal options for sediments treated as part of the proposal, including disposal within the KIWEF and the potential for a level of ecological impacts on species, including the threatened Green and Golden Bell Frog. However, detailed impact assessment of the site was not undertaken at that stage given the final disposal location(s) of treated sediment and related emplacement design was still to be confirmed.

In order to provide an assessment of the potential impacts of the proposed disposal of treated material within the KIWEF as part of the approved HRRP project, further detail on key ecological issues has been requested by authorities.

1.2.1 Description of HRRP

The main contaminant of concern within the sediments of the Hunter River is Polycyclic Aromatic Hydrocarbons (PAHs) which are gases or particles produced when organic matter is burnt. The PAHs within the Hunter River sediments are mainly a result of discharges from coke ovens used to convert coal to coke for steelmaking at the Newcastle Steelworks site. The main PAH present within the Hunter River is Naphthalene. PAHs can be broken down when they are exposed to sunlight and/or by microorganisms found naturally in soil.

Dredged materials will primarily consist of clays, silts, sands and gravels from the bed of the Hunter River. Dredged contaminated sediments will be loaded into a barge and transported to shore for treatment.

Originally, the dredged contaminated materials were proposed to be disposed of on the Newcastle Steelworks site at Mayfield. However, this was ultimately rejected by the landowner (NSW Government) and the nearby former Newcastle Steelworks waste emplacement site was then considered to be a more suitable location for treatment of contaminated sediments dredged from the Hunter River as part of the HRRP. The proposed site and surrounds on Kooragang Island do have a number of high value ecological features such as habitat for threatened species including Green and Golden Bell Frog (*Litoria aurea*) and the aquatic plant, *Zannichellia palustris* in addition to Freshwater Wetlands on Coastal Floodplains and Coastal Saltmarsh Endangered Ecological Communities (EECs).

During consultation with the various authorities and community-based stakeholder groups regarding the project, the proposed waste emplacement area design has undergone a number of refinements aimed at avoiding in the first instance and otherwise minimising the potential impacts on the ecology of the site, as discussed below.

1.2.2 Proposed Waste Emplacement

The proposed waste emplacement footprint will be approximately 36.3ha, including a temporary equipment and material storage area. Figure 1-2 shows the location of the proposed waste emplacement. It is proposed that contaminated sediments removed from the Hunter River would be treated with slag cement adopting processes approved by the Department of Environment and Climate Change (DECC) prior to disposal within the waste emplacement to minimise mobilisation of sediments and contaminants. Any run-off waters from within the emplacement generated during construction will be stored and treated within a leachate collection facility at the east of the site.

The revised emplacement will have a maximum final surface height of approximately 15m AHD at the ridge peak, though the final level post-settlement is likely to be less than this level. The northern bund of the landfill has been located to avoid the existing wetland habitats and the southern bund has been located so as to avoid existing freshwater wetland and estuarine habitats to the south along the Hunter River.

1.2.3 Design Evolution and Consideration of Alternatives

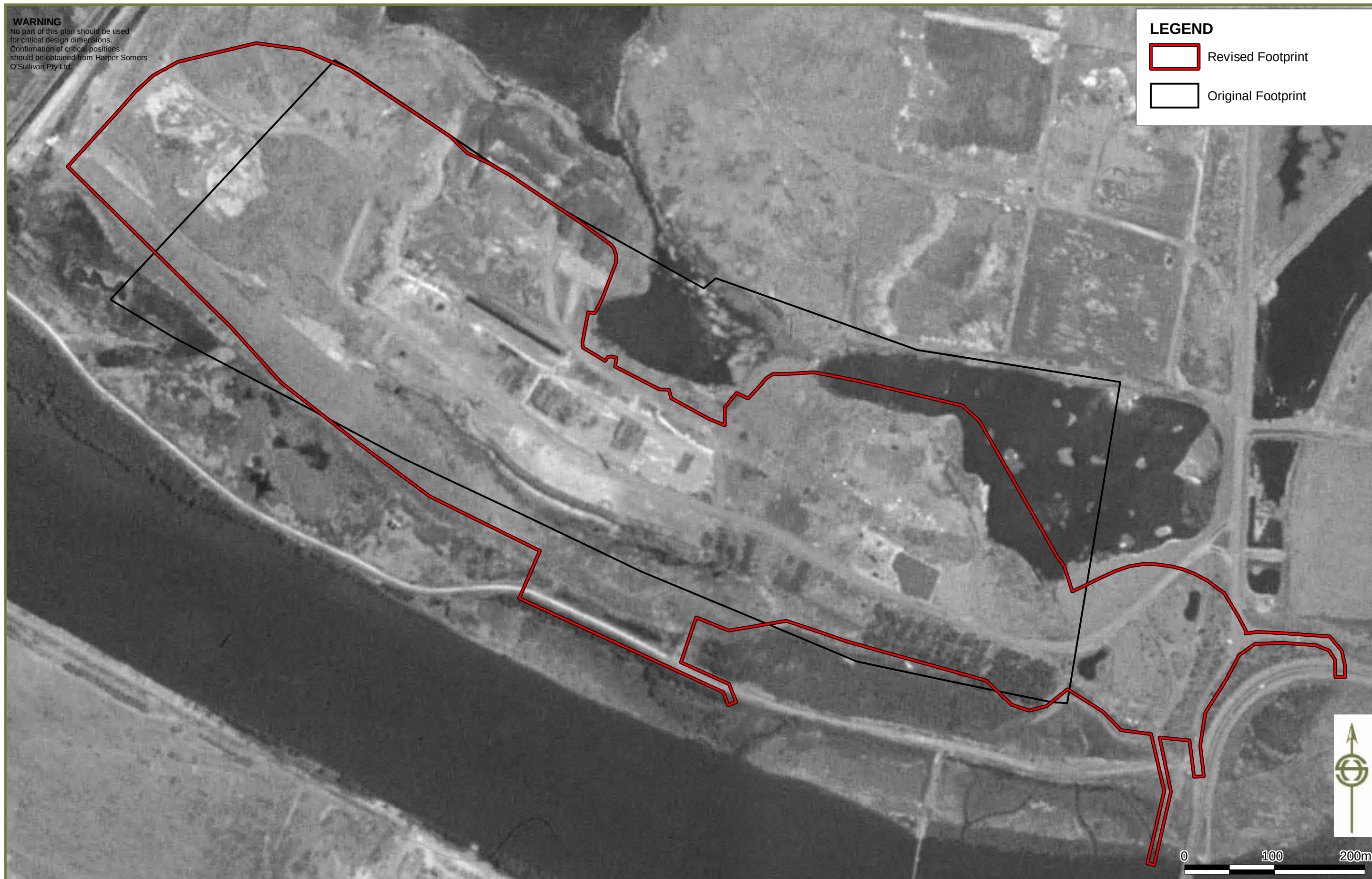
Originally the proposed emplacement footprint within the KIWEF required the filling of much of the wetland habitat of the Eastern Low-lying Area. However, subsequent to significant ecological constraints being identified within the site, further refinement of the emplacement design was undertaken by BHPB in consultation with DECC, the landowner (NSW Government represented by HDC) and community-based and academic research groups, including the Hunter Bird Observer Club and University of Newcastle frog research team, to minimise potential impacts on threatened species and endangered ecological communities (EECs) found within the site. Figure 1-2 shows the original emplacement footprint in comparison with the refined design discussed within this report.

The redesign has resulted in a large reduction in the amount of wetland habitat removed through recontouring the emplacement boundary to fringe habitat areas, extending west as far as practically possible and maximising the emplacement height. The wetland habitats are considered to be core habitat for Green and Golden Bell Frog (*Litoria aurea*) in addition to providing habitat opportunities for the aquatic plant *Zannichellia palustris* and several avifauna species.

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APPROVED: C. Anderson

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Report Figures\25123 Fig 1-2 Development footprints A A3

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1.3 Scope of the Study

The scope of this flora, fauna and ecological constraints assessment report is to:

- identify vascular plant species found on the site;
- identify and map existing vegetation communities;
- assess the status of identified plant species and vegetation communities under relevant legislation;
- identify existing habitat types on the site and assess the habitat potential for threatened species, populations, or ecological communities known from the proximate area;
- through preliminary research identify threatened fauna potentially using the site;
- employ targeted survey techniques and habitat assessment to identify fauna, in particular threatened species using the site;
- assess the potential of the proposed waste emplacement site to have a significant impact on any threatened species, populations or ecological communities identified during field surveys or as having potential habitat on the site; and
- Where feasible, provide management measures recommendations to reduce and/or mitigate any potential impacts identified.

Whilst survey work has been undertaken wholly within the bounds of the site, consideration has been afforded to areas off the site in order to appreciate the environmental context of the site.

The purpose of this report is to:

- ensure planning, management and development decisions are based on sound scientific information and advice by documenting the presence of biodiversity components and/or potential significant impacts that may exist on the site;
- provide information to enable compliance with applicable assessment requirements contained within the *TSC Act (1995)* and *EP&A Act (1979)*, and any other relevant state, regional and local environmental planning instruments; and
- enable the provision and analysis of ecological data that is comparable with data for other sites within the region to ensure continuity and consistency for survey and results.

1.4 Qualifications and Licensing

Qualifications

This report was written by Craig Anderson BLMC, Anna McConville BEnvSc, Allan Richardson BEnvSc (Hons), Sam Bishop BEnvSc of RPS HSO, and was peer reviewed by Dr Arthur White of Biosphere Environmental Consultants (BEC). The academic qualifications and professional experience of all RPS HSO consultants involved in the project are documented in Appendix D.

Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 November 2008);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2009);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2010); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 26 May 2009).

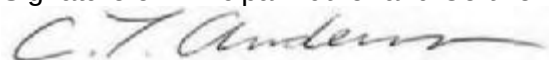
1.5 Certification

Principal Author

As the principal author, I, Craig Anderson BAppSc(EAM), make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site and their habitats;
- State and local government policies and guidelines formed the basis of project surveying methodology, or where the survey work has been undertaken with specified departures from industry standard guidelines, details of which are discussed and justified in Section 2;
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the *Animal Research Act 1995*, *National Parks and Wildlife Act 1974* and the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*.

Signature of Principal Author and Certifier:



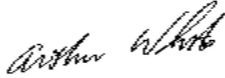
Craig Anderson
Director - Environment
RPS Harper Somers O'Sullivan Pty Ltd

Peer Reviewer and Contributor

As the peer reviewer and contributor, I, Arthur White of Biosphere Environmental Consultants, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site and their habitats.

Signature of Peer Reviewer and Contributor:



Dr Arthur White
Ecologist
Biosphere Environmental Consultants

2 Methodology

A variety of field survey techniques were employed over the course of fieldwork for this assessment to record the suite of flora species and fauna guilds across the site.

Due to the limited habitats present for native terrestrial and arboreal mammals, trapping surveys were not undertaken. Additionally, due to the high number of recent surveys within the site targeting threatened species considered likely to occur such as Green and Golden Bell Frog and threatened avifauna, full targeted surveys for these species were not considered necessary when combined with habitat assessment and mapping. Previous survey data from the site was utilised to provide background information on the types of habitats that threatened species may utilise within the site. Previous data sources utilised within this report included:

- Hunter Bird Observers Club (HBOC) bird data;
- Connell Hatch (2006) Green and Golden Bell Frog, Australasian Bittern and *Zannichelia palustris* surveys for NCIG Coal Unloader;
- Avifauna Research Services (2006) Shorebird Study and Habitat Assessment for NCIG Project;
- Dr Arthur White of Biosphere Environmental Consultants, personal observations;
- RPS HSO Ecologist personal observations;
- Michelle Stockwell, PhD candidate, The University of Newcastle, personal communications;
- Andrew Hamer (1996) Port Waratah Coal Services flora and fauna surveys;
- Andrew Hamer (1998) *Aspects of the Ecology of the Green and Golden Bell Frog (Litoria aurea) on Kooragang Island, New South Wales, Australia*, Masters thesis, The University of Newcastle;
- Andrew Hamer (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;
- ERM Mitchell McCotter (1996) *Kooragang Coal Terminal Stage Three Expansion Environmental Impact Statement*, Port Waratah Coal Services.

Data on threatened species occurrence and habitat assessment was collected over a two year period from winter 2006 to 2008. A range of survey methodologies were undertaken during this time by including:

- nocturnal and diurnal frog surveys,
- avifauna surveys,
- vegetation and habitat surveys,
- targeted *Zannichelia palustris* surveys
- opportunistic observations.

Green and Golden Bell Frog (*Litoria aurea*) habitat assessment was undertaken in conjunction with Dr Arthur White of Biosphere Environmental Consultants during April 2008. Additionally, a site inspection was undertaken with representatives of the DECC to discuss and verify habitat assessment, EEC presence and undertake threatened flora and fauna searches during June 2008. Numerous visits to the site were made by RPS HSO ecologists during May to August 2006 to inspect geotechnical investigation sites during which opportunistic searches and observations were also conducted.

Within this report, numbering and nomenclature of wetland ponds follows that presented within Resource Strategies (2005) for the NCIG project in order to allow consistency across the wider KI site.

2.1 Flora Survey

2.1.1 Vegetation Mapping

Flora surveys and vegetation mapping were undertaken within the site during August and September 2008 and was undertaken as follows:

- Aerial Photograph Interpretation (API) to map the community(s) extent into definable map units.
- Review of House (2003) *Lower Hunter & Central Coast Regional Biodiversity Conservation Strategy, Technical Report, Digital Aerial Photo Interpretation & Updated Extant Vegetation Community Map*.
- Confirmation of the community type(s) present (dominant species) via undertaking flora surveys and identification.
- Consideration was given to the potential for the derived vegetation communities to constitute 'Endangered Ecological Communities' (EEC) as listed within the *TSC Act (1995)*.
- Flora surveys were carried out across the site, with an emphasis on potentially significant species, as outlined below. The general flora survey also included the casual consideration of the site in line with methodology such as the "Random Meander Technique" described by Cropper (1993).
- Map the type and general extent of the community(s) present into definable map units where appropriate.

2.1.2 Significant Flora Survey

A list of potentially occurring significant flora species from the locality (10km radius) was compiled, which included threatened species (Endangered or Vulnerable) and EEC's listed under the *TSC Act (1995)*, Rare or Threatened Australian Plants (ROTAP) listed flora species (Briggs and Leigh 1996), as well as any other species deemed to be of local importance. Where suitable habitat for potentially occurring significant flora species was found on site, targeted surveys were conducted across the site during the field survey. Habitat assessments for significant flora species were also undertaken during investigations in conjunction with the findings of previous ecological investigations.

2.2 Habitat Survey

A RPS HSO Ecologist along with environmental consultant and Green and Golden Bell Frog specialist Dr Arthur White carried out an assessment of the relative value of the habitat present on site for the Green and Golden Bell Frog. Dr Arthur White is President of the Frog and Tadpole Study Group of NSW and a Research Associate

of the Australian Museum. Dr Arthur White has been involved in reptile and frog studies for over 30 years and has written over 50 scientific papers dealing with the taxonomy, ecology and management of herpetofauna. Dr Arthur White is also the Director of Biosphere Environmental Consultants Pty Ltd (BEC), a company that specialises in studies on Australian native fauna.

This habitat assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region. The assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

Habitat assessment was based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

Green and Golden Bell Frog habitat mapping involved the following:

- Aerial Photograph Interpretation (API) to map the community(s) extent;
- Detailed site inspections to delineate micro-habitat types present; and
- Mapping of delineated areas with sub-metre accurate GPS equipment.

2.3 Fauna Survey

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix C) and an assessment of the potential use of the site by threatened fauna species (as listed under the *TSC Act 1995* and/or *EPBC Act 1999*) identified from the vicinity of the site. This was achieved by undertaking literature and database reviews followed by confirmation through field surveys and any additional species observed were noted on the list. Targeted flora and fauna surveys were conducted throughout the site in August, October and November 2006. Additional incidental fauna observations were carried out on at least seven occasions during May and June 2008.

2.3.1 Avifauna Survey

The presence of avifauna on the site was carried out via targeted diurnal surveys and opportunistic observations during site fieldwork visits. Incidental bird surveys were conducted during all onsite investigations and in conjunction with onsite habitat assessments. Birds were identified by direct observation or by recognition of calls or distinctive features such as nests, feathers, and owl regurgitation pellets etc. The potential for threatened avifauna to use the site was also assessed by habitat attributes occurring within the site and their capacity to support threatened species that are known to occur in the wider locality. Assessment of the site's potential to provide opportunities for Forest Owl species was based upon the known habitat requirements of these species.

Continual opportunistic searches have also been undertaken during other fieldwork project components.

2.3.2 Herpetofauna Survey

Opportunistic diurnal and nocturnal amphibian and reptile searches were conducted during fauna surveys. Known occurrences of threatened herpetofauna species from the region were taken into account during assessment of onsite habitat, to determine the potential for the site to support such species. Diurnal targeted searches for threatened herpetofauna were conducted on the 22nd of August, 17th of October and both diurnally and nocturnally on the 19th and 20th of November 2006. Additional incidental herpetofauna surveys were conducted onsite during bore-hole site investigations carried out in May and June 2008.

In addition to opportunistic surveys and due to the known occurrence of Green and Golden Bell Frog from the site, targeted surveys were conducted for Green and Golden Bell Frog during both diurnal and nocturnal hours, throughout the site and adjacent areas. Studies conducted for the project included targeted and opportunistic nocturnal and diurnal searches throughout spring 2006. Consideration was given to the results of numerous Green and Golden Bell Frog surveys undertaken within the site and known occurrences of the species were incorporated into habitat mapping and discussion of potential impacts of the proposal on the species.

Continual opportunistic searches have also been undertaken during other fieldwork project components throughout 2007 and 2008.

2.3.3 Secondary Indications and Incidental Observations

Opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of resident fauna were noted. Such indicators included:

- Distinctive scats and scents left by mammals;
- Nests made by various guilds of birds;
- Potential whitewash, regurgitation pellets and prey remains from owls;
- Skeletal material of vertebrate fauna; and
- Footprints left by mammals.

Any other incidental observations of fauna were recorded during all phases of fieldwork and opportunistic searches for threatened species considered likely to occur such as Green and Golden Bell Frog were undertaken during all phases of fieldwork.

2.4 Survey Limitations

Timing limitations are often encountered during ecological surveys due to variation in the seasonality and detectability of the flora and fauna species being studied. Many of the site inspections for frog species were undertaken during cooler months of the year, when many frog species (including Green and Golden Bell Frog) are less active and therefore, more difficult to locate. However, the results of previous studies undertaken within the site combined with detailed habitat assessment and mapping were utilised along with a precautionary approach when assessing the potential impacts of the proposal for species that were less likely to be detected during site inspections.

In addition, the seasonality of surveys also places limits on the number of flora species identified in the site. Therefore, some threatened species not detected cannot be totally discounted due to seasonality and other factors, and therefore these species have been addressed in terms of their potential for occurrence within the site based on habitat factors. As such, the precautionary principle has been applied and for some species, where appropriate, assumed presence is made for assessment purposes.

3 RESULTS

3.1 Flora Survey

3.1.1 Vegetation Community Mapping

Consultation with regional mapping - '*Lower Hunter & Central Coast Regional Biodiversity Conservation Strategy*', (House 2003) in conjunction with ground-truthing identified six vegetation communities within the site, the majority of which, being Grassy Waste Emplacement Lands (Figure 3-1). All vegetation communities occurring within the site are most likely a function of the historical reclamation and waste disposal actions undertaken within the site.

LHCCREMS (2003) vegetation mapping designates all wetland areas occurring within the site as MU 47 Mangrove-Estuarine Complex. However, much of LHCCREMS vegetation mapping is derived from regional scale API with little ground-truthing. During flora surveys and vegetation mapping within the site, only small areas of MU 47 Mangrove-Estuarine Complex were found to exist within the southeast extremity of the site as a narrow linear strip (Figure 3-1).

In the southeast of the site there are small patches of Landscape Planting represented by mixed stands of planted non-endemic *Acacia* and *Eucalyptus* spp (Figure 3-1).

The site's historical use as a waste emplacement has been incomplete and as a result there remain low areas that either hold freshwater permanently or on a semi-permanent basis. There are wetland plants growing in these areas to varying degrees, due to the variation in water permanence within these areas. The assemblage of plants within these freshwater communities is commensurate with MU 46 Freshwater Wetland Complex, which is listed under the final determination of the EEC 'Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions' (see Figure 3-1). Additionally, Saltmarsh and Swamp Oak Floodplain Forest are also considered to be EECs listed under the *TSC Act 1995*.

All flora species recorded are listed in Appendix A.

Grassland - exotic species dominant

Grassy Waste Emplacement areas are characterised by filled substrates, predominantly capped with coal spoil, and covered by a sparse to relatively dense layer of exotic grasses and introduced herbaceous plants. These areas are dominated by non-endemic plant species including *Pennisetum setaceum* (Fountain Grass), *Melinis repens* (Red Natal Grass), *Andropogon virginicus* (Whisky Grass), *Pennisetum clandestinum* (Kikuyu) and *Hydrocotyle bonariensis* (Kurnell Curse).

The following mapping sub-units have been incorporated into this vegetation community as displayed in Figure 3-1:

- Kikuyu dominant grassland; and
- Bamboo.

The Kikuyu dominant grassland consisted almost entirely of *Pennisetum clandestinum* (Kikuyu) and was mapped separately due to its likely value for foraging and shelter habitat for the threatened Green and Golden Bell Frog (A White, pers comm., RPS HSO ecologists pers obs), despite its exotic nature.

The Bamboo mapping unit consisted of a dense stand of an exotic Bamboo species and was mapped separately due to its differences in habitat potential and the reasonable extent of the occurrence.

Landscape Planting

Landscape Planting areas include species such as *Acacia longifolia* (Sydney Golden Wattle) and *Eucalyptus camaldulensis* (River Red Gum) that are not endemic to the site with occasional plantings of *Casuarina glauca* (Swamp Oak). These appear to have been planted as visual screening for the KIWEF.

Mangrove-Estuarine Complex

Although LHCCREMS (2003) regional mapping shows wet areas within the site as being dominated by Mangrove-Estuarine Complex, ground-truthing of the site found that this community does not occur widely within the site and is represented by a narrow linear strip of *Avicennia marina* (Grey Mangrove) along the shore of the Hunter River and some estuarine habitats immediately adjacent.

Mangroves are protected under the *Fisheries Management Act 1994*.

Saltmarsh

Saltmarsh was found to occur within the intertidal zone to the south of the utility road running parallel to the Hunter River. This community was found to have several variations where external influences contributed species from other communities within. This included co-dominants of Mangrove, Exotic Grasses and Reed (*Phragmites australis*) species. These variations have been groundtruthed and mapped and are shown in Figure 3-1. The dominant species within this community is *Sporobolus virginicus* with co-dominant species found to occur being *Sarcocornia quinqueflora* ssp *quinqueflora* (Samphire) and *Suaeda australis* (Austral Seabite). In addition to this *Zoysia macrantha* (Coast Couch) and *Juncus acutus* were found to occur in several locations.

This community is considered to be commensurate with Coastal Saltmarsh, an Endangered Ecological Community (EEC) listed under the *TSC Act 1995*.

Areas mapped as Saltmarsh with Mangroves, consist predominantly of Saltmarsh vegetation with some scattered Mangroves also occurring.

Freshwater Wetland Complex

This community occurs within the site where unfilled low-lying areas retain water after rainfall. The community occurs within a number of location within the site, being ponds H, I, A, AA and AC. The northeast pond (Pond I) is largely ephemeral, although there are deeper areas within the impoundment that retain water into dry periods. The substrate of the impoundment is largely represented by slag making it difficult for plants to take hold and its ephemeral nature gives opportunity for terrestrial species like *Paspalum dilatatum* (Paspalum). The deeper areas contain *Typha orientalis* (Cumbungi) and *Phragmites australis* (Common Reed) at their

edges and the introduced *Juncus acutus* (Sharp Rush) occurs as clumps within the impoundment.

The north-western pond (Pond H) is permanent, containing open deep water. Pond H has steep embankments with narrow edges being dominated by stands of *T. orientalis* (Cumbungi).

The south-western occurrence of this community (Pond A) is partly ephemeral and contains shallow open water fringed by moderate stands of *T. orientalis* (Cumbungi), with *Schoenoplectus* sp. occurring in meadows and mudflats when water levels are low.

Other small areas of Freshwater Wetland Complex occur within Ponds AA and AC. Pond AC is a linear depression that has formed between two parallel embankments. It is dominated by *T. orientalis* (Cumbungi) and has a small portion of open water. Pond AA consists of dense reedland of *T. orientalis* (Cumbungi) in the west and *Phragmites australis* (Common Reed) in the east with no open water present.

This community is considered to be commensurate with Freshwater Wetlands on Coastal Floodplains, an Endangered Ecological Community (EEC) listed under the TSC Act 1995.

Swamp Oak Floodplain Forest

The Swamp Oak Floodplain Forest was found to occur adjacent to Pond A as shown in Figure 3-1. The determination of this vegetation community was based on the overstorey dominance of *Casuarina glauca* (Swamp Oak) as a precautionary approach. The Swamp Oak Floodplain Forest consisted of a grove of approximately 20 *Casuarina glauca* trees and was located adjacent to Mangroves to the east/west and a steep embankment with Grassland-exotic species dominant to the north.

This community is considered to be commensurate with Swamp Oak Floodplain Forest, an Endangered Ecological Community (EEC) listed under the TSC Act 1995.

3.1.2 Significant Flora

One flora species of conservation significance was recorded within the site, being *Zannichellia palustris*, which is listed as Endangered under the TSC Act 1995. *Z. palustris* was recorded within the three major freshwater wetland areas (Ponds A, H and I) previously by Mary Greenwood (reported in Connell Hatch, 2006) and by Connell Hatch (2006).

No other flora species of conservation significance were recorded within the site, or considered likely to occur within the site.

WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.
Note that this Vegetation Community Map depicts clearly defined boundaries between vegetation communities that are the product of individual interpretation and are not distinguished by clearly defined boundaries 'on the ground'.
Therefore, this map should only be treated as an indication of approximate peripheries between delineated vegetation communities.
Caution should therefore be exercised when using this data for purposes requiring high levels of accuracy. Furthermore, no account for intergrading areas between delineated vegetation communities has been made.

LEGEND

Revised Footprint

Vegetation Composition

Works

Swamp Oak Floodplain (EEC)

Saltmarsh (EEC)

Saltmarsh (EEC) highly disturbed exotic grass dominant

Saltmarsh (EEC) with Phragmites

Landscape Planting

Saltmarsh (EEC) with Mangrove

Mangrove Estuarine Complex

Kikuyu dominant Grassland

Juncus Phragmites Reedland

Grassland - exotic species dominant

Freshwater Wetland Complex (EEC)

Bamboo



TITLE: Figure 3-1 Vegetation Map
Koorangang

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SCALE:	1: 4000 at A3 Size	DRAWN:	S. Bishop	APPROVED:	A. McConville
		DATUM:	MGA Zone 56 (GDA 94)	DATE:	31/10/2008
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		CONTOUR INTERVAL:	N/A		
		JOB REF:	25123		

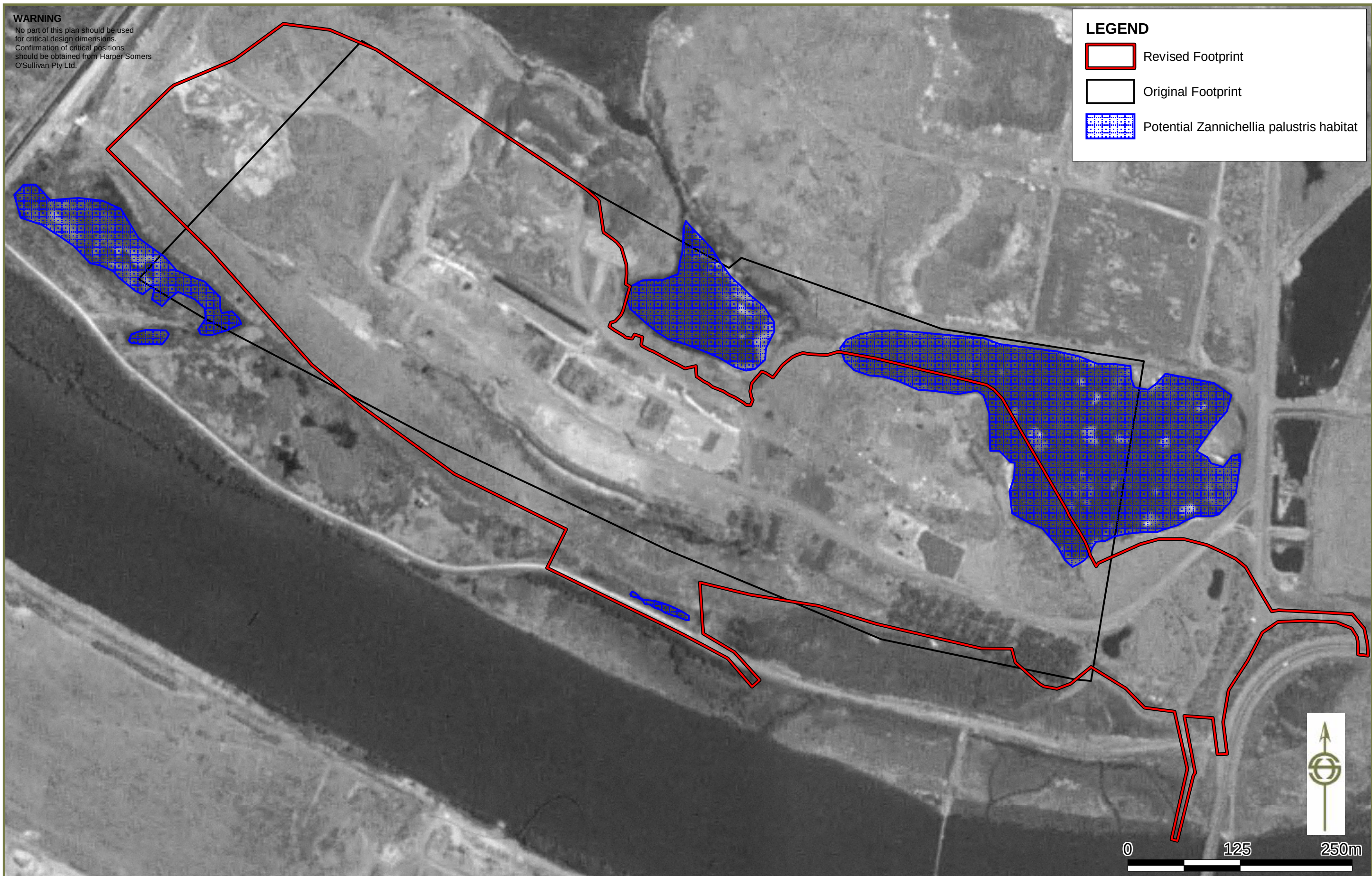
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LEGEND

Revised Footprint

Original Footprint

Potential *Zannichellia palustris* habitat



TITLE: Figure 3-2 Potential *Zannichellia palustris*
Habitat Kooragang

CLIENT: BHP Billiton Limited

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3.2 *Habitat Survey*

Habitat within the site was assessed for its potential to support native fauna species including threatened fauna for which records occur within the wider locality. The site was found to be relatively depauperate with regard to structural diversity within its terrestrial vegetation communities, as most of the land is covered with sparse to dense occurrences of exotic grass species. There are no opportunities for locally occurring threatened plants within the terrestrial habitats of the site.

Although the grassy waste emplacement areas are limited in cover, they provide some foraging and shelter areas for open country birds, such as the Australian Pipit (*Anthus novaeseelandiae*) and Brown Quail (*Coturnix ypsilophora*). These grassland habitats may provide intermittent foraging opportunities for Red-backed Button-quail (*Turnix maculosa*), a threatened species listed under *TSC Act 1995* which has been previously recorded in the vicinity of the site (HBOC).

Planted vegetation provides limited foraging and shelter for songbirds due to the isolation of this habitat from similar vegetation in the region and due to the young age cohort of onsite trees there are no hollows, which might provide nesting or shelter opportunities for Microchiropteran bats or other native fauna. The grassland areas represent some hunting opportunities for common small to medium raptors, such as Nankeen Kestrel (*Falco cenchroides*), Whistling Kite (*Haliastur sphenurus*) and Swamp Harrier (*Circus approximans*). The presence of isolated shrubs offers shelter for common passerines, such as Finches, Tawny Grassbirds (*Megalurus timorensis*) and Fairy-wrens.

Wetland communities within the site represent the greatest opportunities for local native fauna. Wetland habitat within the site can be broadly categorised into three different types based on the persistence of water, being permanent, semi-permanent and ephemeral. The persistence of water within the site has a direct influence upon vegetation occurring within the wetland areas.

The eastern impoundment (Pond I) is represented by a mixture of permanent and semi-permanent habitat with deeper areas that hold water into dry times and a much greater area of shallow waters that periodically dry out. The ephemeral aspect of this impoundment is suited to the breeding habits of Green and Golden Bell Frog (*Litoria aurea*), as the ephemerality of the shallow areas is likely to break the cycle of those factors that are detrimental to the persistence of this species, such as Chytrid fungus and Plague Minnow (*Gambusia holbrooki*).

Associated reed beds and dense vegetation provide cover and foraging opportunities for bitterns, rails and other reed bed frequenting birds. The shallow areas of this impoundment are likely to represent potential foraging habitat for the *TSC Act 1995* listed Australasian Bittern (*Botaurus poiciloptilus*), as this species has been observed some 100m to the east of the site during HBOC surveys conducted in 2006 (RPS HSO ecologist pers. obs.). Vegetation within this impoundment is not of sufficient extent or density to represent potential breeding habitat for this species. The ephemerality of the site suggests that it might provide foraging opportunities for migratory wading birds, as substrates become exposed during dry periods, but foraging opportunities for these species, including the *TSC Act 1995* listed Australian Painted Snipe (*Rostratula australis*), are not available due to the compacted slag substrate underlying the impoundment. There is potential for other locally occurring threatened bird species, such as Black-necked Stork (*Ephippiorhynchus asiaticus*), Magpie Goose (*Anseranas semipalmata*), Blue-billed Duck (*Oxyura australis*) and

Freckled Duck (*Stictonetta naevosa*) to occur within the eastern impoundment on a rare occasion, but this habitat is not considered to be highly suited to the foraging habits of any of these species.

The western impoundment (Pond H) is characterised by permanent water of sufficient depth to suit the foraging requirements of diving ducks, such as the Musk and Blue-billed Ducks. Both the Freckled Duck and Magpie Goose may also potentially occur within the western pond, although this is only considered likely on a rare occasion. The surrounding reed beds provide shelter and foraging opportunities for bitterns, rails and reed bed avifauna, such as the Clamorous Reed Warbler (*Acrocephalus stentoreus*) and Little Grassbird (*Megalurus gramineus*). This pond and the surrounding vegetation also represent potential breeding / foraging and shelter habitat for Green and Golden Bell Frog.

To the south of the northwest pond (See Figure 1-1) are a number of highly ephemeral shallow ponds, which occur during wet periods. Green and Golden Bell Frog tadpoles have been observed in the most easterly of these ponds, while the species has been heard calling in the two ponds occurring to the west. The area around these ponds and intervening areas between ponds are likely to represent foraging habitat for Green and Golden Bell Frog and habitat across which this species would traverse to access different habitat areas.

Ponds A, H and I contain wetland habitat within which the Endangered aquatic plant, *Zannichellia palustris*, has been recorded (Mary Greenwood, reported in Connell Hatch, 2006). This species requires still or slowly moving water with an Australian range limited to the Lower Hunter Region. Marginal habitat for this species also occurs within Pond AA which is heavily vegetated with reeds.

Habitat assessment and mapping was undertaken in early 2008 in conjunction with Dr Arthur White of BEC to quantify potential habitat for specific threatened species in the area. Refer to Figure 3-3 below.



TITLE: Figure 3-3 Green and Golden Bell Frog
Core Habitat
Kooragang

CLIENT: BHP Billiton Limited

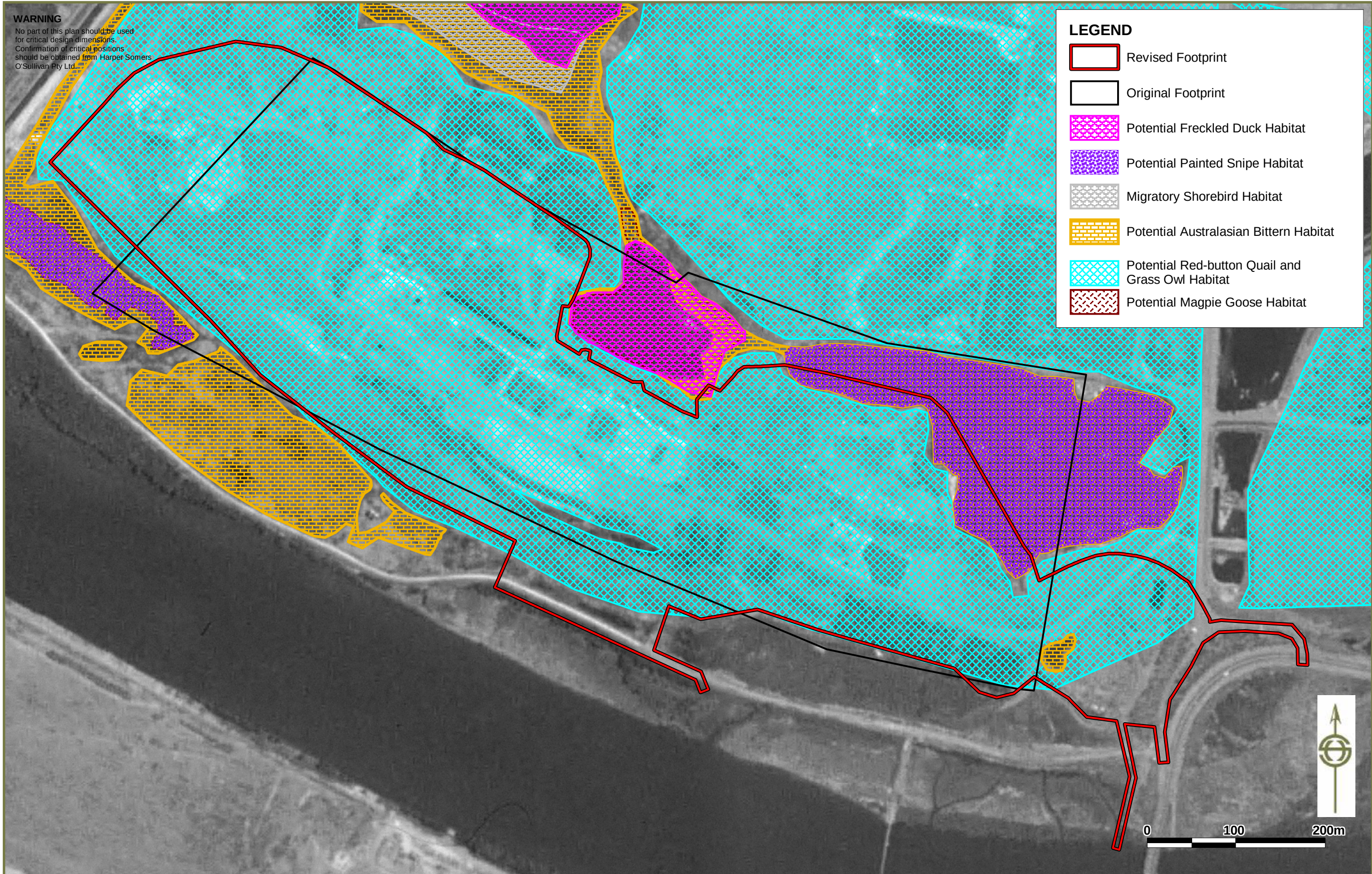


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APPROVED: C. Anderson
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DATE: 7/11/2008
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3.3 Fauna Survey

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix C) and an assessment of the potential use of the site by threatened fauna species as listed under the *TSC Act 1995* identified from the vicinity of the site. This was achieved by undertaking literature and database reviews followed by confirmation through field surveys where additional species observed were noted on the list.

3.3.1 Mammal Species

No terrestrial mammal species were recorded within the site during surveys, although it is likely that the site may support introduced rodent species, such as House Mouse (*Mus musculus*) and Black Rat (*Rattus rattus*). Scent markings of Red Fox (*Vulpes vulpes*) were detected in the locality and Brown Hare (*Lepus capensis*) has been observed in the vicinity of the site.

The potential for threatened mammal species to occur within the site is limited to highly mobile species such as bats. However, habitat within the site for bat species is limited to aerial foraging opportunities for insectivorous Microchiropteran bats. The State and Federally listed Grey-headed Flying-fox (*Pteropus poliocephalus*) has been observed in high numbers over Ash and Kooragang Islands as they search out potential foraging resources, but only marginal roosting (no evidence of camps was found within the site) and highly limited foraging opportunities for this species occur within the site (only within Landscape Plantings) or its locality.

3.3.2 Avifauna Survey

Terrestrial bird species recorded within the site are largely limited to common open country species such as Welcome Swallow (*Hirundo neoxena*), Australian Pipit (*Anthus novaeseelandiae*), Brown Quail (*Coturnix ypsilophora*) and Golden-headed Cisticola (*Cisticola exilis*). Where vegetation is denser and occasional shrubs occur the increased complexity provides sufficient shelter for other small birds species, including White-browed Scrubwren (*Sericornis frontalis*), Superb Fairy-wren (*Malurus cyaneus*), Chestnut-breasted Mannikin (*Lonchura castaneothorax*), Silvereye (*Zosterops lateralis*) and Tawny Grassbird (*Megalurus timorensis*). Planted *Eucalyptus* and *Acacia* spp. provide foraging opportunities for common woodland species such as Yellow Thornbill (*Acanthiza nana*), Leaden Flycatcher (*Myiagra rubecula*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*), Rufous Whistler (*Pachycephala rufiventris*) and Grey Fantail (*Rhipidura fuliginosa*), although these species are unlikely to occur within the site in isolation as their presence is most likely a function of populations occurring within mangrove forests in the locality.

Wetland habitats within the site containing reed beds and dense grasses and rushes, provide foraging and nesting opportunities for waterbird species such as Baillon's Crake (*Porzana pusilla*), Dusky Moorhen (*Gallinula tenebrosa*) and Purple Swamphen (*Porphyrio porphyrio*) and reed bed passerine species such as the Clamorous Reed Warbler (*Acrocephalus stentoreus*) and Little Grassbird (*Megalurus gramineus*). This wetland vegetation also represents potential foraging opportunities for Little Bittern (*Ixobrychus minutus*), Australasian Bittern (*Botaurus poiciloptilus*) and Nankeen Night Heron (*Nycticorax caledonicus*). A range of common waterfowl, including Pacific Black Duck (*Anas superciliosa*), Chestnut Teal (*Anas castanea*), Grey Teal (*Anas gracilis*) and Australian Shoveler (*Anas rhynchotis*) have been recorded within Pond H as have diving ducks such as the Hardhead (*Aythya*

australis), Musk Duck (*Biziura lobata*) and Blue-billed Duck (*Oxyura australis*). This species is normally a more westerly species, but occurs in more coastal areas during dry periods in its more westerly range. Another more westerly waterfowl species, the Freckled Duck (*Stictonetta naevosa*), that also occurs intermittently in coastal areas, has been recorded in Deep Pond to the north of the site and may use Pond H for foraging purposes on an intermittent basis when in the area. Black Swan (*Cygnus atratus*) breed within Pond H and have been recorded in the northeast impoundment (Pond I).

A range of other bird guilds use the site as part of a larger foraging range, including small to medium-sized raptors, ravens, herons and egrets. Both Wedge-tailed Eagles (*Aquila audax*) and White-bellied Sea-eagles (*Haliaeetus leucogaster*) have been recorded perching within onsite eucalypt plantings, although these trees are not of sufficient size to represent nesting opportunities for these species.

Although there is suitable foraging habitat for migratory wading birds at the southern end of Deep Pond, most wetlands within the site do not contain habitat opportunities for the wading bird guild, due to excessive water depth in the northwest impoundment (Pond H) and impenetrable slag substrates in the north-eastern impoundment (Pond I). Pond A within the south-west of the site does have some wading bird habitat due to the shallow nature of the freshwater pond. There are also some insect foraging opportunities for Black-fronted Dotterels (*Elseya melanops*) at the edges of receding water when water levels fall in the northeast impoundment (Pond I).

3.3.3 Herpetofauna Survey

A number of targeted searches for amphibians have been conducted over the site and the wider locality in the past (RPS HSO 2006, Hamer 1997, Connell Hatch 2006, BEC), combined with incidental observations records at other times. Surveys in the vicinity of the site have found that the Ponds A, H and I are used by Green and Golden Bell Frog (*Litoria aurea*) individuals for breeding purposes (RPS HSO 2006). Juvenile Green and Golden Bell Frog individuals were recorded in the northeast impoundment (RPS HSO 2006) and tadpoles were observed in the south-western ephemeral pond (A White pers. obs.). In addition to onsite observations, advertising Green and Golden Bell Frog have been recorded in ponds to the east of the site, along the southern extremity of Deep Pond and in ponds to the north. Green and Golden Bell Frog has been recorded within Pond AC, being the long gully in the south of the site (Hamer 1998) and in the pond at the eastern end of the planted eucalypt stand. Green and Golden Bell Frog have also been recorded in the wetlands (Pond A) occurring to the southwest of the site between the waste emplacement site and River Road. Dense grasses adjacent to these areas are likely to represent foraging and shelter opportunities for Green and Golden Bell Frog and the intervening areas between habitat (apart from where significant barriers exist) would represent probable dispersal routes.

3.3.4 Spotlighting

Spotlighting surveys conducted in November 2006 recorded Grey-headed Flying-fox (*Pteropus poliocephalus*) flying over the site, however, there is no roosting habitat and only limited seasonal foraging opportunity (landscape plantings) on site for this species. Green and Golden Bell Frog (*Litoria aurea*), Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*) and Spotted Grass Frog (*Limnodynastes tasmaniensis*) was also recorded on site during spotlighting.

The potential occurrence of other threatened species occurring in the wider locality of the site to occur onsite is addressed within Section 4 of this report.

4 Threatened Species and Communities Assessment

4.1 Identification of Subject Species and Communities

Threatened flora and fauna species (listed under the *TSC Act 1995*) that have been recorded within a 10 km radius of the site have been considered within this assessment. Endangered Ecological Communities (EEC's) known from the broader area have also been addressed. Each species / community is considered for its potential to occur on the site and the likely level of impact as a result of the proposal. This assessment deals with each species / community separately and identifies the ecological parameters of significance associated with the proposal.

Those species / communities that have been identified as having either a moderate or greater chance of occurring within the site or that have been recorded on site during field investigations have been subject to further considerations in following sections.

This assessment deals with the following heads of consideration in tabulated form (refer to Table 4-1 overleaf):

Species / Community / Population – Lists each threatened species / EEC / population known from the vicinity. The status of each threatened species under the *TSC Act (1995)* is provided.

Habitat Description – Provides a brief account of the species / community / population and the preferred habitat attributes required for the existence / survival of each species / community / population.

Chance of Occurrence on Site – Assesses the likelihood of each species / community / population to occur on or within the immediate vicinity of the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of current field investigations, data gained from various sources (such as Atlas of NSW Wildlife, Hunter Bird Observer Club records etc) and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

Likely Level of Impacts from Proposal – Assesses the likely level / significance of impacts to each species / community / population that would result from the proposed development, taking into account both short and long-term impacts. This assessment is largely based on the chance of occurrence of each species / community / population on site with due recognition to other parameters such as home range, habitat utilisation, connectivity etc. It also considers the scope of the proposal, including the likely extent of disturbance, duration of construction works etc. **It is important to note that the assessment in this column excludes the consideration of avoidance, mitigation and offset measures that are proposed by BHPB.**

Note: No Endangered Populations occur within this locality of relevance to this site.

Table 4-1: Threatened Species and Communities Considered and Assessment of Potential Impacts

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
Plants			
<i>Callistemon linearifolius</i> (V)	Shrub that grows in dry sclerophyll forest on the coast and adjacent ranges. Re-sprouting / juvenile specimens difficult to distinguish from other <i>Callistemon</i> species such as <i>C. rigidus</i> or <i>C. linearis</i> without the aid of flowering parts.	Low – The site is highly disturbed and modified with few natural habitats. No suitable dry sclerophyll forest habitat is present within the site. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Cryptostylis hunteriana</i> Leafless-tongue Orchid (V)	Saprophytic orchid. Grows predominately in swamp heath on sandy soils, but has been recorded in other habitat types. Distribution limits N-Gibraltar Range S- south of Eden.	Low – The site is highly disturbed and modified with few natural habitats. No suitable swamp heath or forested habitat is present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Diuris praecox</i> Newcastle Doubletail (V)	Found predominantly in coastal Eucalypt forests on hilltops or slopes. This species has been recorded at a number of dry woodland around Lake Macquarie to Port Stephens.	Low – The site is highly disturbed and modified with few natural habitats. No suitable Eucalypt forest habitat is present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Eucalyptus camfieldii</i> Camfield's Stringybark (V)	Tree or mallee to 10m high, but often less. Rare and localised, in coastal shrub heath on sandy soils on sandstone, often restricted drainage. Records from the Hunter Region largely in near coastal areas from the Port Stephens LGA to the Central Coast (Atlas of NSW Wildlife data). An apparently isolated population occurs in Kurri Sand Swamp Woodland within Cessnock LGA.	Low – The site is highly disturbed and modified with few natural habitats. No suitable coastal shrub heath habitat is present within the site. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Eucalyptus parramattensis</i> ssp. <i>decadens</i> Drooping Red Gum (V)	A red gum species that grows in dry sclerophyll woodland on sandy soils, often in low damp sites. Locally, this species occurs almost exclusively in association with Kurri Sand Swamp Woodland and ecotonal areas, but a small disjunct stand of stunted individuals have been recently recorded within coastal heath in the Lake Macquarie LGA (RPS HSO pers. obs.).	Low – The site is highly disturbed and modified with few natural habitats. No suitable woodland habitat is present within the site. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Grevillea parviflora</i> ssp. <i>parviflora</i> (V)	Occurs in light, clayey soils in woodlands. Most plants appear capable of suckering from a rootstock. Much confusion surrounds the taxonomy of this species and other similar <i>Grevillea</i> taxa (S. Bell pers. comm.), and a NPWS-funded study of the species is currently in progress.	Low – The site is highly disturbed and modified with few natural habitats. No suitable woodland or forested habitat is present within the site. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Persicaria elatior</i> Knotweed (V)	<i>Persicaria elatior</i> is sparsely distributed through Queensland and eastern New South Wales. It is an erect, branched herb up to 1m tall. <i>P. elatior</i> occurs in damp places such as swamps and margins of dams. This species is ROTAP-coded 3V.	Low - Moderate – Marginal habitat for this species exists within the freshwater wetlands within the site. However, the species has not been recorded from the site previously and was not recorded within the site during recent targeted surveys.	Low – Due to the lack of records within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Rulingia prostrata</i> Dwarf Kerrawang (E)	A prostrate shrub forming mats greater than 1m in width and occurring within heath, dry sclerophyll and coastal sands around Tomago.	Low – The site is highly disturbed and modified with few natural habitats. The species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Rutidosia heterogama</i> (V)	Small asteraceous herb recently rediscovered in the Hunter Region growing in disturbed areas and adjacent parcels of bushland within the Cessnock LGA.	Low – The site is highly disturbed and modified with few natural habitats. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Tetratheca juncea</i> Black-eyed Susan (V)	Occurs in a variety of forested and heathy habitats. Locally found in Open Forests and Woodlands with dense, undisturbed understorey, often in association with <i>Angophora costata</i> / <i>Corymbia gummifera</i> on slopes with south-easterly aspects.	Low – The site is highly disturbed and modified with few natural habitats. No suitable Eucalypt forest habitat is present within the site. Furthermore, the species was not recorded during targeted surveys.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Zannichellia palustris</i> (E)	An aquatic plant growing in estuarine waters. Recorded in Hexham Swamp and on Kooragang Island.	High – Habitat present in Pond H and Pond I (likely to reside in deeper portions during dry periods and extend outwards during wet conditions). Recorded within Pond H by Connell Hatch (2006) and within Pond I by Mary Greenwood (reported in Connell Hatch, 2006). Other areas may also provide some opportunity.	Moderate – High – The proposal will remove known habitat for the species. However, significant redesign of the emplacement has protected the majority (i.e. more than 80%) of this habitat with direct disturbance now confined to fringe areas of the emplacement footprint. The proposal also has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this species outside of the immediate emplacement footprint unless specific mitigation and management measures are put in place. <u>As this species has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
Herpetofauna			
<i>Litoria littlejohni</i> Little John's Tree Frog (V)	A pale brown frog with dark speckles which occurs along permanent rocky creeks with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. Occurs on the plateaus and eastern plains of the Great Dividing Range. Records within the Hunter Region occur from within the Watagan State Forest.	Low – The site is highly disturbed and modified with few natural habitats. No suitable rocky creek or sandstone habitat is present for this species within the site. Furthermore, the species was not recorded during the numerous amphibian surveys undertaken within Kooragang Island.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Litoria aurea</i> Green and Golden Bell Frog (E)	Inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins. Thought to be displaced from more established sites by other frog species, thus explaining its existence on disturbed sites. Previously widespread within the region, but now sparsely distributed within the Lower Hunter and Central Coast areas. A documented population occurs on Kooragang Island.	High – The species has been recorded within the site on a number of occasions. Evidence of breeding within the site such as tadpoles and sub-adults has been recorded.	Moderate – High – The proposal will remove known foraging and breeding habitat for the species. However, significant redesign of the emplacement has protected the majority (i.e. more than 80%) of this habitat with direct disturbance now confined to fringe areas of the emplacement footprint. The proposal also has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this species outside of the immediate emplacement footprint unless specific mitigation and management measures are put in place. <u>As this species has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Hoplocephalus bungaroides</i> Broad-headed Snake (E)	Largely confined to Triassic sandstones, including the Hawkesbury, Narellan and Shoalhaven formations, within the coast and ranges. Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	Low – The site is highly disturbed and modified with few natural habitats. No suitable sandstone habitat is present within the site or within the locality.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
Avifauna			
<i>Oxyura australis</i> Blue-billed Duck (V)	A frequenter of deep freshwater swamps with thick vegetation. In NSW mostly occurring within 300km of the Murray-Darling basin, but may occur in more coastal areas during dry inland conditions. This species has been observed in the Hunter Region on Ash Island and Walka Water Works (RPS HSO ecologist pers. obs.).	Moderate – Habitat exists for this species within the deeper waters of Pond H of which past records exist. The species has some potential to occur on occasion within the deeper portion of Pond I; however, this is not considered to be highly suitable for the species.	Moderate – Habitat that may be used occasionally by the species within Pond H will be modified as a result of the proposal. <u>As this species has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
<i>Stictonetta naevosa</i> Freckled Duck (V)	Inhabits both open lakes and wetlands surrounded by thick vegetation, especially swamps in which lignum, Cumbungi or Paperbarks grow. Permanent or temporary wetlands of varying salinity are known to be used. It is thought to be a frequent visitor to inland districts and rare in coastal areas. Records in the Hunter Region exist from Ellalong Lagoon, Pambalong Nature Reserve, Hunter Wetland Centre, Grahamstown Reservoir (Atlas of NSW Wildlife data), Deep Pond and Walka Water Works (RPS HSO ecologist pers. obs.).	Moderate – Potential habitat exists within the deeper waters of Pond H. Records exist from Deep Pond (HBOC, 2000). The species has some potential to occur on occasion within the deeper portion of Pond I; however, this is not considered to be highly suitable for the species.	Moderate – Habitat that may be used occasionally by the species within Western Pond will be modified as a result of the proposal. <u>As this species has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
<i>Rostratula australis</i> Australian Painted Snipe (E)	A small freshwater and estuarine wader, which prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. This species has been recorded in Pambalong N.R. and Ash Island (HBOC, 2004) and Lenaghan's Flat (RPS HSO ecologist pers. obs.).	Moderate – Potential habitat for this species exists within the freshwater wetland in the south-west of the site and to a lesser degree within select fringing areas of Pond I. Potential foraging habitat within Pond I is limited by slag substrates and is considered to be marginal.	Moderate – Marginal potential habitat for the species will be removed as a result of the proposal. The proposal also has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect the habitat outside of the immediate emplacement footprint unless specific mitigation and management measures are put in place. <u>Notwithstanding, as this species has a moderate chance of being recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
<i>Anseranas semipalmata</i> Magpie Goose (V)	Prefers shallow wetlands (especially those with a dense growth of rushes or sedges), drying ephemeral swamps, wet grasslands and floodplains, often roosting in fringing Paperbarks. A resident population exists on the southern edge of the Hunter River Floodplain, centred around the Hunter Wetland Centre, and the species has been recorded breeding at Seaham Swamp.	Low – Moderate – Marginal potential habitat for this species exists within reed bed areas and associated waters within the site and records exist from Pond H. However, habitats within the site are considered sub-optimal for this species.	Low – Moderate – Due to the relatively low chance of occurrence of this species within the site, and the occurrence of larger areas of more preferred habitat in the immediate locality, this species is unlikely to be affected by the proposal to any degree of note.
<i>Ixobrychus flavicollis</i>	Solitary species, living near water (estuarine to brackish)	Low – Moderate – Whilst potential habitat for this species exists within	Low – Due to the low chance of occurrence of this species within the

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
Black Bittern (V)	in mangroves and other trees which need to form only a narrow fringe of cover. A riparian species that occasionally ventures into the open within estuarine habitats. Sedentary resident along Dora and Stockton Creeks in western Lake Macquarie, but is likely to occur in any brackish to estuarine forested coastal creeks in the lower NSW coast.	estuarine habitats to the south of the site, habitats within the site are considered marginal for the species.	site, this species is unlikely to be affected by the proposal.
<i>Botaurus poiciloptilus</i> Australasian Bittern (V)	A secretive species inhabiting permanent freshwater swamps possessing stands of tall rush species such as Bull Rushes (<i>Typha</i> sp.) and Spike Rushes (<i>Eleocharis</i> sp.). Records exist for this species within wetlands of the Hunter Floodplain (Atlas of NSW Wildlife data).	Moderate – High – May occur within fringing wetland vegetation within the site and records occur within the immediate vicinity of the site.	Moderate – Potential habitat for the species will be removed as a result of the proposal. The proposal also has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this community outside of the immediate emplacement footprint unless specific mitigation and management measures are put in place. <u>Notwithstanding, as this species has a moderate chance of being recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
<i>Irediparra gallinacea</i> Comb-crested Jacana (V)	This species inhabits mostly deep permanent freshwater wetlands that are abundant with floating aquatic vegetation that forms dense mats or rafts on the surface of the water. Known to breed within the Hunter as far south as Mandalong (HSO ecologist pers. obs.).	Low – The site contains highly marginal habitat for this species within the wetland habitats; however, due to the numerous wetland habitats in the locality, its occurrence within the site on occasion cannot be entirely discounted.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Burhinus grallarius</i> Bush Stone-curlew (E)	Prefers open woodland, dry watercourses with fallen branches, leaf litter and sparse grass. Also occurs in coastal scrub, mangrove fringes, golf courses, rail reserves, wooded remnants on roadsides, orchards and plantations. Breeding pairs observed in near shore habitats in southwestern Port Stephens and Brisbane Waters.	Low – The site contains highly marginal habitat for this species within mangrove fringes; however, due to the numerous wetland habitats in the locality, its occurrence within the site on occasion cannot be entirely discounted.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Pandion cristatus</i> Eastern Osprey (V)	Requires water bodies for fishing in close proximity (usually <1km) to suitably tall nesting site such as dead tree, power pole etc. Recorded from various sites around Lake Macquarie, Port Stephens and the Hunter River Estuary. An accidental species on freshwater wetlands away from the coast.	Low – Whilst the species may occasionally fly over the site, the open water habitats within the site are not considered to offer suitable foraging habitats for the species and the species is considered unlikely to occur within the site on more than a rare occasion.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Haematopus fuliginosus</i> Sooty Oystercatcher (V)	Marine, usually rock shoreline, high rocky islets, boulders below cliffs, wave-cut platforms and reefs. Also inhabits sandy beaches and coves between rocky headlands (Morcombe, 2000). Also occurs within closed estuarine habitats where rocky substrates are present (e.g. Hunter Estuary).	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Calidris tenuirostris</i> Great Knot (V)	Large sandpiper visiting Australian coasts and estuaries during the austral summer. In the Hunter Region this species occurs in the Hunter River estuary during summer in relatively low numbers with very low numbers over wintering within the estuary (HBOC, RPS HSO	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
	ecologist pers. obs.).		
<i>Charadrius leschenaultia</i> Greater Sand Plover (V)	A small plover distinguished from its close relative <i>C. mongolus</i> by longer legs and larger bill size. NSW birds occur largely within estuarine habitats, including. Once occurring within the Hunter estuary in small numbers on a regular basis recent records have been confined to the Manning estuary in the north of the Hunter Region (HBOC).	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Charadrius mongolus</i> Lesser Sand Plover (V)	When in Australia, this migratory species inhabits sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats. Prey includes molluscs, worms, crustaceans and insects. Low numbers of this species visit the Hunter estuary during the austral summer.	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Limosa limosa</i> Black-tailed Godwit (V)	A medium sized wading bird species that breeds in the northern hemisphere during the austral winter. During the northern winter it migrates to Australian salt and freshwater wetlands where it feeds on invertebrate species within muddy sediments. It is easily confused with the more common Bar-tailed Godwit, but can be distinguished by a slighter build and more powdery plumage colouration. It lacks the striations of the Bar-tail and has a white rump and distinctive black and white under-wing colouration. May turn up in any suitable habitat (freshwater or estuarine) on the NSW coast and is likely to be associated with Bar-tailed Godwits and/or other waders.	Low – The site contains highly marginal habitat for this species. However, the species has been recorded within the southern portion of Deep Pond to the north of the site. Its occurrence within the site on a rare occasion cannot be entirely discounted.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Xenus cinereus</i> Terek Sandpiper (V)	Recorded on coastal mudflats, lagoons, creeks and estuaries. It favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs occasionally up to 10km inland around brackish pools.	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Limicola falcinellus</i> Broad-billed Sandpiper (V)	Small sandpiper visiting NSW estuaries and shores often associated with other wading species. Difficult to separate from Curlew sandpipers without some experience, but can be distinguished from this species by shorter legs and a second superciliary stripe above the eye. Once visiting the Hunter Estuary on a regular basis its occurrences in the region are now relatively rare.	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Ephippiorhynchus asiaticus</i> Black-necked Stork (E)	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds. Within the Hunter Region it occurs spasmodically on freshwater or estuarine wetlands.	Low – Moderate – Marginal potential habitat for this species exists within suitably shallow water and reed areas and adjacent areas.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Haematopus longirostris</i> Pied Oystercatcher (V)	This species prefers undisturbed sandy shell-grit or pebble beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands. Occasionally rocky reefs, shores rock-stacks, brackish or saline wetlands. Also grassy paddocks, golf-courses or parks near coast. Forages for molluscs, crustaceans, polychaetes, ascidians, echinoderms and small fish, probes for worms in short wet grass.	Low – Whilst the species may fly over the site to suitable local habitats, the site contains no suitable habitat (tidal flats) for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Sterna albifrons</i> Little Tern (E)	Migratory bird from eastern Asia, which occurs in sheltered coastal environments. This species has been recorded in Hexham Swamp, Stockton Bridge, Swansea and Newcastle Bars (HBOC, 1996).	Low – Moderate – Whilst the species may fly over the site to more suitable local habitats, the site contains highly marginal habitat for this species. However, due to the numerous estuarine habitats in the locality, its occurrence within the site on occasion cannot be entirely discounted.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Ptilinopus regina</i> Rose-crowned Fruit-Dove (V)	Generally lives in rainforest, though it also frequents brushes of coastal districts as well as forests and mangroves.	Low – The site is highly disturbed and modified with few natural habitats. No suitable rainforest habitat or fruiting trees are present within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Ptilinopus magnificus</i> Wompoo Fruit-Dove (V)	Frugivorous bird favouring rainforest, occasionally straying to other forest types containing fruiting trees. A nomadic species that sometimes roosts in dry forest adjacent to rainforest habitats and is known to access small rainforest remnants.	Low – The site is highly disturbed and modified with few natural habitats. No suitable rainforest habitat or fruiting trees are present within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Ptilinopus superbus</i> Superb Fruit-dove (V)	Occurs in rainforest and similar closed forests including, monsoon forest, regrowth, lantana thickets and woodland adjoining rainforest at all altitudes.	Low – The site is highly disturbed and modified with few natural habitats. No suitable rainforest habitat or fruiting trees are present within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Calyptorhynchus lathamii</i> Glossy Black-Cockatoo (V)	Occurs in forests and woodlands where it forages predominantly on <i>Allocasuarina</i> cones. Requires large Eucalypt tree hollows for nesting. Sparse occurrences on the valley floor, but resident in ranges and adjacent areas surrounding the Hunter Valley.	Low – The site is highly disturbed and modified with few natural habitats. No suitable foraging habitat (<i>Allocasuarina</i> sp.) is present within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Lathamus discolor</i> Swift Parrot (E)	On the mainland this species frequents Eucalypt forests and woodlands with large trees having high nectar production during winter. Mainland winter foraging sites often vary from year to year. Nests only in Tasmania, but regularly visits the Hunter Region in winter.	Low – The site is highly disturbed and modified with few natural habitats. No foraging habitat for this species such as winter flowering eucalypts exist within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Neophema pulchella</i> Turquoise Parrot (V)	Inhabits forests and woodlands with suitable nest hollows and grassy foraging areas. Generally found in more western locations within the Hunter Region (found coastally north of Port Stephens), although some isolated records from the forested areas within the Cessnock LGA do exist.	Low – The site is highly disturbed and modified with few natural habitats. No suitable forest or woodland habitat for this species is present within the site.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Ninox connivens</i> Barking Owl (V)	Occurs mainly in dry sclerophyll woodland. Nests in large Eucalypt hollows, and roosts in hollows or thick vegetation. Hunts a range of prey species including birds and both terrestrial and arboreal mammals. Spasmodic Hunter Region records are largely limited to the south-western ranges and adjacent forests on the valley floor.	Low – The site is highly disturbed and modified with few natural habitats. No suitable forest or woodland habitat for this species is present within the site and local records of the species are scarce.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Ninox strenua</i> Powerful Owl (V)	Occurs in sclerophyll forests and woodlands where suitable prey species occur (being predominantly arboreal mammals). Requires large hollows, usually in Eucalypt trees, for nesting. Roosts in dense vegetation within such areas.	Low – The site is highly disturbed and modified with few natural habitats. The planted trees provide highly marginal habitat for Powerful Owl prey species such as possums with no hollows observed; however, this habitat is highly limited in extent and quality. As such it is considered unlikely that a Powerful Owl pair would utilise the site as part of a home range.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Tyto capensis</i> Grass Owl (V)	Prefers tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heath, grassy woodland, cane-grass, lignum, sedges, cumbungi, cultivated sorghum, sugar cane and grain stubble. Roosts and nests low to or on the ground. The species has been recorded locally from Tomago and Ash Island.	Moderate – The site is highly disturbed and modified with few natural habitats. Potential foraging and nesting habitats for the species exist within grassland and wetland fringes of the site. The grassland habitats are likely to support terrestrial mammal prey for the species and may be used by the species for nesting.	Low – Moderate – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. However, the proposal in conjunction with other projects within Kooragang Island may contribute to cumulative loss of potential habitat for the species. <u>As such, potential impacts to the species have been addressed in Section 7.</u>
<i>Tyto novaehollandiae</i> Masked Owl (V)	Found in a range of habitats, locally within sclerophyll forests and woodlands where appropriate / preferred prey species occur (being predominantly terrestrial mammals). Requires large Eucalypt hollows for nesting and prefers to roost in these hollows as well. Recorded at Medowie, Heddon Greta and the Dungog area (HSO ecologist pers. obs.).	Low – Moderate – The site is highly disturbed and modified with few natural habitats. The grassland habitats are likely to support terrestrial mammal prey for the species. However, few areas adjoining woodland or forested areas occur. As such, habitats within the site are considered highly marginal for this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Xanthomyza phrygia</i> Regent Honeyeater (E)	Nomadic Honeyeater that disperses to non-breeding areas, including the coast, in winter, where flowering trees are sought. Within the region, mostly recorded in Box-Ironbark Eucalypt associations along creek flats, river valleys and foothills. Coastal swamp forests in Lower Hunter are used when more western resources fail. Nests mainly west of the divide, although local breeding attempts have occurred at Quorrobolong.	Low – The site is highly disturbed and modified with few natural habitats. Due to the distinct lack of forested habitats in close proximity, the occurrence within the site is considered highly unlikely.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
<i>Stagonopleura guttata</i> Diamond Firetail (V)	Small Finch occupying open woodlands / forests and associated habitats with grassy understorey. Generally found west of the Divide or in drier semi-coastal areas such as the upper Hunter Valley. Appears unable to persist in remnants less than 200ha. A small number of records exist from the Lower Hunter Region (HBOC, Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural habitats. No suitable woodland or forested habitat is present of a sufficient size or quality to support this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Turnix maculosa</i> Red-backed Button-Quail (V)	Inhabit grasslands, woodlands and cropped lands of warm temperate areas that annually receive 400 mm or more of summer rain. Prefers sites near water, including grasslands and sedgelands near creeks, swamps and springs, and wetlands. This species usually breed in dense grass near water, and nests are made in a shallow depression sparsely lined with grass and ground litter. The species has a largely coastal and sub-coastal range from the Kimberley region, Western Australia, through the Northern Territory, Queensland and NSW. Locally the species is scant however one record exists on Kooragang Island (HBOC).	Moderate – Potential habitat exists within grassland areas and the use of intermittently dry reedbed areas is also a possibility. Some records are known from the area.	Low – Moderate – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. However, the proposal in conjunction with other projects within Kooragang Island may contribute to cumulative loss of potential habitat for the species. <u>As such, potential impacts to the species have been addressed in Section 7.</u>
<i>Lophoictinia isura</i> Square-tailed Kite (V)	Inhabits open forests and woodlands, particularly those on fertile soils with abundant passerines. They may also range in nearby open habitats but not into extensive treeless regions. This species is notably absent from alpine regions and small isolated remnant woodlands in large open areas. Records exist from the Cessnock and Maitland LGA's and north of Port Stephens (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural habitats. Whilst the species may fly over the site on a rare occasion, no suitable woodland or forested habitat is present with sufficient prey abundance to support this species.	Low – Due to the low chance of occurrence of this species within the site, this species is unlikely to be affected by the proposal.
Mammals			
<i>Dasyurus maculatus maculatus</i> Spotted-tailed Quoll (V)	Found in a variety of forested habitats. This species creates a den in fallen hollow logs or among rocky outcrops. Generally does not occur in otherwise suitable habitats that are in close proximity to urban development. Hunter Region records are largely confined to the surrounding ranges (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural terrestrial habitats. No suitable forested habitat is present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Phascogale tapoatafa</i> Brush-tailed Phascogale (V)	Inhabits dry open forest and woodlands, often in areas with sparse groundcover. It is one of the most arboreal Dasyurids and hunts mainly invertebrates, although some vertebrate prey is taken on occasion. Utilises small tree hollows for nesting and refuge sites. Within the Hunter Region, records south of the Hunter River are scarce. Other records in the region occur from Medowie (HSO pers. obs.) and Tomago (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural terrestrial habitats. No suitable forested habitat or hollow-bearing trees are present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Petaurus norfolcensis</i> Squirrel Glider (V)	Occurs in eucalypt forests and woodlands where it feeds on sap exudates and blossoms. In these areas tree hollows are utilised for nesting sites. also requires winter foraging resources when the availability of normal food resources may be limited, such as winter-flowering shrub and small tree species. Widely distributed across the lower hunter region (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural terrestrial habitats. No suitable forested habitat or hollow-bearing trees are present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Phascolarctos cinereus</i> Koala (V)	Occurs in forests and woodlands where it requires suitable feed trees (particular <i>Eucalyptus</i> spp.) and habitat linkages. Will occasionally cross open areas, although it becomes more vulnerable to predator attack and road mortality during these excursions. Records from the Lower Hunter Region are largely confined to the greater Port Stephens area, the Lake Macquarie hinterland and the Watagan Mountains, with a small number of records from Cessnock LGA (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural terrestrial habitats. No naturally occurring Koala feed tree species listed within Schedule 2 of SEPP 44 were recorded within the site. <i>E.camaldulensis</i> trees were noted in the landscape plantings, though these are ecologically insignificant in this context due to absence of connected suitable habitat.	Low – Due to the lack of natural habitat within the site, and more importantly the lack of habitat connection within the locality, this species is unlikely to be affected by the proposal.
<i>Potorous tridactylus</i> Long-nosed Potoroo (V)	Prefers cool rainforest, wet sclerophyll forest and heathland. Sleeps by day in a nest on the ground, and digs for succulent roots, tubers, fungi and subterranean insects. Some diggings seemingly attributable to this species may belong to <i>Isoodon macrourus</i> (Northern Brown Bandicoot). Records exist from the Karuah vicinity (Gunninah 1999), Port Stephens LGA and the Gosford LGA (Atlas of NSW Wildlife data).	Low – The site is highly disturbed and modified with few natural terrestrial habitats. No suitable forested habitat is present within the site.	Low – Due to the lack of potential habitat within the site, this species is unlikely to be affected by the proposal.
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox (V)	Forages over a large area for nectar / fruits etc. Seasonally roosts in communal base camps situated within wet sclerophyll forests or rainforest. Frequently observed to forage in flowering Eucalypts. May occur anywhere within the Hunter Region where food or roosting resources are available.	Low – Moderate – Whilst the species may fly over the site, there is highly limited foraging opportunity within planted trees only. No camps of the species have been identified during surveys or during previous investigations within the site. A camp has been recorded from mangroves within Kooragang Nature Reserve at Fullerton Cover to the north-east of the site (Maddock and Stuart, 2003).	Low – Due to low chance of occurrence of this species foraging within the site, this species is unlikely to be affected by the proposal.
<i>Miniopterus schreibersii</i> Eastern Bentwing-Bat (V)	This species utilises a range of habitats for foraging, including rainforest, wet and dry sclerophyll forests, woodlands and open grasslands. Requires caves or similar structures for roosting habitat. Widely distributed across the Lower Hunter Region (Atlas of NSW Wildlife data).	Moderate – Marginal foraging habitat for this species exists over wetland areas which are likely to contain a high abundance of insect prey for this highly mobile species. No potential roosting habitat (caves) is present within the site.	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
<i>Miniopterus australis</i> Little Bentwing-bat (V)	Prefers to forage in well-vegetated areas, such as within wet and dry sclerophyll forests and rainforests. Requires caves or similar structures for roosting habitat. Largely confined to more coastal areas in the Lower Hunter Region (Atlas of NSW Wildlife data).	Moderate – Marginal foraging habitat for this species exists over wetland areas which are likely to contain a high abundance of insect prey for this highly mobile species. No potential roosting habitat (caves) is present within the site.	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>
<i>Mormopterus norfolkensis</i> Eastern Freetail-bat (V)	This species forages predominantly in dry forests and woodlands east of the divide. It roosts in tree hollows, under bark and within man-made structures. Widely distributed across the Lower Hunter Region (Atlas of NSW Wildlife data).	Moderate – Marginal foraging habitat for this species exists over wetland areas which are likely to contain a high abundance of insect prey for this highly mobile species. Anecdotal reports of captures of this species within mangroves do occur. No potential roosting habitat (hollow-bearing trees) is present within the site.	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat (V)	This species forages in tall open forests and the edges of rainforest. It roosts in mine shafts and similar structures. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Hirundo ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Hunter Region records for this species are largely confined to the Watagan Mountains, but it has been recorded on the southern side of Port Stephens (Atlas of NSW Wildlife data).	Moderate – Marginal foraging habitat for this species exists over wetland areas which are likely to contain a high abundance of insect prey for this highly mobile species. No potential roosting habitat (caves) is present within the site.	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>
<i>Myotis adversus</i> Large-footed Myotis (V)	Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas including rainforest, wet and dry sclerophyll forest, woodland, and swamp forest. Roosts in small colonies of between 15 and several hundred individuals in caves, mines and disused railway tunnels.	Moderate – Suitable foraging habitat for this species exists over wetland areas for this highly mobile species. No potential roosting habitat (caves) is present within the site.	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>
<i>Scoteanax rueppellii</i> Greater Broad-nosed Bat (V)	Forages in moister gullies and wet sclerophyll forests as well as in lightly wooded areas and open spaces / ecotones. This species roosts in tree hollows and is	Moderate – Marginal foraging habitat for this species exists over wetland areas which are likely to contain a high abundance of insect prey for this highly mobile species. No potential roosting habitat (hollow-bearing trees)	Low – Due to the small amount of potential foraging habitat to be removed as a result of the proposal in relation to other habitat available in the immediate locality, this species is unlikely to be affected by the

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
Bat (V)	relatively widespread within the Lower Hunter Region (Atlas of NSW Wildlife data).	is present within the site.	proposal. <u>Notwithstanding, microchiropteran bats have been further considered for potential impacts in Section 7.</u>
Endangered Ecological Communities			
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bio-regions	Associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. Wetlands or parts of wetlands that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including <i>Paspalum distichum</i> , <i>Leersia hexandra</i> and <i>Carex appressa</i> . Wetlands or parts of wetlands subject to regular inundation and drying may include large emergent sedges over 1 metre tall, such as <i>Baumea articulata</i> , <i>Eleocharis equisetina</i> and <i>Lepironia articulata</i> .	High – Found to occur within wetland habitats in both the Eastern Low-lying Area and the Western Pond. The freshwater wetland recorded within the site is considered to be in relatively poor condition due to slag substrate and high incidence of weed invasion.	High – Removal/disturbance of habitat. The proposal has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this community outside of the immediate emplacement footprint. <u>As this community has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
Coastal Saltmarsh in the North Coast Bioregion	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner occurs in the intertidal zone on the shores of estuaries and lagoons, including when they are intermittently closed along the NSW coast. Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 47a.	High – Found to occur within southern portion of the site, but outside of the proposed emplacement area in conjunction with mangroves.	Low – Moderate – This community will not be removed as a result of the proposal. However, the proposal has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this community outside of the immediate emplacement footprint. <u>Notwithstanding, as this community has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
Swamp Oak Floodplain Forest on Coastal Floodplains	This community is associated with periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains, typically occurring on grey-black clay-loams and sandy loams. Usually occurring below 20 m altitude.	High – Found to occur within south-eastern portion of the site, but outside of the proposed emplacement area.	Low – The proposal will not remove any part of this community. However, the proposal has the potential for indirect impacts on the species via alterations to groundwater and runoff from the emplacement area which may affect this community outside of the immediate emplacement footprint. <u>Notwithstanding, as this community has been recorded on the site, potential impacts to the species have been addressed in Section 7.</u>
White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are	Low – Vegetation within the site was found to be inconsistent with this community.	Low – Due to the lack of potential habitat within the site, this EEC is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact (this assessment excludes consideration of proposed avoidance, mitigation and offset measures)
Derived Native Grassland	one or more of the following: White Box (<i>Eucalyptus albens</i>), Yellow Box (<i>E. melliodora</i>) and Blakely's Red Gum (<i>E. blakelyi</i>). Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs.		

Notes: (V) = Vulnerable Species listed under the *Threatened Species Conservation Act 1995*.
(E) = Endangered Species listed under the *Threatened Species Conservation Act 1995*.
(CE) = Critically Endangered Species listed under the *Threatened Species Conservation Act 1995*.

4.2 Key Threatening Processes

A Key Threatening Process (KTP) is defined in the *TSC Act 1995* as a process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities. Something can be a threat if it:

- *adversely affects two or more threatened species, populations or ecological communities; or*
- *could cause species, populations or ecological communities that are not currently threatened to become threatened.*

KTP's are listed in Schedule 3 of the *TSC Act (1995)*. Those potentially applicable to proposal (both directly and indirectly) are summarised below and detailed in Appendix A (Section g).

- The proposal will require the removal of native vegetation and as such could contribute to the KTP "Clearing of Native Vegetation". The amount of vegetation to be cleared as a result of the proposal is a relatively small area, and whilst some of these areas do contain occupied habitat for threatened species and will contribute to cumulative impact at a regional scale, proposed mitigation and offset measures will ensure this impact is not of a significant magnitude.
- The KTP "Invasion by Exotic Perennial Grasses" is considered to be already active within the site and the proposal may increase the action of this KTP through the spread of weeds via construction machinery and vehicles. The extent to which the proposal could contribute to this process is, for the most part, considered unlikely to be significant, given that this KTP is already prevalent within the site.
- The proposal is likely to contribute to the KTP "Alteration of the natural flow regimes of rivers, streams, floodplains & wetlands" as a result of the infilling of wetland areas. The site is highly disturbed and it is considered that the natural flow regime has been considerably altered through reclamation works and waste disposal. However, the wetland areas within the site are likely to be reliant on current flow regimes.
- The proposal has the potential to contribute to the KTP "Infection of frogs by amphibian chytrid causing the disease chytridiomycosis" as a result of the activity of vehicles and machinery through wetland habitats in the locality. Specific management responses will be required to ensure that this KTP does not become an issue on this site.
- The proposal may contribute to the KTP "Human Caused Climate Change" as a result of clearing vegetation. It is considered that clearing and modification of the landscape would constitute a minor incremental change. Thus the extent to which a potential development might contribute to this process is considered unlikely to be significant.

5 Considerations under SEPP 44 – ‘Koala Habitat Protection’

First Consideration – Is the Land ‘Potential Koala Habitat’?

Schedule 2 of State Environmental Planning Policy (SEPP) No. 44 – ‘Koala Habitat Protection’ lists 10 tree species that are considered indicators of ‘Potential Koala Habitat’. The presence of any of the species listed on a site proposed for development triggers the requirement for an assessment for ‘Potential Koala Habitat’. SEPP 44 defines Potential Koala Habitat as:

“areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component”.

No tree species listed under Schedule 2 of SEPP No. 44 – ‘Koala Habitat Protection’ were recorded as naturally occurring within the site.

It is noted that specimens of *Eucalyptus camaldulensis* (River Red Gum) occur within the landscape plantings occurring on visual screening embankments within the site. *E. camaldulensis* is listed under Schedule 2 of SEPP 44. However, these landscape planting areas would not constitute “native vegetation” per se.

Therefore, the site does not constitute Potential Koala Habitat as defined by SEPP 44 and further provisions of the SEPP do not apply.

Irrespective of the above findings, no sign of any Koala activity or Koalas was noted on site. The lack of habitat connection to occupied koala habitat would mean it is extremely unlikely that Koalas could ever access this site.

6 Discussion

The potential impacts of the proposal on threatened species and EECs recorded or considered likely to occur within the site without the implementation of proposed ameliorative measures and offsets, following a precautionary approach, are discussed below. Due to the proposed avoidance, ameliorative and offset measures, the potential impacts on these species and EECs are likely to be significantly less than that discussed below.

6.1 *Litoria aurea* (Green and Golden Bell Frog)

6.1.1 Context

The Green and Golden Bell Frog (*Litoria aurea*) was formerly known to inhabit sites with elevations between sea level and 1000m along the eastern seaboard of New South Wales and Victoria from Byron Bay to the Gippsland Lake Region including highland sites (New England District, south-western slopes of NSW and Monaro District). This frog species inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins, and tolerates a wide range of physical and chemical water properties. In NSW, most known sites it inhabits are either largely or completely human-made. The Green and Golden Bell Frog is thought to be displaced from more established sites by other frog species thus explaining its existence on disturbed sites.

For a site to support a breeding population of the species, it should contain water bodies, which are still, shallow, ephemeral, unpolluted, unshaded and free of *Gambusia* and other predatory fish. It should have a grassy area nearby and other nearby vegetation should be no higher than woodland. The substrate of the ponds should be sand or rock, aquatic plants should be present and there should be a range of possible diurnal shelter sites, including vegetation and rocks. Whilst the KIWEF is highly disturbed and has been used as a waste emplacement site for a number of years, its wetland habitats support, in conjunction with other areas on Kooragang Island, the second largest remaining population of Green and Golden Bell Frog in NSW.

The Green and Golden Bell Frog is a spring – summer breeder. Most activity is recorded at night during warmer months when this species is observed breeding and feeding and diurnal basking behaviour has been observed in summer. During cooler months they are observed to be active, but to a far lesser degree. They can be relatively wide ranging in their movements and have been observed sheltering 300m from their breeding site.

Pond I consists of a scattered mosaic of vegetation, which offers known ephemeral habitat for Green and Golden Bell Frog. It was anticipated and confirmed by the site inspection that Green and Golden Bell Frog utilises wet habitat areas containing vegetation and also utilises adjacent dry habitats for foraging. The fringing vegetation of Pond H also provides habitat for Green and Golden Bell Frog. Smaller areas of wetland habitat also exist within Ponds AA and AC in the south of the emplacement. The Kooragang Island population of the Green and Golden Bell Frog is considered to be the second largest population remaining within NSW, making it of high significance. Green and Golden Bell Frogs known to occur within the site are considered to be part of the Kooragang Island local population.

Kikuyu is thought to provide occasional foraging and shelter habitat for Green and Golden Bell Frog and occurs across a large portion of the site.

6.1.2 Potential Impacts

Habitat

The proposed emplacement area design has been specifically designed to minimise the removal of known core wetland habitats for the Green and Golden Bell Frog to reduce potential impacts on the species.

The proposed emplacement area will involve the direct removal of small areas of core Green and Golden Bell Frog habitat within wetland fringes of Pond I and Pond H and entire small wetlands in the south of the site (Ponds AC and AA). Additionally, surrounding foraging, shelter and dispersal habitat for Green and Golden Bell Frog would be removed as a result of the proposed emplacement. A total of 1.37ha of core habitat would be removed as a result of the proposal.

Core Green and Golden Bell Frog habitat is considered to be breeding habitat for the species in addition to providing some foraging and shelter habitat. Whilst core habitat for Green and Golden Bell Frog is highly important in relation to the life cycle of the species, foraging and shelter habitat in close proximity is also required to fulfil the life cycle requirements of the species.

Mortality

Mortality of individual Green and Golden Bell Frogs may occur through vehicle movements during construction and as a result of emplacing treated material within the proposed cell. However, the proposed pre-clearing surveys, frog exclusion fencing and ongoing frog patrols within the construction zone would significantly minimise the potential for frog mortality during construction.

Fragmentation and connectivity

The proposal would not impact on wetland connectivity between Pond I and Deep Pond since the majority of wetland habitat has been retained within the current design. Terrestrial connectivity may be slightly impeded by the proposed emplacement through the installation of elevated embankments surrounding the remaining water bodies although in many cases raised embankments already exist around the core habitat area and do not appear to provide impediments to species movement.

Transmission of Chytrid fungus

Green and Golden Bell Frogs are known to be highly susceptible to Chytridiomycosis as a result of infection by chytrid fungus. Green and Golden Bell Frogs have been found to be more susceptible to Chytridiomycosis than other frog species (such as Dwarf Green Tree Frog - *Litoria fallax* and Striped Marsh Frog - *Limnodynastes peronii*) that commonly occur in the same locality (M. Stockwell, PhD thesis data, pers. comm.).

Green and Golden Bell Frogs are known to be highly susceptible to Chytridiomycosis as a result of infection by chytrid fungus. The project has the potential to transport the Chytrid fungus across the site through vehicle movements, disturbance of sediments and soil transport. However, management strategies such as disinfection of vehicles, footwear, machinery and equipment following the DECC Frog Hygiene Protocol have been recommended to minimise potential impact associated with disease transmission.

Contamination

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River where required by statutory authorities, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Alteration to hydrology and water quality

The proposed emplacement has been designed to minimise any potential impacts on the hydrology of the surrounding environment including wetland areas and groundwater. The potential impacts of construction along the fringes of Ponds H and I such as increased turbidity would be managed through the implementation of mitigation measures such as silt curtains to minimise the potential for the mobilisation of sediments into the water column.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), and is located immediately adjacent to core breeding habitat for the Green and Golden Bell Frog. Currently the eastern low-lying area (Pond I) has a steep embankment to the north. The proposed emplacement will form steep embankments to the immediate south of Pond I and to the south and west of Pond H. Shading of wetland areas may reduce the suitability of these ponds for the species which is known to bask in the sun; however, other ponds to the north of the site are surrounded by high embankments and are still utilised for breeding by the species. The height of the embankment is largely a function of the reduction of footprint area to avoid direct impacts on core habitat. Given the evidence of use of ponds to the north of the site, this is not deemed to be a significant impact.

Noise, Vibration and Lighting

Noise, vibration and night lighting during construction may cause temporary disturbance to Green and Golden Bell Frog breeding behaviour reducing the effectiveness of frog calls or possibly causing frogs to cease calling. Lighting baffles, louvers or shields have been proposed to be installed on lighting plants immediately adjacent to wetland areas and where safe to do so to reduce the potential impacts of light spill on surrounding areas during construction. Operating equipment will be maintained in a proper and efficient manner to minimise noise.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on the species in conjunction with other large scale industrial activities on Kooragang Island. Cumulative impacts are likely to be loss of breeding, foraging and shelter habitat within industrial areas of Kooragang Island. However, the DECC has formulated a framework for the management of Green and Golden Bell Frog that addresses the cumulative loss of habitat for the species and provides for the ongoing management of the species in or adjacent to industrial land on Kooragang Island by the relevant proponents causing impacts. BHPB is committed to contributing to and actively supporting this DECC framework for Green and Golden Bell Frog management on Kooragang Island, including working closely with NCIG and HDC to ensure aligned outcomes.

6.1.3 Specific Mitigation Measures

A number of mitigation measures specifically designed to minimise the potential impacts of the proposal on the Green and Golden Bell Frog have been generated by project ecologists, and committed to by BHPB. Mitigation measures aimed at reducing potential impacts on the Green and Golden Bell Frog are discussed further in Section 8 and include the following:

- Significant redesign of the emplacement footprint which has reduced the amount of core habitat to be removed as a result of the proposal by more than 80% from the original design. This reduction required negotiations with the landowner (NSW Government, represented by HDC) with penalty costs to BHPB to amend the footprint and raise the height of the emplacement that are in the order of several millions of dollars. These design changes have solely been made for ecological purposes. This process of negotiation with HDC has also delayed the finalisation of the project emplacement design (for a critical project schedule) by more than 3 months, demonstrating BHPB's firm commitment to significantly reducing its potential for ecological impacts as part of the HRRP.
- Pre-clearing inspections by ecologists, frog exclusion fencing and ongoing frog patrols within the construction zone to minimise the potential for frog mortality during construction.
- Disinfection of footwear, equipment, vehicles and machinery as per the frog hygiene protocol to minimise the potential for the transmission of Chytrid fungus.
- Design of the surface water management and emplacement to return water run-off to the existing ponds (to be conserved) and in doing so minimise the potential for changes to hydrology on habitat value.
- Monitoring of groundwater and surface water within the KIWEF, in addition to upstream and downstream monitoring of the Hunter River where required by DECC, so that any contaminant movement in excess of extant background levels would be able to be detected.
- A contingency plan is to be developed to address the unlikely scenario of contaminant movement being detected from monitoring.

- Appropriate measures to prevent the suspension of sediments into the water column and reduce turbidity would be put in place during construction to minimise impacts on core habitat.
- Regular inspection and maintenance of equipment to minimise operating noise levels and lighting baffles, louvres or shields are to be installed adjacent to wetland areas to reduce the potential impacts of noise and light spill on surrounding areas during construction.
- The commitment of BHPB to the DECC Framework for the management of the Green and Golden Bell Frog population on Kooragang Island through the enhancement and protection of existing habitat and the provision of offset habitat for the species in addition to other measures, including contributions to research and ongoing management, in conjunction with other relevant stakeholders.

6.2 *Oxyura australis* (Blue Billed Duck) and *Stictonetta naevosa* (Freckled Duck)

The Blue-billed Duck is endemic to Australia occurring mainly in the southeast and southwest regions. The species is widespread through NSW, though mainly found south of the Murray-Darling Basin and young birds may disperse widely. The Blue-billed Duck is almost wholly aquatic, preferring deep water in large permanent wetlands or dams where aquatic flora is abundant. Feeding occurs in permanent freshwater zones where the water is clear, there is an absence of turbulence and the substrate is firmer (Braithwaite 1976).

Non-breeding flocks of Blue-billed Duck congregate on large, deep and open freshwater lakes and dams. Sewage ponds, large rivers and saline waterbodies are also used during the non-breeding period. During the breeding season, Blue-billed Ducks disperse to breed in heavily vegetated areas of freshwater (e.g. cumbungi, lignum, sedge) swamps and lakes. Breeding is in spring with cup-shaped nests built in vegetation over water or on small islands in lakes.

The Freckled Duck occurs in the river-dependent wetlands of south-eastern Australia, including the Murray-Darling and Lake Eyre regions, and southwest WA. The Freckled Duck is a nomadic vagrant elsewhere in Australia, including coastal movements during inland drought. The major breeding stronghold for the Freckled Duck in the east is the Murray-Darling, southwest Queensland and the Lake Eyre region of southern South Australia. This species generally inhabits plankton-rich lentic freshwaters, particularly marshes with dense vegetation of lignum, cumbungi, canegrass, paperbark or tea-tree. Although freshwaters are favoured, waterbodies of various salinities are utilised. The preferred breeding habitats of the Freckled Duck are permanent freshwater swamps or creeks with dense vegetation. Out of the breeding season, more temporary and open waterbodies are also used by the Freckled Duck, particularly large exposed wetlands with shallow shorelines and sandy spits or islands. The main dietary feature is algae, making the species reliant on permanent waterbodies, but insects, crustaceans, small fish and seeds of aquatic plants are also eaten. Nests are shallow bowls of sticks and grass within flood debris or a bush at water level

The Blue-billed Duck has been recorded within the deep water habitats offered by Pond H and this species has also been recorded locally within Deep Pond to the north. The Freckled Duck has also been recorded in the locality and has the potential to occur within the deep water habitats offered by Pond H. The site may possibly be used as breeding habitat for these species during Spring/Summer in drier years when the species comes to the coast, though this is not considered likely. The Blue-billed Duck is largely aquatic and prefers to dive if disturbed; though, it will fly sometimes. The Freckled Duck generally rests within dense vegetation in deep water during the day and feeds at night, dawn and dusk.

6.2.1 Potential Impacts

Habitat

The proposed emplacement has been specifically designed to minimise the removal of wetland habitats to reduce potential impacts on the species. However, a very small portion (approximately 0.02ha) of foraging and potential breeding habitat would be removed as a result of the proposal. The proposal will only remove a small portion of habitat for the species and large areas of similar habitat are available for these species within the Hunter Estuary and within Deep Pond to the north.

Fragmentation and connectivity

These species are highly mobile and are not likely to be isolated as a result of the proposal and whilst the proposal may be seen to contribute in general to habitat fragmentation, this is likely to be of little consequence to these species due to their mobility.

Disturbance during construction

The short-term impacts associated with noise, vibration and night lighting during construction may cause some disturbance to Blue-billed Duck and/or Freckled Duck that may utilise the site at the time of construction. During the construction phase, the proposal has the potential to disturb these species during the breeding season (Spring/Summer) within Pond H. Noise, vibration and lighting at night may disturb roosting individuals and may preclude use by the species during construction. Short-term disturbance of breeding habitat may result in reduced breeding success or abandonment of a breeding site should it be in use at the time of construction, though again as mentioned above breeding is considered unlikely. Lighting baffles or equivalent controls are to be installed on lighting plants (where safe and feasible to do so) adjacent to wetland areas to reduce the potential short-term impacts of light spill on surrounding areas during construction. Operating equipment will be maintained in a proper and efficient manner to minimise the potential for excessive noise.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River where required by DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and

movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Steep embankments and shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), making it from 5 – 9m above existing surface levels, is located immediately adjacent to habitat for Blue Billed and Freckled Ducks and is located on top of existing steep embankments surrounding Pond H. The proposed emplacement will form steep embankments to the immediate south and west of Pond H. The creation of steep embankments and shading of some portion of the wetland areas may reduce the suitability of the Pond H for these species due to the reduced ability to detect predators. However, steep embankments already exist at the site, in particular NCIG's proposed rail easement to the north of the wetlands (unrelated to this proposal), and which do not appear to be compromising the habitat value for many species and large areas of suitable habitat exist within the Hunter Estuary and nearby Deep Pond.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on the species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for these species within the Hunter Estuary, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.2.2 Conclusion

The proposal will only remove a small portion of habitat for the Blue-billed Duck and Freckled Duck, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of suitable habitat occur for these species within the Hunter Estuary and most of the habitat for these species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact these species.

6.3 *Rostratula australis* (Australian Painted Snipe)

The Australian Painted Snipe (*R. australis*) occurs over a wide area of Australia. Breeding records are confined to the Murray-Darling Basin and south-eastern Australia. Within NSW, the Australian Painted Snipe occurs at both inland and coastal localities. The Australian Painted Snipe may be migratory in Australia, breeding in southern Australia in spring and summer and over-wintering in the north. It is known to inhabit shallow freshwater wetlands with muddy ground for foraging and dense low vegetation for cover. Such wetlands can be permanent or ephemeral in nature (Smith 1991). Kingsford (1991) suggests the species is most commonly recorded in freshly flooded areas and shallow freshwater swamps that have rushes, as well as wet pastures. Breeding occurs in shallow, marshy wetlands, usually in rank vegetation, but sometimes in more open sites. The nest is placed in a

depression in damp mud, often near water, and usually lined with plant material to form a platform (Smith 1991).

Potential habitat for the Australian Painted Snipe occurs within wetland vegetation within the site, although foraging opportunities for this species are considered to be marginal, due to the existence of impervious substrates underlying shallow areas in Pond I. Furthermore, all but the very edges of Pond H are of too great a depth to represent potential foraging for this species. It is unlikely that vegetation on the site is of sufficient density and extent to represent potential breeding habitat for this species.

6.3.1 Potential Impacts

Habitat

The proposed emplacement has been specifically designed to minimise the removal of wetland habitats to reduce potential impacts. The direct impacts associated with the proposal are considered to be limited to the disturbance of small areas (1.01ha) of wetland fringes which represent marginal potential foraging habitat for the species. It is considered unlikely that breeding habitat for the species occurs within the site. The amount of marginal potential foraging habitat to be removed as a result of the proposal is considered to be a small portion of more suitable habitat available to the species within the Hunter Estuary.

Fragmentation and connectivity

The Australian Painted Snipe is a highly mobile species that is not likely to be isolated as a result of the proposal and whilst the proposal may be seen to contribute slightly to habitat fragmentation, this is likely to be of little consequence to this species due to its mobility.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on the species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for this species within the Hunter Estuary, cumulative impacts on this species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.3.2 Conclusion

The proposal will only remove a small portion of marginal potential foraging habitat for the Australian Painted Snipe, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of more suitable habitat occur for the species within the Hunter Estuary and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact this species.

6.4 *Botaurus poiciloptilus (Australasian Bittern)*

The Australasian Bittern is confined to Australia and New Zealand. Within Australia this species occurs in the southeast and southwest as well as in Tasmania and is also known as a vagrant in the northwest of Australia. This species is probably sedentary in permanent habitat with possible regular short distance movements during winter and occasional irruptions associated with wet years. The Australasian Bittern lives alone or in loose groups and favours permanent fresh-waters dominated by sedges, rushes, reeds or cutting grasses (eg *Phragmites*, *Scirpus*, *Eleocharis*, *Juncus*, *Typha*, *Baumea* and *Gahnia*). Breeding is sometimes loosely colonial but in

other cases pairs have been observed to maintain territories when several are present in a reedbed. The Australasian Bittern feeds on insects, small fish, eels, frogs and other aquatic life, sometimes in ricefields. The breeding season is from October to January and it is during time that the distinct 'booming' calls can be heard.

Records for the Australasian Bittern exist to the east and west of the site and potential foraging habitat occurs within the site. It is unlikely that vegetation on the site is of sufficient density and extent to represent potential breeding habitat for this species. This species, although cryptic in colouration, is easily observed in relatively open habitats as occur within the site.

6.4.1 Potential Impacts

Habitat

The proposed emplacement has been specifically designed to minimise the removal of wetland habitats to reduce potential impacts. The proposed emplacement area will involve the direct removal of small areas (1.12ha) of habitat for the species within wetland fringes and small wetlands in the south of the site. The portion of habitat to be removed as a result of the proposal may be utilised by the species for foraging, shelter and breeding as it has been recorded within the industrial area of Kooragang Island previously.

Fragmentation and connectivity

The Australasian Bittern is a highly mobile species that is not likely to be isolated as a result of the proposal and whilst the proposal may be seen to contribute slightly to habitat fragmentation, this is likely to be of little consequence to this species due to its mobility.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), is located immediately adjacent to habitat for Australasian Bittern and is located on top of existing steep embankments surrounding Pond H. The proposed emplacement will form steep embankments to

the immediate south and west of Pond H. The creation of steep embankments and shading of the wetland areas may reduce the suitability of the Pond H for this species due to the reduced ability to detect predators. However, steep embankments already exist at the site, in particular NCIG's proposed rail easement to the north of the wetlands (unrelated to this proposal), and which do not appear to be compromising the habitat value for many species and large areas of suitable habitat exist within the Hunter Estuary and other areas of the KIWEF.

Disturbance during Construction

Noise, vibration and lighting at night may disturb foraging individuals on dusk and roosting individuals during the day and may preclude use by the species during construction. Lighting baffles or equivalent controls are to be installed on lighting plants (where safe and feasible to do so) adjacent to wetland areas to reduce the potential short-term impacts of light spill on surrounding areas during construction. Operating equipment will be maintained in a proper and efficient manner to minimise the potential for excessive noise.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on the species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for this species within the Hunter Estuary, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.4.2 Conclusion

The proposal will only remove a small portion of potential foraging habitat for the Australasian Bittern, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of more suitable habitat occur for the species within the Hunter Estuary and KIWEF and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact this species.

6.5 *Tyto capensis (Grass Owl) and Turnix maculosa (Red-backed Button Quail)*

The Grass Owl ranges from India eastward to Fiji, excluding New Guinea. Movements are nomadic and irruptive, with local colonisations taking place after irruptions of prey species populations. Island birds appear to breed up in response to plagues of small mammals then disperse, often to die as the plague subsides. Coastal populations of the Grass Owl are considered fairly sedentary though numbers have been observed to fluctuate. The Grass Owl lives in a loose community, with several hundred metres usually separating solitary roosting birds or breeding pairs. The birds roost and nest on the ground in crops or thick tussocky grasslands often associated with swamps, where they form extensive tunnels and trample the area. The species usually hunts by night but when under stress will hunt by day.

The Red-backed Button-quail is a small, ground-dwelling bird that inhabits grasslands, woodlands and cropped lands of warm temperate areas. It prefers sites near water, including grasslands and sedgeland near creeks, swamps and springs, and wetlands. This species usually breeds in dense grass near water and nests are made in a shallow depression sparsely lined with grass and ground litter. The

species has a largely coastal and sub-coastal range from the Kimberley region, Western Australia, through the Northern Territory, Queensland and NSW.

Potential foraging and breeding habitat for these species exist to varying degrees within grassland and adjacent swampy areas within the site.

6.5.1 Potential Impacts

Habitat

The proposed emplacement area will involve the direct removal of 32.55ha of potential foraging and breeding habitat for these species. This is considered to be a small portion of the habitat available to the species within Kooragang Island. To date, there has been no indication that the habitats present on-site are of any significant importance to either of these species.

Fragmentation and connectivity

The Grass Owl and Red-backed Button Quail are highly mobile species that are not likely to be isolated as a result of the proposal and whilst the proposal may be seen to contribute slightly to habitat fragmentation, this is likely to be of little consequence to these species due to their mobility.

Contamination

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Disturbance during Construction

Noise, vibration and lighting at night may disturb Red-backed Button Quails and foraging Grass Owl individuals at night and may preclude use by these species during construction. Lighting baffles or equivalent controls are to be installed on lighting plants (where safe and feasible to do so) adjacent to wetland areas to reduce the potential short-term impacts of light spill on surrounding areas during construction. Operating equipment will be maintained in a proper and efficient manner to minimise the potential for excessive noise.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on the species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for this species within the locality, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.5.2 Conclusion

The proposal will only remove a small portion of potential foraging habitat for these species, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of more suitable habitat occur for the species within the Hunter Estuary and KIWEF and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact these species.

6.6 Microchiropteran Bat Species

The following threatened microchiropteran bat species have been considered potentially likely to occur within the site:

- *Miniopterus schreibersii* (Eastern Bentwing Bat);
- *Miniopterus australis* (Little Bentwing Bat);
- *Mormopterus norfolkensis* (East Coast Freetail Bat);
- *Chalinolobus dwyeri* (Large-eared Pied Bat);
- *Myotis adversus* (Large-footed Myotis); and
- *Scoteanax rueppellii* (Greater Broad-nosed Bat).

Foraging habitat for *Myotis adversus* (Large-footed Myotis) exists within the open water areas of wetland habitats within the site. Foraging habitat for the other threatened microchiropteran bat species exists above wetland habitats which typically have an abundance of insects and over grassland and around the canopy of scattered trees. The wetland habitats with open water are also likely to be used for drinking by these threatened microchiropteran bat species.

No roosting habitat for threatened microchiropteran bat species occur within the site due to the absence of tree hollows, caves, overhangs or similar artificial structures.

6.6.1 Potential Impacts

Habitat

Direct impacts associated with the proposal on threatened microchiropteran bat species is likely to be limited to the removal of foraging habitat over large areas of grassland and small areas of wetland. Direct impacts on the foraging habitat (approximately 1.37ha) of *Myotis adversus* (Large-footed Myotis) are considered to be limited since the majority of open water habitats will be retained as a result of the proposal.

Approximately 32.55ha of grassland foraging habitat and a further 1.37ha of wetland foraging habitat for threatened microchiropteran bats would be modified as a result of the proposal. However, this is considered to be a small portion of foraging habitat available to these highly mobile species within the locality and no potential roosting or breeding habitat would be removed as a result of the proposal.

Fragmentation and connectivity

The threatened microchiropteran bat species that are considered likely to occur within the site are highly mobile species and are not likely to be isolated as a result of the proposal and fragmentation is likely to be of little consequence to these species.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on these species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for this species within the locality, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.6.2 Conclusion

The proposal will only remove a small portion of potential foraging habitat for these species, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of more suitable habitat occur for the species within the Hunter Estuary and KIWEF and most of the habitat for these species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact these species.

6.7 *Zannichella palustris*

Zannichella palustris has been recorded previously within both Pond I and Pond H. The species is considered likely to reside in deeper watery areas during dry periods and extend into proximate ephemeral areas during periods of high rainfall. The species dies almost completely back during summer.

6.7.1 Potential Impacts

Habitat

The proposed emplacement has been specifically designed to minimise the removal of wetland habitats to reduce potential impacts on the species. The proposed emplacement area will involve the direct removal of small areas of known habitat (approximately 1.05ha) within the wetland fringes of Pond H and Pond I. Additionally, individuals within these areas may also be removed as a result of the proposal.

Fragmentation and connectivity

The proposal would not impact on wetland connectivity between Pond I and Deep Pond since the majority of wetland habitat has been retained within the current design.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), making it from 5 – 9m above existing surface levels and is located immediately adjacent to known habitat for *Z. palustris*. Currently Pond H has a steep embankment to the north. The proposed emplacement will form steep embankments to the immediate south of the Pond I and to the south and west of Pond H. Shading of the wetland areas may reduce the suitability of these ponds for the species, however, it is known to occur within ponds adjacent to steep embankments elsewhere within the KIWEF.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on this species in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of suitable habitat for this species within the locality, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.7.2 Conclusion

The proposal will only remove a small portion of habitat for this species, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large areas of more suitable habitat occur for the species within the Hunter Estuary and KIWEF and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would significantly impact this species.

6.8 Freshwater Wetlands EEC

Freshwater wetlands on coastal floodplains typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. The composition of Freshwater Wetlands on Coastal Floodplains is primarily determined by the frequency, duration and depth of waterlogging and may be influenced by the level of nutrients and salinity in the water and substrate.

Within the Lower Hunter, this community is associated with permanently or inundated swamps or wetlands along the floodplain of the Hunter Valley. A distinct vegetation complex dominated by various sedge, rush and obligate waterplants exists within this assemblage. Significant examples include Hexham Swamp, Ellalong Lagoon and wetlands situated along the Wallis Creek floodplain.

The site has a long history of disturbance through reclamation and dumping of waste materials. The wetland vegetation contained within areas mapped as Freshwater Wetland EEC contains species consistent with the Scientific Determination of this EEC, however, they are in relatively poor condition due to weed invasion and the presence of slag substrates.

6.8.1 Potential Impacts

Habitat

The proposed emplacement has been specifically designed to minimise the removal of wetland habitats to reduce potential impacts on this community. The proposed emplacement area will involve the removal of small areas (approximately 1.52ha) of relatively poor quality Freshwater Wetland EEC within wetland fringes and small wetlands in the south of the site.

Fragmentation and connectivity

The proposal would not impact on wetland connectivity between Pond I and Deep Pond since the majority of wetland habitat has been retained within the current design.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), and is located immediately adjacent to Freshwater Wetland EEC and is located on top of existing steep embankments surrounding Pond H. Currently the eastern low-lying area (Pond I) has a steep embankment to the north. The proposed emplacement will form steep embankments to the immediate south of the Pond I and to the south and west of Pond H. Shading of the wetland areas may slightly alter the composition and flora species within the community; however, this is not considered likely to have a significant impact on this community.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on this community in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of this community within the locality, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.8.2 Conclusion

The proposal will only remove a small portion of this community, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large higher quality examples of this community occur for the species within the Hunter Estuary and KIWEF and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact this community. Furthermore, commitment by BHPB to current DECC programs targeting Green and Golden Bell Frog management will involve the improvement and / or creation of additional freshwater wetland areas as habitat in the Hunter Estuary.

6.9 Coastal Saltmarsh EEC

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons, including those that are intermittently closed, along the NSW coast. Coastal Saltmarsh has been recorded in association with estuarine interface areas of the Hunter River and usually adjacent to Mangroves.

6.9.1 Potential Impacts

Habitat

The Coastal Saltmarsh EEC mostly occurs outside the emplacement footprint. However, some very small areas may be removed in association with the outlets. Outlet construction will remove approximately 0.01ha of Coastal Saltmarsh EEC from the area.

Fragmentation and connectivity

Due to the small portion of Saltmarsh to be removed as a result of the proposal it is anticipated that this minor fragmentation will not impact considerably upon this community in the area as it already exists throughout the site in isolated patches.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), and is located immediately adjacent to Coastal Saltmarsh EEC and is located on top of existing steep embankments. Currently, Coastal Saltmarsh EEC in the south of the site has a steep embankment to the north which will be extended in height to approximately 12.5m AHD. Shading of the Coastal Saltmarsh EEC may slightly alter the composition and flora species within the community. However, Coastal Saltmarsh is known to occur in some areas adjacent to steep embankments.

Cumulative Impacts

The proposal has the potential to contribute to cumulative impacts on this community in conjunction with other industrial activities within Kooragang Island. However, due to the presence of large areas of this community within the locality, cumulative impacts on these species resulting from industrial development of Kooragang Island are likely to be minimal, providing that development is undertaken in a sensitive manner as proposed.

6.9.2 Conclusion

The proposal will only remove a very small portion of this community, will not sever connectivity and any potential short-term impacts during construction would be managed appropriately. Since large higher quality examples of this community occur for the species within the Hunter Estuary and KIWEF and most of the habitat for this species within the site would remain after the proposal, it is considered unlikely that the proposal would adversely impact this community.

6.10 Swamp Oak Floodplain Forest EEC

Swamp Oak Floodplain Forest on Coastal Floodplain is the name given to the ecological community associated with periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains, typically occurring on grey-black clay-loams and sandy loams. It usually occurs below 20 m altitude. A small stand of *Casuarina glauca* was recorded within the site during surveys; however, it is located outside of the proposed emplacement footprint.

6.10.1 Potential Impacts

Habitat

The Swamp Oak Floodplain Forest EEC occurs outside the emplacement footprint and as such direct impacts are not considered likely to occur as a result of the proposal.

Fragmentation and connectivity

No further fragmentation or isolation of this community is considered likely to occur as a result of the proposal.

Contamination and alteration to hydrology and water quality

The emplacement design includes many features to reduce the potential for interaction with surface and groundwaters and as a consequence the potential for any impacts on terrestrial ecology. These features include liner systems, a stand-off of the emplacement floor above the highest aquifer, and leachate collection system (that may not ever be required for use but will be built in the construction as a contingency measure).

Monitoring of adjacent ponds, groundwater and the Hunter River as required by the DECC, will occur as part of the proposal to ensure environmental requirements regarding protection of river, surface water and ground water qualities are met. A contingency plan to address the unlikely scenario of contaminant release and movement from the emplacement is being developed so that any potential issue is addressed in an appropriate and timely manner.

Regarding contamination, it is important to note that the existing surface and sub-surface environment of the emplacement site, including highest aquifers, are already affected by and/or exposed to contaminated materials that were disposed at this site over a long period during its former use as a dump site by the Newcastle Steelworks. BHPB's current commitment is to not exacerbate these existing conditions from the emplacement activities.

Shading

The proposed emplacement will be up to 15 m high (note the final elevation is estimated to be less due to settlement after construction and this will accommodate the maximum volume expected), and is located in the vicinity of Swamp Oak Floodplain Forest EEC. Shading of the Swamp Oak Floodplain Forest EEC may

slightly alter the composition and flora species within the community. However, it is relatively unlikely that this would occur due to the ability of *Casuarina glauca* to withstand partial shade.

6.10.2 Conclusion

Since none of this community would be removed as a result of the proposal and since adequate mitigation measures have been recommended to minimise potential indirect impacts, it is considered unlikely that the proposal would adversely impact this community.

7 Offsets Proposal

The proposal includes the commitment to the provision of compensatory habitat to offset and minimise potential impacts on Green and Golden Bell Frog and Freshwater Wetlands EEC. It is likely these offset activities will also provide habitat for other relevant threatened species such as Australasian Bittern, Australian Painted Snipe and the plant *Zannichellia palustris*.

The offsets proposal will be further developed in consultation with DECC, HDC (as landowner), NCIG, frog biologists and other relevant stakeholders. A broad outline of the offsets proposal based on DECC advice provided until now is given below.

7.1 Aims of the Offset Proposal

The offset proposal has two main broad objectives aimed at minimising the potential impacts of the proposal on habitat:

- to provide compensatory habitat in perpetuity to support all life-cycle phases (breeding, foraging and shelter habitat) for the Green and Golden Bell Frog;
- to provide compensatory habitat in perpetuity which supports plant and fauna species considered to be representative of the Freshwater Wetlands EEC disturbed/removed as a result of the proposal and/or a species composition similar to this community found within the broader Kooragang and Ash Islands locality.

In order to determine the success of the compensatory habitat program in relation to these broad aims, a number of criteria would be established against which the success of the habitat would be monitored and assessed. The proposal will be governed by best practice methodology and techniques as contained within the scientific literature and verified in consultation with recognised experts in amphibian research.

7.2 General Principles

As determined during consultation with DECC (DECC Presentation, August 2008), the preferred approach for areas of Green and Golden Bell Frog habitat within Kooragang and Ash Island is as follows, with the ranking from most preferred to least:

1. Preserve habitat in-situ;
2. Enhance existing habitats or create others within HDC land;
3. Protect and/or enhance existing habitats or create others within Ash Island Nature Reserve; and
4. Protect and/or enhance existing habitats or create others outside of Kooragang and Ash Islands.

The re-design of the proposal to reduce the emplacement footprint and conserve a large portion of wetland habitat (in total, more than 80 percent was retained), has aimed to achieve the first preference of preserving habitat in-situ for Green and Golden Bell Frog as far as feasibly possible within the scope of the proposal.

However, a small area of core habitat and surrounding areas of foraging and shelter habitat would still require removal as a result of the proposal.

The enhancement and/or creation of Green and Golden Bell Frog habitat within HDC land may be able to be undertaken in consultation with HDC and DECC. Habitats within HDC land could, in theory, be conserved in perpetuity with the agreement of HDC and enhanced as an offset for the proposal.

The creation of artificial habitat in areas where Green and Golden Bell Frogs have disappeared and subsequent reintroduction has been found to be largely unsuccessful and is not a preferred conservation initiative.

The following compensatory habitat principles will be applied in the provision of offsets for Green and Golden Bell Frog in accordance with DECC (presentation August 2008):

- Compensatory habitat to have good connectivity to other areas of occupied or suitable habitat (reduce predatory opportunities through providing cover and minimise anthropogenic risks such as roads and vegetation management).
- Compensatory habitat to be at least twice the amount of wetland and foraging habitat to be removed. However, it should be noted that the focus should be on creating habitat that is most likely to be utilised by Green and Golden Bell Frog in consultation with current best practice and expert knowledge therefore emphasising quality rather than area. Compensatory habitat should mimic known habitats for the species within Kooragang Island where feasible to do so.
- A range of shelter habitat features such as rocks, logs and emergent vegetation should be installed on the fringes and within the surrounding areas.
- It is likely that a combination of permanent and ephemeral freshwater habitats is important in supporting the species during both dry and wet periods. Both permanent and ephemeral freshwater wetlands should be present within the immediate vicinity of the compensatory habitat (ie if large areas of ephemeral habitat is already present then enhancement combined with the construction of permanent waterbodies should be undertaken and vice versa).
- The establishment of emergent aquatic plants such as reeds to provide suitable basking, foraging and breeding advertisement opportunities.
- Ongoing maintenance of ephemeral wetlands to prevent emergent vegetation from completely covering wetlands may be required over time in response to declines in usage detected during monitoring.
- A management strategy be implemented and funded that will ensure the ongoing management and monitoring of the offsets project beyond the release stage of the emplacement project. Management strategy should include project timeline, performance criteria for each project component, monitoring regime with feedback mechanisms.

The propagation and introduction of *Zannichellia palustris* into any constructed wetland will only be considered in consultation with DECC.

8 Recommended Mitigation Measures

In addition to the substantial measures already undertaken by BHPB, including the significant redesign and modification to the proposed emplacement footprint to avoid substantial areas of core habitat and commitment to implement the significant compensatory habitat offsets proposal developed by DECC, a number of mitigation measures are recommended to further minimise the potential for direct and indirect impacts on threatened species and EEC's.

The following sections outline the mitigation measures that need to be applied to the proposed works to minimise the potential impacts on threatened species and EEC's.

- The commitment of BHPB to the DECC Framework for the management of Green and Golden Bell Frog within Kooragang Island through the enhancement, protection and provision of habitat for the species.
- A Green and Golden Bell Frog Construction Management Plan will be prepared for the site prior to the commencement of works and will reflect the recommendations outlined below.
- Lighting, noise and vibration should be kept to a minimum during construction and in particular during nocturnal hours. Screens, shields or louvers or other control(s) to minimise the potential for light spill onto adjacent wetland areas will be considered to minimise potential lighting impacts on threatened fauna species. Equipment will be maintained in a proper and efficient manner to minimise potential for excessive noise levels.
- A pre-clearing inspection will be undertaken by an Ecologist prior to the commencement of works to ascertain which species are utilising the site around the time of works. This would be undertaken in the week prior to commencement of works. This site inspection would include searches for evidence of breeding or nests of threatened species.
 - o Should the site inspection reveal breeding or likely breeding of any threatened species at the time of proposed commencement, activities will be immediately reviewed as appropriate and potential impacts on the species reduced to ensure that a significant impact is unlikely. If found, frogs in the path of activities will need to be dealt with appropriately in consultation with DECC.
- Frog exclusion fencing will be installed, monitored and maintained along relevant boundaries where habitat exists to minimise the potential for frog mortality during construction.
- Ensure appropriate erosion and sediment control measures are put in place during and subsequent to soil disturbance and construction.
- Vehicle and machinery movements on site are limited to defined roads and tracks.
- Site briefings to all field staff to ensure that workers are aware of the sensitive nature of the site and the proposed mitigation measures.
- The DEC "Hygiene Protocol for the Control of Disease in Frogs" should be applied during all works in or near the site. Footwear, clothing, machinery,

vehicles and instruments are to be cleaned of possible contaminants from other sites prior to entering the site.

- Monitoring of groundwater and surface water within the site, in addition to monitoring of the Hunter River will be undertaken in accordance with DECC requirements so that any contaminant movement (should it occur, although not anticipated given the significant number of treatment and emplacement design controls) would be able to be detected.
- Appropriate measures to prevent the suspension of sediments into the water column and reduce turbidity would be put in place during construction to minimise impacts on wetland habitats.

Note, these recommendations are consistent with those identified within the separate EPBC Act Referral application made by BHPB to the Department of Environment, Water, Heritage and the Arts (DEWHA) in December 2008. A copy of this separate Referral application was provided to the DECC's Newcastle regional office (per email comms from BHPB's Carl Bagnall to DECC's Josh Gibson and Grahame Clarke dated 11 December 2008).

9 Conclusion

Conclusion

RPS Harper Somers O'Sullivan (RPS HSO) has been engaged by BHP Billiton (BHPB) to undertake ecological investigations and subsequently prepare a Flora and Fauna Assessment over lands in the vicinity of and to the west of Area C on NSW Government's land managed by the Hunter Development Corporation (HDC) on Kooragang Island. This Assessment is part of the environmental impact assessment accompanying BHPB's application to proceed to Stage 2 works (as defined by the relevant development consent dated 9 August 2005) as part of its Hunter River Remediation Project (HRRP). The affected land, already licensed by DECC to receive waste material, has been identified for the emplacement of treated sediment within engineered cell(s) resulting from BHPB's nearby river remediation activities. Biosphere Environmental Consultants (BEC) has been engaged to contribute to the ecological assessment given their extensive survey and knowledge of the Kooragang Island area.

Kooragang Island is a natural delta that historically exhibited a combination of estuarine wetlands and freshwater wetlands. The location which is the subject of this proposal is a highly disturbed and modified site. The site was used for grazing and dairy farming from the 1830's and the site was used for soil disposal in the late 1880's through until the 1950's. Within the last 40 years, the site has been used as a waste disposal ground (facility) for a range of heavy industrial wastes generated from the operation of the former Newcastle Steelworks. This latter activity ceased prior to the closure of the Steelworks in 1999, however, the site is still licensed to receive particular types of wastes. Six vegetation communities were found to occur within the site, being, Grassy Waste Emplacement Lands, Planted Vegetation, Freshwater Wetland Complex, Coastal Saltmarsh, Swamp Oak Floodplain Forest and Mangrove-Estuarine Complex.

One threatened flora species (*Zannichellia palustris*), eight threatened fauna species (Green and Golden Bell Frog, Australasian Bittern, Australian Painted Snipe, Red-backed Button Quail, Grass Owl, Magpie Goose, Blue Billed Duck and Freckled Duck) and three EECs (Freshwater Wetland, Swamp Oak Floodplain Forest and Coastal Saltmarsh) were recorded or considered to have at least a moderate chance of occurring within the site.

Whilst the proposal will result in the removal of known or potential habitat for a small number of threatened species, BHPB has already undertaken or committed to substantial preventative and mitigation measures, including significant redesign of the emplacement footprint to conserve more than 80% of the core habitat for the Green and Golden Bell Frog and other threatened species/communities. In addition, BHPB is firmly committed to strictly implementing a number of additional mitigation measures during construction as identified in this report, in addition to providing an offsets package in accordance with the principles outlined by DECC to ensure that an overall holistic balanced outcome is achieved for the ecology of the Lower Hunter estuary.

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APPENDIX A FLORA SPECIES LIST

Flora Species List

The following list includes all species of vascular plants observed on site during fieldwork. It should be noted that such a list cannot be considered comprehensive, but rather indicative of the flora present on the site. It can take many years of flora surveys to record all of the plant species occurring within any area, especially plant species that are only apparent in some seasons such as Orchids.

A number of species cannot always be accurately identified during a brief survey, generally due to a lack of suitable flowering and/or fruiting material. Any such species are identified as accurately as possible, and are indicated in the list as indicated:

- specimens that could only be identified to genus level are indicated by the generic name followed by the abbreviation “sp.”, indicating an unidentified species of that genus;
- specimens for which identification of the genus was uncertain are indicated by a question mark (“?”) placed in front of the generic, which is followed by the abbreviation “sp.” and;
- specimens that could be accurately identified to genus level, but could be identified to species level with only a degree of certainty are indicated by a (“?”) placed in front of the epithet.

Authorities for the scientific names are not provided in the list. These follow the references outlined below.

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Names of families and higher taxa follow a modified Cronquist System (1981). Introduced species are indicated by an asterisk “*”.

Threatened species listed under the Threatened Species Conservation Act 1995 (TSC Act 1995) or the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999) and / or Rare or Threatened Australian Plant (ROTAP) listed species are indicated in bold font and marked as:

(V) = Vulnerable Species listed under the TSC Act

(E) = Endangered Species listed under the TSC Act

(R) = ROTAP as per Briggs and Leigh (1996)

The following standard abbreviations are used to indicate subspecific taxa:

ssp. - subspecies

var.- variety

Flora Species List

Class/Subclass	Family	Scientific Name	Common Name
Magnoliidae	Aizoaceae	<i>Carpobrotus glaucescens</i>	Pigface
	Apiaceae	<i>Foeniculum vulgare</i> *	Fennel
	Apiaceae	<i>Hydrocotyle bonariensis</i> *	Kurnell Curse
	Apocynaceae	<i>Nerium oleander</i> *	Oleander Bush
	Asclepiadaceae	<i>Araujia hortorum</i> *	Mothvine
	Asclepidaceae	<i>Gomphocarpus fruiticosus</i> *	Narrow Leaf Cotton Bush
	Asteraceae	<i>Ageratina adenophorum</i> *	Crofton Weed
	Asteraceae	<i>Ambrosia artemisifolia</i> *	Annual Ragweed
	Asteraceae	<i>Arctotheca calendula</i> *	Capeweed
	Asteraceae	<i>Bidens pilosa</i> *	Cobbler's Pegs
	Asteraceae	<i>Chrysanthemoides monilifera</i> subsp. <i>monilifera</i> *	Bitou Bush
	Asteraceae	<i>Chrysanthemoides monilifera</i> subsp. <i>rotundata</i> *	Boneseed
	Asteraceae	<i>Cirsium vulgare</i> *	Spear Thistle
	Asteraceae	<i>Conyza albida</i> *	Fleabane
	Asteraceae	<i>Cotula australis</i>	Common Cotula
	Asteraceae	<i>Hypochaeris radicata</i> *	Flatweed
	Asteraceae	<i>Senecio madagascariensis</i> *	Fireweed
	Asteraceae	<i>Senecio pterophorus</i> *	African Daisy
	Asteraceae	<i>Senecio quadridentatus</i>	Cotton Fireweed
	Asteraceae	<i>Soliva pterosperma</i> *	Bindii
	Asteraceae	<i>Sonchus oleraceus</i> *	Common Sow-thistle
	Asteraceae	<i>Taraxacum officinale</i> *	Dandelion
	Brassicaceae	<i>Brassica tournefortii</i> *	Wild Turnip
	Carophyllaceae	<i>Cerastium glomeratum</i> *	Mouse-ear Chickweed
	Caryophyllaceae	<i>Silene gallica</i> *	French Catchfly
	Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-oak
	Casuarinaceae	<i>Casuarina equisetifolia</i>	Swamp Oak
	Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak
	Chenopodiaceae	<i>Sarcocornia quinqueflora</i>	Glasswort
	Chenopodiaceae	<i>Suaeda australis</i>	Austral Seablite
	Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed
	Convolvulaceae	<i>Ipomoea cairica</i> *	Blue Morning Glory
	Euphorbiaceae	<i>Glochidion ferdinandii</i>	Cheese Tree
	Euphorbiaceae	<i>Ricinus communis</i> *	Castor Oil Plant
	Fabaceae	<i>Hardenbergia violacea</i>	False Sarsparilla
	Fabaceae	<i>Medicago polymorpha</i> *	Burr Medic
	Fabaceae	<i>Medicago truncatula</i>	Barrel Medic
	Fabaceae	<i>Melilotus indicus</i> *	-

Class/Subclass	Family	Scientific Name	Common Name
	Fabaceae	<i>Trifolium repens</i> *	White Clover
	Fabaceae	<i>Vicia sativa</i> subsp. <i>sativa</i> *	Common Vetch
	Fumariaceae	<i>Fumaria muralis</i> *	Wall Fumitory
	Geraniaceae	<i>Geranium molle</i> *	Geranium
	Lamiaceae	<i>Stachys arvensis</i> *	Stagger Weed
	Lauraceae	<i>Cinnamomum camphora</i> *	Camphor Laurel
	Malvaceae	<i>Malva parviflora</i> *	Small-flowered Mallow
	Malvaceae	<i>Sida rhombifolia</i> *	Paddy's Lucerne
	Meliaceae	<i>Melia azedarach</i> var. <i>australasica</i>	White Cedar
	Mimosaceae	<i>Acacia binervia</i>	Coast Myall
	Mimosaceae	<i>Acacia falcata</i>	Sickle Wattle
	Mimosaceae	<i>Acacia fimbriata</i>	Fringed Wattle
	Mimosaceae	<i>Acacia irrorata</i> subsp. <i>irrorata</i>	Green Wattle
	Mimosaceae	<i>Acacia longifolia</i> var. <i>longifolia</i>	Sydney Golden Wattle
	Mimosaceae	<i>Acacia longifolia</i> var. <i>sophorae</i>	-
	Mimosaceae	<i>Acacia saligna</i>	Orange Wattle
	Moraceae	<i>Ficus rubiginosa</i>	Port Jackson Fig
	Myrtaceae	<i>Angophora costata</i>	Smooth-barked Apple
	Myrtaceae	<i>Callistemon citrinus</i>	Crimson Bottlebrush
	Myrtaceae	<i>Callistemon salignus</i>	Willow Bottlebrush
	Myrtaceae	<i>Callistemon</i> sp. (cultivar)	-
	Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum
	Myrtaceae	<i>Eucalyptus botryoides</i>	Southern Mahogany
	Myrtaceae	<i>Eucalyptus citriodora</i>	Lemon-scented Gum
	Myrtaceae	<i>Eucalyptus cladocalyx</i>	Sugar Gum
	Myrtaceae	<i>Leptospermum trinervium</i>	Flaky-barked Tea-tree
	Myrtaceae	<i>Lophostemon confertus</i>	Brush Box
	Myrtaceae	<i>Melaleuca armillaris</i>	Bracelet Honey Myrtle
	Myrtaceae	<i>Melaleuca ericifolia</i>	Swamp Paperbark
	Myrtaceae	<i>Melaleuca hypericifolia</i>	-
	Myrtaceae	<i>Melaleuca linariifolia</i>	Snow in Summer
	Myrtaceae	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark
	Myrtaceae	<i>Melaleuca stypheloides</i>	Prickly-leaved Tea Tree
	Myrtaceae	<i>Syncarpia glomulifera</i>	Turpentine
	Oleaceae	<i>Ligustrum sinense</i> *	Small-leaved Privet
	Oleaceae	<i>Olea europaea</i> subsp. <i>africana</i> *	Common Olive
	Oxalidaceae	<i>Oxalis corniculata</i> *	Yellow Wood Sorrel
	Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum
	Plantaginaceae	<i>Plantago lanceolata</i> *	Ribwort
	Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed
	Polygonaceae	<i>Rumex crispus</i> *	Curled Dock
	Portulacaceae	<i>Portulaca oleracea</i>	Purslane

Class/Subclass	Family	Scientific Name	Common Name
	Primulaceae	<i>Anagallis arvensis</i> *	Scarlet Pimpernel
	Proteaceae	<i>Banksia integrifolia</i> subsp. A	
	Proteaceae	<i>Grevillea robusta</i>	Silky Oak
	Proteaceae	<i>Grevillea</i> sp. (cultivar)	-
	Rubiaceae	<i>Galium aparine</i> *	Cleavers
	Sapindaceae	<i>Dodonaea viscosa</i> subsp. <i>angustifolia</i>	-
	Solanaceae	<i>Solanum nigrum</i> *	Black Nightshade
	Verbenaceae	<i>Lantana camara</i> *	Lantana
	Verbenaceae	<i>Verbena bonariensis</i> *	Purpletop
	Verbenaceae	<i>Verbena rigida</i> *	Veined Verbena
Liliidae	Arecaceae	<i>Phoenix canariensis</i> *	Canary Island Date Palm
	Asparagaceae	<i>Protasparagus aethiopicus</i> *	Asparagus Fern
	Cyperaceae	<i>Carex appressa</i>	Tall Sedge
	Cyperaceae	<i>Schoenoplectus validus</i>	River Clubrush
	Juncaceae	<i>Juncus acutus</i> *	-
	Poaceae	<i>Andropogon virginicus</i> *	Whisky Grass
	Poaceae	<i>Avena fatua</i> *	Wild Oats
	Poaceae	<i>Avena sativa</i> *	Oats
	Poaceae	<i>Bambusa</i> sp. *	Bamboo
	Poaceae	<i>Briza maxima</i> *	Quaking Grass
	Poaceae	<i>Briza minor</i> *	Shivery Grass
	Poaceae	<i>Bromus cartharticus</i> *	Prairie Grass
	Poaceae	<i>Chloris gayana</i> *	Rhodes Grass
	Poaceae	<i>Cortaderia selloana</i> *	Pampas Grass
	Poaceae	<i>Cynodon dactylon</i>	Common Couch
	Poaceae	<i>Ehrharta erecta</i> *	Panic Veldtgrass
	Poaceae	<i>Lolium rigidum</i> *	Stiff Ryegrass
	Poaceae	<i>Melinus repens</i> *	Red Natal Grass
	Poaceae	<i>Panicum maximum</i> *	Guinea Grass
	Poaceae	<i>Paspalum distichum</i>	Water Couch
	Poaceae	<i>Pennisetum clandestinum</i> *	Kikuyu
	Poaceae	<i>Phragmites australis</i>	Common Reed
	Poaceae	<i>Poa annua</i> *	Winter Grass
	Poaceae	<i>Sporobolus virginicus</i>	Sand Couch
	Poaceae	<i>Zoysia macrantha</i>	Coast Couch
	Typhaceae	<i>Typha orientalis</i>	Cumbungi
Filicopsida	Azollaceae	<i>Azolla pinnata</i>	Ferny Azolla

APPENDIX B EXPECTED FAUNA SPECIES LIST

Below is a list of fauna species that could be *reasonably* expected to be found within the site at some occurrence. Such an approach has been taken given the unlikelihood to record *all* potentially occurring species within an area during formal fauna surveys (due to seasonality, climatic limitations, crypticism etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (1994).

Herpetofauna - Cogger (1996).

Mammals - Strahan (ed) (1995) and Churchill (1998).

✓ - Species observed or indicated by scats, tracks etc. on site during this investigation.

* - Indicates an introduced species

KNOWN AND EXPECTED BIRD LIST

- Appendix Key:**
- ✓ = Species Detected
 - * = introduced species
 - (C) = listed as CAMBA species
 - (J) = listed as JAMBA species
 - (E) = listed as Endangered in NSW.
 - (V) = listed as Vulnerable in NSW.
 - (EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
 - (EE) = Species listed under the Commonwealth EPBC Act as Endangered
 - (EM) = Species listed under the Commonwealth EPBC Act as Migratory
 - (EMa) = Species listed under the Commonwealth EPBC Act as Marine
- Species indicated in **BOLD** font are those threatened species known from within 10km of site (Atlas of NSW Wildlife data)
- Data Source:** ✓ = Species recorded during this survey

Family Name	Scientific Name	Common Name	
Phasianidae (True Quails, Pheasants and Fowls)	<i>Coturnix pectoralis</i>	Stubble Quail (EMa)	
	<i>Coturnix ypsilophora</i>	Brown Quail	✓
Anatidae (Swans, Geese and Ducks)	<i>Anas castanea</i>	Chestnut Teal (EM)	✓
	<i>Anas gracilis</i>	Grey Teal (EM)	✓
	<i>Anas platyrhynchos</i>	*Mallard	
	<i>Anas rhynchos</i>	Australasian Shoveler	✓
	<i>Anas superciliosa</i>	Pacific Black Duck (EM)	✓
	<i>Aythya australis</i>	Hardhead (EM)	✓
	<i>Chenonetta jubata</i>	Australian Wood Duck (EM)	✓
	<i>Cygnus atratus</i>	Black Swan (EM)	✓
	<i>Biziura lobata</i>	Musk Duck	✓

Family Name	Scientific Name	Common Name	
	<i>Oxyura australis</i>	Blue-billed Duck (V)	
	<i>Stictonetta naevosa</i>	Frecked Duck (V)	
Podicipedidae (Grebes)	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	✓
Anhingidae (Darters)	<i>Anhinga melanogaster</i>	Darter	
Phalacrocoracidae (Cormorants)	<i>Phalacrocorax carbo</i>	Great Cormorant	
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	✓
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	
	<i>Phalacrocorax varius</i>	Pied Cormorant	✓
Pelecanidae (Pelicans)	<i>Pelecanus conspicillatus</i>	Australian Pelican (EMa)	✓
Ardeidae (Hérons, Bitterns and Egrets)	<i>Ardea alba</i>	Great Egret (C,J, EM, EMa)	✓
	<i>Ardea ibis</i>	Cattle Egret (C,J, EM, EMa)	
	<i>Ardea intermedia</i>	Intermediate Egret (EMa)	
	<i>Ardea pacifica</i>	White-necked Heron	✓
	<i>Botaurus poiciloptilus</i>	Australasian Bittern (V)	
	<i>Butorides striatus</i>	Striated Heron	
	<i>Egretta garzetta</i>	Little Egret	
	<i>Egretta novaehollandiae</i>	White-faced Heron	✓
	<i>Ixobrychus minutus</i>	Little Bittern	
	<i>Ixobrychus flavicollis</i>	Black Bittern (V)	
	<i>Nycticorax caledonicus</i>	Nankeen Night Heron (EMa)	
Threskiornithidae (Ibises and Spoonbills)	<i>Platalea flavipes</i>	Yellow-billed Spoonbill	
	<i>Platalea regia</i>	Royal Spoonbill	✓
	<i>Threskiornis molucca</i>	Australian White Ibis (EMa)	✓
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis (EMa)	
Ciconiidae (Storks)	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork (E)	
Accipitridae (Hawks, Kites and Eagles)	<i>Accipiter fasciatus</i>	Brown Goshawk (EM, EMa)	✓
	<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk (EM)	
	<i>Accipiter novaehollandiae</i>	Grey Goshawk (EM)	
	<i>Aquila audax</i>	Wedge-tailed Eagle (EM, EMa)	✓
	<i>Aviceda subcristata</i>	Pacific Baza (EM)	
	<i>Circus approximans</i>	Swamp Harrier (EM, EMa)	✓
	<i>Circus assimilis</i>	Spotted Harrier (EM)	
	<i>Elanus axillaris</i>	Black-shouldered Kite (EM)	✓
	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle (C, EM, EMa)	✓
	<i>Haliastur sphenurus</i>	Whistling Kite (EM, EMa)	✓
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard (V)	
	<i>Hieraaetus morphnoides</i>	Little Eagle (EM)	
	<i>Pandion haliaetus</i>	Osprey (V, EMa)	✓
Falconidae (Falcons)	<i>Falco berigora</i>	Brown Falcon (EM)	✓
	<i>Falco cenchroides</i>	Nankeen Kestrel (EM, EMa)	✓
	<i>Falco longipennis</i>	Australian Hobby (EM)	✓
	<i>Falco peregrinus</i>	Peregrine Falcon (EM)	

Family Name	Scientific Name	Common Name	
	<i>Falco subniger</i>	Black Falcon	
Rallidae (Crakes, Rails and Gallinules)	<i>Fulica atra</i>	Eurasian Coot	
	<i>Gallinula philippensis</i>	Buff-banded Rail (EMa)	
	<i>Gallinula tenebrosa</i>	Dusky Moorhen	✓
	<i>Porphyrio porphyrio</i>	Purple Swampphen (EMa)	✓
	<i>Porzana fluminea</i>	Australian Spotted Crake	
	<i>Porzana pusilla</i>	Baillon's Crake (EMa)	✓
	<i>Porzana tabuensis</i>	Spotless Crake (EMa)	
	<i>Rallus pectoralis</i>	Lewin's Rail	
Turnicidae (Button-Quails)	<i>Turnix pyrrhotorax</i>	Red-chested Button-quail	
	<i>Turnix varia</i>	Painted Button-quail	
Rostratulidae (Painted Snipe)	<i>Rostratula benghalensis</i>	Painted Snipe (EM, V, EMa)	
Jacaniidae (Jacanas))	<i>Irediparra gallinacea</i>	Comb-crested Jacana (V)	
	<i>Vanellus miles</i>	Masked Lapwing (EM)	
	<i>Erythrogonyx cinctus</i>	Red-kneed Dotterel (EM)	
	<i>Elseyornis melanops</i>	Black-fronted Dotterel (EM)	
Laridae (Gulls and Terns)	<i>Chlidonias hybrida</i>	Whiskered Tern (EMa)	
	<i>Larus novaehollandiae</i>	Silver Gull (EMa)	
Columbidae (Pigeons and Doves)	<i>Columba livia</i>	Rock Dove	
	<i>Chalcophaps indica</i>	Emerald Dove	
	<i>Columba leucomela</i>	White-headed Pigeon	
	<i>Geopelia humeralis</i>	Bar-shouldered Dove	
	<i>Geopelia striata</i>	Peaceful Dove	
	<i>Leucosarcia melanoleuca</i>	Wonga Pigeon	
	<i>Macropygia amboinensis</i>	Brown Cuckoo-Dove	
	<i>Ocyphaps lophotes</i>	Crested Pigeon	✓
	<i>Phaps chalcoptera</i>	Common Bronzewing	
	<i>Phaps elegans</i>	Brush Bronzewing	
	<i>Ptilinopus magnificus</i>	Wompoo Fruit-dove (V)	
	<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	
	<i>Lopholaimus antarcticus</i>	Topknot Pigeon	
Cacatuidae (Cockatoos)	<i>Calyptrohynchus funereus</i>	Yellow-tailed Black-Cockatoo	
	<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo (V)	
	<i>Cacatua roseicapilla</i>	Galah	
	<i>Cacatua tenuirostris</i>	Long-billed Corella	
	<i>Cacatua sanguinea</i>	Little Corella	
	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	
	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	
Psittacidae (Parrots)	<i>Alisterus scapularis</i>	Australian King Parrot	
	<i>Glossopsitta pusilla</i>	Little Lorikeet	
	<i>Lathamus discolor</i>	Swift Parrot (E, EE, EMa)	
	<i>Neophema pulchella</i>	Turquoise Parrot (V)	
	<i>Platycercus elegans</i>	Crimson Rosella	
	<i>Platycercus eximius</i>	Eastern Rosella	✓

Family Name	Scientific Name	Common Name	
	<i>Psephotus haematonotus</i>	Red-rumped Parrot	
	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	
	<i>Trichoglossus concina</i>	Musk Lorikeet	
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	
Cuculidae (Old World Cuckoos)	<i>Cuculus saturatus</i>	Oriental Cuckoo (C,J, EM)	
	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo (EMa)	
	<i>Cacomantis variolosus</i>	Brush Cuckoo	
	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo (EMa)	
	<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo (EMa)	
	<i>Cuculus pallidus</i>	Pallid Cuckoo (EMa)	
	<i>Eudynamys scolopacea</i>	Common Koel (EMa)	
	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo (EMa)	
Centropodidae (Coucals)	<i>Centropus phasianinus</i>	Pheasant Coucal	
Strigidae (Hawk Owls)	<i>Ninox strenua</i>	Powerful Owl (V)	
	<i>Ninox connivens</i>	Barking Owl (V)	
	<i>Ninox boobook</i>	Southern Boobook (EMa)	
Tytonidae (Barn Owls)	<i>Tyto alba</i>	Barn Owl	
	<i>Tyto capensis</i>	Grass Owl (V)	
	<i>Tyto novaehollandiae</i>	Masked Owl (V)	
	<i>Tyto tenebrisco</i>	Sooty Owl (V)	
Podargidae (Frogmouths)	<i>Podargus strigoides</i>	Tawny Frogmouth	
Caprimulgidae (Nightjars)	<i>Eurostopodus mystacalis</i>	White-throated Nightjar (EMa)	
Aegothelidae (Owlet-nightjars)	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	✓
Apodidae (Typical Swifts)	<i>Hirundapus caudacutus</i>	White-throated Needletail (C,J, EM)	
	<i>Apus pacificus</i>	Fork-tailed Swift (C,J, EM)	
Alcedinidae (True Kingfishers)	<i>Alcedo azurea</i>	Azure Kingfisher	
Halcyonidae (Kingfishers and Kookaburras)	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	✓
	<i>Todiramphus sanctus</i>	Sacred Kingfisher (EMa)	✓
Meropidae (Bee-eaters)	<i>Merops ornatus</i>	Rainbow Bee-eater (J, ,EM, EMa)	
Coraciidae (Typical Rollers)	<i>Eurystomus orientalis</i>	Dollarbird (EMa)	
Menuridae (Lyrebirds)	<i>Menura novaehollandiae</i>	Superb Lyrebird	
Climacteridae (Australo-Papuan Treecreepers)	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	
	<i>Climacteris picumnus</i>	Brown Treecreeper (V)	
Maluridae (Fairy-Wrens and Emu-Wrens)	<i>Malurus cyaneus</i>	Superb Fairy-wren	✓
	<i>Malurus lamberti</i>	Variegated Fairy-wren	
	<i>Stipiturus malachurus</i>	Southern Emu-wren	

Family Name	Scientific Name	Common Name	
Pardalotidae (Pardalotes, Scrubwrens, Thornbills)	<i>Pardalotus punctatus</i>	Spotted Pardalote	
	<i>Paradalotus striatus</i>	Striated Pardalote	✓
	<i>Sericornis frontalis</i>	White-browed Scrubwren	✓
	<i>Sericornis magnirostris</i>	Large-billed Scrubwren	
	<i>Gerygone mouki</i>	Brown Gerygone	
	<i>Gerygone olivacea</i>	White-throated Gerygone	
	<i>Acanthiza pusilla</i>	Brown Thornbill	
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	
	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	
	<i>Acanthiza nana</i>	Yellow Thornbill	
	<i>Acanthiza lineata</i>	Striated Thornbill	
Meliphagidae (Honeyeaters)	<i>Anthochaera carunculata</i>	Red Wattlebird	
	<i>Anthochaera chrysoptera</i>	Little Wattlebird	
	<i>Plectrhynga lanceolata</i>	Striped Honeyeater	
	<i>Anthochaera chrysoptera</i>	Brush Wattlebird	
	<i>Philemon corniculatus</i>	Noisy Friarbird	
	<i>Philemon citreogularis</i>	Little Friarbird	
	<i>Xanthomyza phrygia</i>	Regent Honeyeater (E, EE, EM)	
	<i>Manorina melanophrys</i>	Bell Miner	
	<i>Manorina melanocephala</i>	Noisy Miner	
	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	
	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	
	<i>Melithreptus lunatus</i>	White-naped Honeyeater	
	<i>Melithreptus gularis</i>	Black-chinned Honeyeater (V)	
	<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	
	<i>Lichmera indistincta</i>	Brown Honeyeater	✓
	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	
	<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	
	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	
	<i>Epthianura albigula</i>	White-fronted Chat	
Pomatostomidae	<i>Pomatostomus temporalis</i> subsp <i>temporalis</i>	Grey-crowned Babbler	
Eopsaltriidae (Robins)	<i>Microeca fascians</i>	Jacky Winter	
	<i>Petroica multicolor</i>	Scarlet Robin	
	<i>Petroica phoenicea</i>	Flame Robin (EMa)	
	<i>Petroica rosea</i>	Rose Robin	
	<i>Eopsaltria australis</i>	Eastern Yellow Robin	
Cinclosomidae (Quail-thrushes and allies)	<i>Psophodes olivaceus</i>	Eastern Whipbird	
	<i>Cinclosoma punctatum</i>	Spotted Quail-thrush	
Neosittidae (Sittellas)	<i>Daphoenositta chrysoptera</i>	Varied Sittella	
Pachycephalidae (Whistlers, Shrike-tit, Shrike-thrushes)	<i>Falcunculus frontatus</i>	Crested Shrike-tit	
	<i>Pachycephala pectoralis</i>	Golden Whistler	
	<i>Pachycephala rufiventris</i>	Rufous Whistler	✓

Family Name	Scientific Name	Common Name	
	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
Dicruridae (Monarchs, Fantails and Drongo)	<i>Monarcha melanopsis</i>	Black-faced Monarch	
	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	
	<i>Myiagra rubecula</i>	Leaden Flycatcher	
	<i>Myiagra inquieta</i>	Restless Flycatcher	
	<i>Grallina cyanoleuca</i>	Magpie-lark (EMa)	✓
	<i>Rhipidura rufifrons</i>	Rufous Fantail (EMa)	
	<i>Rhipidura fuliginosa</i>	Grey Fantail	✓
	<i>Rhipidura leucophrys</i>	Willie Wagtail	✓
	<i>Dicrurus bracteatus</i>	Spangled Drongo (EMa)	
Campephagidae (Cuckoo-shrikes and Trillers)	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike (EMa)	✓
	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike (EMa)	
	<i>Coracina tenuirostris</i>	Cicadabird (EM, (EMa)	
	<i>Lalage sueurii</i>	White-winged Triller	
Oriolidae (Orioles and Figbird)	<i>Oriolus sagittatus</i>	Olive-backed Oriole	
	<i>Sphecotheres viridis</i>	Figbird	
Artamidae (Woodswallows, Butcherbirds, Currawongs)	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	
	<i>Artamus cyanopterus</i>	Dusky Woodswallow	
	<i>Artamus personatus</i>	Masked Woodswallow	
	<i>Cracticus torquatus</i>	Grey Butcherbird	✓
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	
	<i>Gymnorhina tibicen</i>	Australian Magpie	✓
	<i>Strepera graculina</i>	Pied Currawong	✓
Corvidae (Crows and allies)	<i>Corvus coronoides</i>	Australian Raven	✓
	<i>Corvus orru</i>	Torresian Crow	
	<i>Corvus tasmanicus</i>	Forest Raven (EMa)	
Coraciidae (Mud-nesters)	<i>Corcorax melanorhamphos</i>	White-winged Chough	✓
Ptilinorhynchidae (Bowerbirds)	<i>Ptilinorhynchus violaceus</i>	Satin Bowerbird	
	<i>Sericulus chrysocephalus</i>	Regent Bowerbird	
Motacillidae (Old World Wagtails, Pipits)	<i>Anthus novaeseelandiae</i>	Richard's Pipit	✓
	<i>Alauda arvensis</i>	Skylark	
Passeridae (Sparrows, Weaverbirds, Waxbills)	<i>Passer domesticus</i>	House Sparrow #	
	<i>Taeniopygia bichenovii</i>	Double-barred Finch	
	<i>Neochmia temporalis</i>	Red-browed Finch	✓
	<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin	
Dicaeidae (Flowerpeckers)	<i>Dicaeum hirundinaceum</i>	Mistletoebird	
Hirundinidae (Swallows and Martins)	<i>Hirundo neoxena</i>	Welcome Swallow (EMa)	✓
	<i>Hirundo nigricans</i>	Tree Martin (EMa)	
	<i>Hirundo ariel</i>	Fairy Martin	✓

Family Name	Scientific Name	Common Name	
Sylviidae (Old World Warblers)	<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler	✓
	<i>Cincloramphus mathewsi</i>	Rufous Songlark	
	<i>Cisticola exilis</i>	Golden-headed Cisticola	✓
	<i>Megalurus gramineus</i>	Little Grassbird	✓
	<i>Megalurus timorensis</i>	Tawny Grassbird	✓
Zosteropidae (White-eyes)	<i>Zosterops lateralis lateralis</i>	Silvereye (EMa)	
	<i>Zosterops lateralis familiaris</i>	Silvereye (EMa)	✓
Muscicapidae (Thrushes)	<i>Zoothera lunulata</i>	Bassian Thrush	
	<i>Zoothera heinei</i>	Russet-tailed Thrush	
Sturnidae (Starlings and allies)	<i>Sturnus vulgaris</i>	Common Starling #	✓
	<i>Acridotheres tristis</i>	Common Myna #	✓

KNOWN AND EXPECTED MAMMAL LIST

Appendix Key: ✓ = Species Detected
 * = introduced species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
 Species indicated in **BOLD** font are those threatened species known from within 10km of site (NPWS, 2003)

Data Source: 1 = Species recorded during this survey

Family Name	Scientific Name	Common Name	
Tachyglossidae (Echidnas)	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	
Dasyuridae (Dasyurids)	<i>Antechinus flavipes</i>	Yellow-footed Antechinus	
	<i>Antechinus stuartii</i>	Brown Antechinus	
	<i>Antechinus swainsonii</i>	Dusky Antechinus	
	<i>Dasyurus maculatus</i>	Tiger Quoll (V, EV)	
	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale (V)	
	<i>Planigale maculata</i>	Common Planigale (V)	
	<i>Sminthopsis murina</i>	Common Dunnart	
Peramelidae (Bandicoots and Bilbies)	<i>Isodon macrourus</i>	Northern Brown Bandicoot	
	<i>Peremeles nasuta</i>	Long-nosed Bandicoot	
Phascolarctidae (Koala)	<i>Phascolarctos cinereus</i>	Koala (V)	
Vombatidae (Wombats)	<i>Vombatus ursinus</i>	Common Wombat	
Petauridae (Wrist-winged Gliders)	<i>Petaurus breviceps</i>	Sugar Glider	
	<i>Petaurus norfolcensis</i>	Squirrel Glider (V)	
	<i>Petaurus australis</i>	Yellow-bellied Glider (V)	
Pseudocheiridae (Ring-tail Possum)	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	
Acrobatidae (Feathertail Glider)	<i>Acrobates pygmaeus</i>	Feathertail Glider	
Phalangeridae (Brush-tail Possums and Cuscuses)	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	
Potoroidae (Potoroos and Bettongs)	<i>Potorous tridactylus</i>	Long-nosed Potoroo (V, EV)	
Macropodidae (Wallabies and Kangaroos)	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	
	<i>Macropus robustus</i>	Common Wallaroo	
	<i>Macropus rufogriseus</i>	Red-necked Wallaby	
	<i>Wallabia bicolor</i>	Swamp Wallaby	
Pteropodidae (Flying-foxes, Blossom-bats)	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox (V, EV)	✓
	<i>Pteropus scapulatus</i>	Little Red Flying-fox	
Rhinolophidae (Horseshoe-bats)	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	

Family Name	Scientific Name	Common Name	
Emballonuridae (Sheathtail-bats)	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat (V)	
Molossidae (Freetail-bats)	<i>Mormopterus norfolkensis</i>	East Coast Freetail-bat (V)	
	<i>Mormopterus</i> sp.1	Little Freetail-bat	
	<i>Mormopterus</i> sp.2	Eastern Freetail-bat	
	<i>Tadarida australis</i>	White-striped Freetail-bat	
Vespertilionidae (Vespertilionid Bats)	<i>Miniopterus australis</i>	Little Bentwing-bat (V)	
	<i>Miniopterus schreibersii</i>	Large Bentwing-bat (V)	
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	
	<i>Nyctophilus gouldii</i>	Gould's Long-eared Bat	
	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat (V, EV)	
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	
	<i>Falsistrellus tasmaniensis</i>	Eastern Falsistrelle (V)	
	<i>Myotis adversus</i>	Large-footed Myotis (V)	
	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat (V)	
	<i>Scotorepens greyii</i>	Little Broad-nosed Bat	
	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	
	<i>Vespadelus darlingtoni</i>	Large Forest Bat	
	<i>Vespadelus regulus</i>	Southern Forest Bat	
	<i>Vespadelus pumilus</i>	Eastern Forest Bat	
	<i>Vespadelus vulturnus</i>	Little Forest Bat	
Muridae (Murids)	<i>Hydromys chrysogaster</i>	Water Rat	
	<i>Melomys burtoni</i>	Grassland Melomys	
	<i>Mus musculus</i>	House Mouse*	
	<i>Pseudomys novaehollandiae</i>	New Holland Mouse	
	<i>Rattus fuscipes</i>	Bush Rat	
	<i>Rattus lutreolus</i>	Swamp Rat	
	<i>Rattus norvegicus</i>	Brown Rat*	
	<i>Rattus rattus</i>	Black Rat*	
Canidae (Dogs)	<i>Canis familiaris</i>	Dog *	
	<i>Vulpes vulpes</i>	Red Fox*	
Felidae (Cats)	<i>Felis catus</i>	Feral Cat*	
Leporidae (Rabbit and Hare)	<i>Oryctolagus cuniculus</i>	European Rabbit*	

KNOWN AND EXPECTED REPTILE LIST

Appendix Key: ✓ = Species Detected
 * = introduced species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
(EMa) = Species listed under the Commonwealth EPBC Act as Marine
 Species indicated in **BOLD** font are those threatened species known from within 10km of site (NPWS, 2003)

Data Source: ✓ = Species recorded during this survey

Family Name	Scientific Name	Common Name	
Cheloniidae (Turtles)	Chelonia mydas	Green Turtle (V, EMa)	
Chelidae (Tortoises)	<i>Chelodina longicollis</i>	Long-necked Tortoise	
Agamidae (Dragons)	<i>Amphibolurus muricatus</i>	Jacky Lizard	
	<i>Physignathus lesuerii</i>	Eastern Water Dragon	
	<i>Pogona barbata</i>	Eastern Bearded Dragon	
Gekkonidae (Geckos)	<i>Diplodactylus vittatus</i>	Eastern Stone Gecko	
Pygopodidae (Legless Lizards)	<i>Lialis burtonis</i>	Burton's Snake Lizard	
	<i>Pygopus lepidopus</i>	Common Scaly-foot	
	<i>Delma plebeia</i>	Leaden Delma	
Varanidae (Monitors)	<i>Varanus varius</i>	Lace Monitor	
Scincidae (Skinks)	<i>Cryptoblepharus virgatus</i>		
	<i>Ctenotus taeniolatus</i>	Copper-tailed Skink	
	<i>Ctenotus robustus</i>	Striped Skink	
	<i>Cyclodomorphus casuarinae</i>	She-oak Skink	
	<i>Egernia cunninghamii</i>	Cunningham's Skink	
	<i>Egernia major</i>	Land Mullet	
	<i>Egernia modesta</i>	Eastern Ranges Rock Skink	
	<i>Egernia striolata</i>	Tree-crevice Skink	
	<i>Egernia saxatilis</i>	Black Rock Skink	
	<i>Egernia whitii</i>	White's Skink	
	<i>Eulamprus quoyii</i>	Eastern Water Skink	
	<i>Eulamprus tenuis</i>		
	<i>Lampropholis delicata</i>	Grass Skink	✓
	<i>Lampropholis guichenoti</i>	Garden Skink	
	<i>Lerista bouganvillii</i>	South-eastern Slider	
	<i>Lygisaurus foliorum</i>	Tree-base Litter-skink	
	<i>Menetia greyii</i>	Common Dwarf Skink	
	<i>Morethia boulengeri</i>	South-eastern Morethia	
	<i>Pseudomoia platynota</i>	Red-throated Skink	
	<i>Saiphos equalis</i>		
	<i>Saproscincus mustelinus</i>	Weasel Skink	
	<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard	
Typhlopidae (Blind Snakes)	<i>Ramphotyphlops bituberculatus</i>	Prong-snouted Blind Snake	
	<i>Ramphotyphlops weidii</i>	Brown-snouted Blind Snake	
	<i>Ramphotyphlops nigrescens</i>	Black Blind Snake	
Boidae (Pythons)	<i>Morelia spilota</i>	Diamond Python	
Colubridae (Tree Snakes)	<i>Boiga irregularis</i>	Brown Tree Snake	
	<i>Dendrolaphis punctulata</i>	Green Tree Snake	
Elapidae (Venomous Snakes)	<i>Acanthopis antarcticus</i>	Death Adder	
	<i>Cacophis krefftii</i>	Dwarf Crowned Snake	
	<i>Cacophis squamulosus</i>	Golden Crowned Snake	

Family Name	Scientific Name	Common Name	
	<i>Demansia psammophis</i>	Yellow-faced Whip Snake	
	<i>Notechis scutatus</i>	Eastern Tiger Snake	
	<i>Pseudonaja textilis</i>	Eastern Brown Snake	
	<i>Rhinoplocephalus nigrescens</i>	Eastern Small-eyed Snake	
	<i>Vermicella annulata</i>	Bandy Bandy	
	<i>Hemiaspis signata</i>	Black-bellied Swamp Snake	
	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	✓

KNOWN AND EXPECTED FROG LIST

Appendix Key: ✓ = Species Detected
 * = introduced species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
 Species indicated in **BOLD** font are those threatened species known from within 10km of site (NPWS, 2003)

Data Source: ✓ = Species recorded during this survey

Family Name	Scientific Name	Common Name	
Hylidae (Tree Frogs)	<i>Litoria aurea</i>	Green and Golden Bell Frog (E, EV)	✓
	<i>Litoria brevipalmata</i>	Green-thighed Frog (V)	
	<i>Litoria caerulea</i>	Green Tree Frog	
	<i>Litoria chloris</i>	Red-eyed Green Tree Frog	
	<i>Litoria dentata</i>	Bleating Tree Frog	
	<i>Litoria fallax</i>	Dwarf Green Tree Frog	
	<i>Litoria freycineti</i>	Freycinet's Tree Frog	
	<i>Litoria latopalmata</i>	Broad-palmed Frog	
	<i>Litoria lesueuri</i>	Lesueur's Frog	
	<i>Litoris nasuta</i>	Rocket Frog	
	<i>Litoria peronii</i>	Peron's Tree Frog	
	<i>Litoria phyllochroa</i>	Green Leaf Tree Frog	
	<i>Litoria tyleri</i>	Tyler's Tree Frog	
	<i>Litoria verreauxii</i>	Verreaux's Frog	
Myobatrachidae (Ground Frogs)	<i>Adelotus brevis</i>	Tusked Frog	
	<i>Crinia signifera</i>	Common Eastern Froglet	✓
	Crinia tinnula	Wallum Froglet (V)	
	Heleioporus australiacus	Giant Burrowing Frog (V, EV)	
	<i>Limnodynastes dumerilli</i>	Eastern Banjo Frog	
	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	
	<i>Limnodynastes peronii</i>	Striped Marsh Frog	✓
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	✓
	Pseudophryne australis	Red-crowned Toadlet (V)	
	<i>Pseudophryne coriacea</i>	Red-backed Toadlet	
	<i>Pseudophryne bibronii</i>	Brown Toadlet	
	<i>Uperoleia fusca</i>	Dusky Toadlet	
	<i>Uperoleia laevigata</i>	Smooth Toadlet	

APPENDIX C VARIATION OF OPERATIONAL HOURS

A. Introduction

RPS Harper Somers O'Sullivan has been commissioned by BHPB to assess the potential impacts of proposed operational changes on key ecological issues associated with the project site and surrounds.

At the time the original Environmental Impact Statement (EIS) was written by GHD (2003) the operation hours of the KIWEF disposal site were considered to be normal business hours. However, due to the speed at which material will be removed from the Hunter River and treated at the Mayfield site, construction hours will need to be extended to run 24 hours a day.

B. Key Ecological Issues and Potential Impacts

As identified in the Ecological Assessment (RPS HSO, 2008), the following 13 threatened fauna species, one threatened flora species and three endangered ecological communities (EECs) listed under TSC Act were found to have at least a moderate chance of occurrence within the site:

- *Zanichellia palustris*
- Green and Golden Bell Frog (*Litoria aurea*) core, foraging, shelter and dispersal habitats;
- Blue-billed Duck (*Oxyura australis*);
- Freckled Duck (*Stictonetta naevosa*);
- Australian Painted Snipe (*Rostratula australis*);
- Australasian Bittern (*Botaurus poiciloptilus*)
- Grass Owl (*Tyto capensis*);
- Red-backed Button-Quail (*Turnix maculosa*);
- Microchiropteran Bat Species:
 - o *Miniopterus schreibersii* (Eastern Bentwing Bat);
 - o *Miniopterus australis* (Little Bentwing Bat);
 - o *Mormopterus norfolkensis* (East Coast Freetail Bat);
 - o *Chalinolobus dwyeri* (Large-eared Pied Bat);
 - o *Myotis adversus* (Large-footed Myotis); and
 - o *Scoteanax rueppellii* (Greater Broad-nosed Bat).
- Freshwater Wetlands EEC;
- Coastal Saltmarsh EEC; and
- Swamp Oak Floodplain Forest EEC.

C. Potential Impacts of 24hr operation

The potential impacts associated with the proposed 24hr operation of the KIWEF are primarily associated with noise, light and vibration impacts on fauna species outside of daylight hours. Noise and vibration impacts on fauna species are likely to be associated with the movement of heavy machinery within the site during emplacement construction and disposal of material. Continual disturbance is likely to disrupt normal fauna activity more than intermittent disturbance associated with standard daylight hours.

Lighting to allow 24hr construction may affect the behaviour and biological mechanisms of fauna species within the locality. Birds are of particular concern as lighting can cause disturbance to migratory patterns. However, similar lighting has been implemented at the adjacent NCIG construction and at existing Port Waratah Coal Services.

Disturbance to roosting diurnal birds at night may stress birds additionally and result in the abandonment of habitat, particularly during breeding. Nocturnal and crepuscular fauna species such as owls and bitterns may be disturbed during both diurnal roosting times and nocturnal activity times, in comparison with only daylight disturbance.

The potential impacts of 24hour lighting on the wider area is considered to be negligible considering the vast amount of light emitting sources in local area. However, relevant mitigation measures should be employed during the construction of the emplacement area to minimise potential impacts upon local fauna species.

APPENDIX D PERSONNEL INVOLVED IN THE PROJECT

Curriculum Vitae

Name: Craig Anderson
Office: RPS Harper Somers O'Sullivan
Position in Company: Director - Environment
Qualifications / Memberships: Bachelor Applied Science (Environmental Assessment & Management) University of Newcastle, NSW (1994)
Currently undertaking Graduate Diploma in Archaeological Heritage through UNE
Ecological Consultants Association of NSW (ECA)
Planning Institute of Australia (PIA)
Frog and Tadpole Study Group (FATS)
Hunter Birds Observers Club (HBOC) Committee Member 2008
Bird Observers Club of Australia (BOCA)
Hunter Heritage Network (HHN)
RFS/PIA NSW Consulting Planners Bushfire Training

Areas of Expertise:

- Production of complex ecological impact assessment documents
- Detailed understanding of environmental legislation
- Conflict resolution and environmental impact mediation
- Land and Environment Court hearings
- Flora, habitat, and fauna surveys including threatened species
- Bushfire Threat Assessment & Management reporting
- Project Management (including areas outside environmental concern)

Experience Includes:

Craig is the Director of the Environment Division at RPS HSO, and has over 14 years experience in a wide range of environmental consulting. He has undertaken and managed commissions for a diverse range of projects, including State Significant Developments such as the Hunter Economic Zone (HEZ).

Extensive background in ecological field surveys, encompassing all aspects of flora and fauna identification, targeted surveying and mapping. Involved in the initial formulation of an Association of Consulting Ecologists for NSW in 1998. Elected member on the Inaugural Council (served two terms). Has acted as an expert witness in several Land and Environment Court matters relating to ecology and bushfire assessment. An experienced negotiator of ecological / development outcomes, and has a detailed understanding of legislation related to ecological matters. Craig has been actively involved in representations to the Department of Environment on behalf of the NSW Urban Taskforce in regards to proposed changes to the NSW Threatened Species Conservation Act.

Craig has also been involved in submissions on bushfire legislation and represented industry groups such as the NSW Urban Taskforce and Urban Development Institute of Australia (UDIA) on matters relating to issues such as the proposed listing of the Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) as an endangered ecological community, and regional environmental biodiversity strategies. Craig has also recently provided advice and submission material to the UDIA in relation to the Native Vegetation Act 2003 and the operations of the Catchment Management Authority (CMA).

Curriculum Vitae

Name: Allan Richardson

Office: RPS Harper Somers O'Sullivan

Position in Company: Ecologist

Qualifications / Awards

- B.Env.Sc. (Environmental Management)
- B.Env.Sc. (Hons) (Biology) – Migratory Wading Bird Study
- 2002 Hunter Environmental Institute Scholarship
- Waterways Authority Boating Licence
- OH&S Induction Training (Green Card)
- NSW Driver's Licence (Class C)
- NPWS Scientific Licence
- NSW Animal Ethics Research Authority

Memberships: Hunter Bird Observers Club

Areas of Expertise:

- Ornithological Surveys and Research
- Targeted and general Terrestrial flora and fauna surveys
- Threatened Flora & Fauna Assessment, Reporting and Legislation
- GPS Survey and GIS Mapping Projects
- High Level Nature Photography
- Tertiary and General Ecological Tutoring, Demonstrating and Presenting

Project Experience Includes:

Allan Richardson has broad range of Ecological Assessment reporting experience underpinned by over 25 years of ecological field experience. Project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate to domestic client requirements. Allan has a strong grounding in threatened species ecology in both coastal and western NSW regional areas, with specialist migratory wader studies expertise in Central NSW and Roebuck Bay in North Western Australia.

Allan's wide ranging interest across different ecological disciplines, has been a central part of important threatened species projects, including, the Critically Endangered North Rothbury Persoonia, Hunter Estuary Green and Golden Bell Frog populations, Migratory Wader habitat usage surveys and seasonal Swift Parrot movements. Allan's broad ecological experience also represents an important part of RPS HSO's threatened flora and vegetation community mapping, targeted fauna survey works and threatened species habitat assessments over both small and large spatial areas for a range of client needs. His depth of experience and a strong knowledge of Australian fauna and regional vegetation contribute strongly to RPS HSO's ability to meet the consultation and regulatory needs of the development community.

Curriculum Vitae

Name: Anna McConville

Office: RPS Harper Somers O'Sullivan

Position in Company: Ecologist

Qualifications / Memberships: B.Env. Sc.
M.Phil. (Env. Sc.) Candidate
"The Ecology of the East Coast Freetail Bat (*Mormopterus norfolkensis*) in the Hunter Region"
Member of the Australasian Bat Society
Member of the Royal Zoological Society of Australia
Member of the Wildlife Preservation Society of Australia

Areas of Expertise:

- Terrestrial Flora and Fauna Surveys
- Targeted threatened flora and fauna surveys
- Ecological impact assessment and reporting
- Ecological condition and threatened species monitoring
- Geographic Information Systems mapping and analyses
- Detailed understanding of legislation and threatened species issues

Experience Includes:

Anna has over three years experience as an ecological consultant across the Hunter, Central Coast and North Coast regions of NSW. Anna is experienced in designing and conducting flora and fauna surveys for environmental impact assessment and ecological monitoring. Key experience includes large infrastructure projects such as Pacific Highway Upgrades, ecological constraints and opportunities investigations for local environmental studies and implementation of ecological monitoring programs. Anna has also recently undertaken Biodiversity Certification and BioBanking feasibility investigations in the Hunter.

Anna is also currently completing a research degree investigating the habitat preferences of the East Coast Freetail Bat (*Mormopterus norfolkensis*), a threatened species, in the Hunter Region. The project investigates landscape-scale habitat use, roost selection and diet and aims to provide essential information to develop management strategies for the species.