AURIZON – TRAIN SUPPORT FACILITY, HEXHAM

Ecological Investigations

Report Prepared for
Aurizon

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AURIZON
TRAIN SUPPORT FACILITY

Ecological Investigations

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1 Introduction

Eco Logical Australia was commissioned by Aurizon to prepare an ecological assessment for the Train Support Facility at Hexham, NSW. The ecological assessment is to be submitted as supporting information for a major project application under Part 3A of the Environmental Planning and Assessment Act 1979. The Minister for Planning and Infrastructure is the consent authority for the Application.

1.1 PROJECT DESCRIPTION

The proposal involves the establishment of a Train Support Facility (TSF) (**Figure 1**) that will provision trains with fuel, sand, water and oil and enable cab cleaning, routine inspection of trains, planned service and maintenance and emergency repairs, and will incorporate two provisioning tracks and two storage tracks. Three temporary construction compounds will be used, one in the north of the site, one

centrally (storage area / batch plant) and another in the south, all on cleared agricultural land.

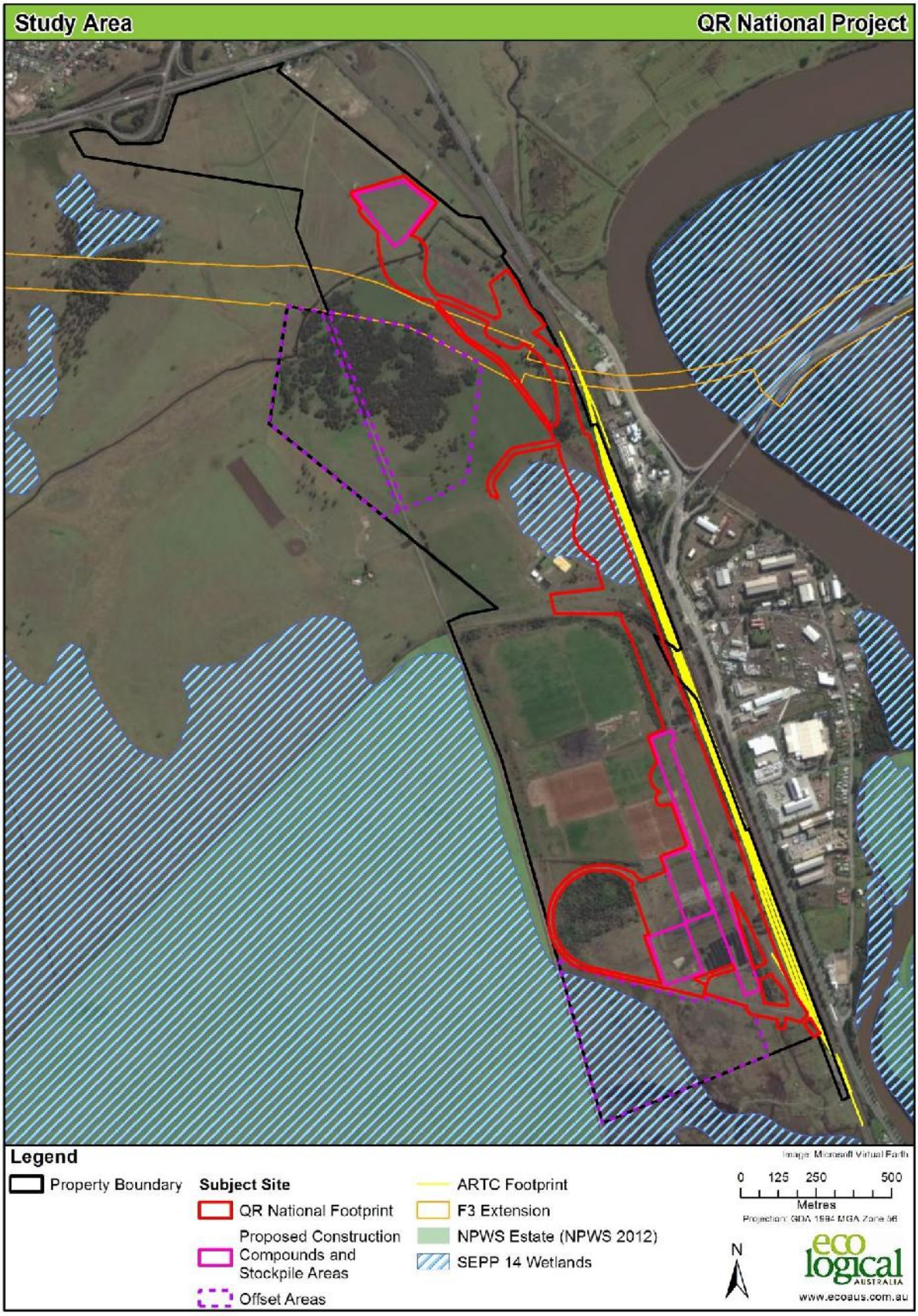

Figure 2**Figure 2** shows the area in which these facilities will be constructed. Whilst the facilities themselves will not require this entire area, this report assumes that vegetation and habitat within the nominated area will be disturbed. Note that **Figure 2** does not show the full extent of possible earthworks. Construction planning has identified that works may include the permanent stockpiling of Potential Acid Sulphate Soils to the north of the balloon loop. The construction footprint is provided in the Preferred Project report prepared by JBA and this additional construction area has been taken into account in the Ecological Investigations Report.

The facility will dispose of domestic effluent on-site via a package treatment plant and spray irrigation. Wastewater from the train wash-down facilities is to be re-used on site following a separate treatment process to remove oils and sludge, with small amounts (125-250 L/day) of wash-down wastewater to be discharged to the spray irrigation area in the southern half of the site.

Stormwater will be directed via grassed swales through gross pollutant traps to three water quality control ponds before being discharged from the site in accordance with a Stormwater Management Plan prepared by Worley Parsons. Stormwater is managed separately from the effluent of wash-down wastewater, and will not include effluent or train wash-down wastewater.

Fuel storage is to be stored within appropriately bunded areas, with impervious flooring and sufficient capacity to contain 110% of the largest container stored within the bund.

The proposal also includes the establishment of two conservation areas that total approximately 53 hectares in close proximity to Hexham Swamp. These areas are proposed to be managed in accordance with a Conservation Management Plan and are planned to be subject of a Conservation Agreement under the National Parks and Wildlife Act 1974 to ensure long term management and security of biodiversity.

If a Conservation Agreement is not deemed suitable Aurizon can instead use an alternative legal agreement to secure the conservation outcome in this area. A Planning Agreement under the EP&A Act can provide legal security to the obligation to manage the offset area for conservation purposes. The conservation options will be investigated and then incorporated into the Conservation Management Plan for the site.

1.2 STUDY AREA DESCRIPTION

The study area is bound by the Pacific Highway and the industrial area of Hexham to the east, by private rural lands to the southeast, by the Hunter Water Corporation pipeline and Hexham Swamp Nature Reserve to the south and southwest, by rural grazing lands to the northwest and by the New England Highway and the township of Tarro to the north (**Figure 1**). The lot and DPs of the property are:

Lot 1	DP 128309
Lot 101	DP 1084709
Lot 102	DP 1084709
Lot 2	DP 735456
Lot 10	DP735235
Lot 104	DP 1084709
Lot 113	DP 755232
Lot 1	DP 155530
Lot 12	DP 1075150
Lot 1	DP1062240
Lot 311	DP 583724

In terms of defining boundaries that are relevant to the project, the following applies:

- The **subject site** represents the proposed development footprint for the project and is approximately 68 ha. This includes the TSF, access roads, drainage basins and three temporary construction compounds, this also includes an approximately 9 ha area to be utilised for Acid Sulphate Soil storage and remediation.
- The **study area** includes the subject site and additional lands that have the potential to be affected by the proposal, either directly or indirectly, as well as lands to be considered for ecological offsets. The total area of the study area is approximately 255 ha

The study area comprises disturbed lands, including evidence of widespread soil disturbance (excavation and filling), interspersed with revegetation and depressions. The southern part of the study area has a long history associated with coal stockpiling, loading and unloading and to this day the site contains a significant quantity of coal tailings. Soil landscape mapping of the site (SCS, Newcastle Sheet 9232) classifies this as disturbed terrain. The northern part of the site comprises the Millers Forest landscape which consists of a floodplain / delta on recent sediments with elevation below 3-6m AHD. These areas have a permanently high water table, seasonal waterlogging and foundation hazard. These soils have a high probability of containing acid sulphate soils within 1m of the surface (DLWC Acid Sulphate Soil Risk Map). The vegetation on the site contains remnant, albeit highly disturbed, swamp oak forest, salt marsh and freshwater wetland as well as artificial freshwater wetlands (i.e. drains and ponds) and open pasture. Much of the site is currently subject to pasture improvement and cattle grazing.

1.3 ADJACENT ARTC DEVELOPMENT

The Australian Rail Track Corporation (ARTC) proposes to develop a project for Relief Roads (train line) adjacent to the Aurizon Hexham Redevelopment Project. This project is described in Parsons Brinckerhoff (2012) 'Proposed Hexham Relief Roads Ecological Assessment' as:

> *ARTC proposes to develop five Relief Roads (train lines) and associated infrastructure at Hexham in the NSW Hunter Valley (the proposed Project). The proposed Project is located approximately 15 kilometres north west of Newcastle and 176 kilometres north of Sydney by rail.*
>
> *Key components of the proposed Project comprise:*
> - *Five Up Relief Roads (train lines) to the west of the existing Up and Down Mains between the existing Up Coal and a new Down Coal including:*
> - *Each Relief Road to accommodate trains generally comprising two or three locomotives and up to 91 wagons (1,543 m long) requiring a minimum standing room of 1,670 m*
>   - *New turnouts, return curves and other track changes*
> - *Installing new signal infrastructure for the five Relief Roads (including signal location cases, huts and gantries)*
> - *Earth and civil works of approximately 265,000 cubic metres, including cut to fill, track formation, drainage and minor structures*
> - *Ancillary infrastructure including vehicle access tracks, temporary construction compounds and stockpile sites*
> - *Vehicular tracks, land acquisition and upgrading of existing rail infrastructure and public utilities*

The ARTC project is shown on **Figure 2** for context; however the ARTC project is a separate proposal.

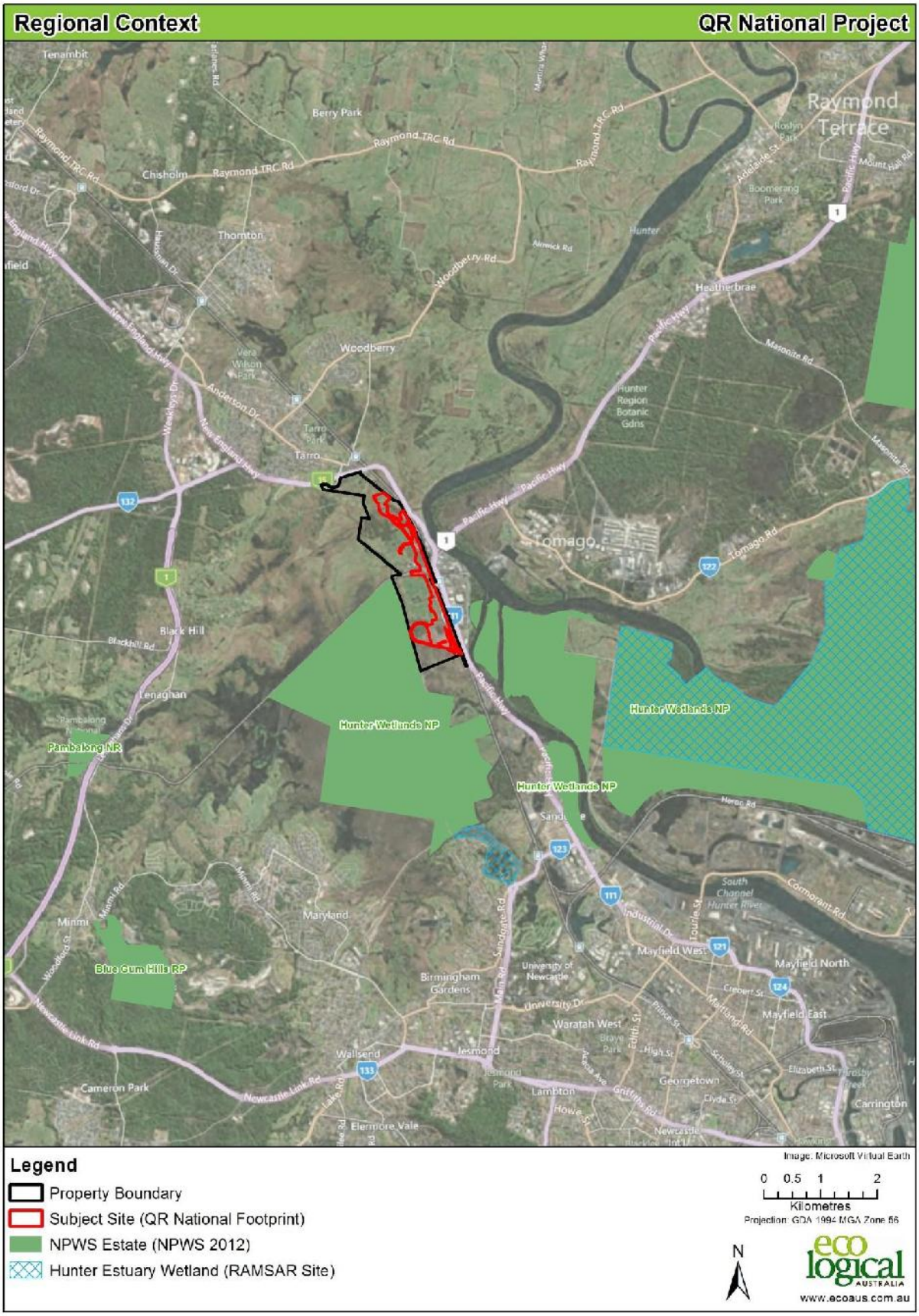

Figure 1: Regional Context

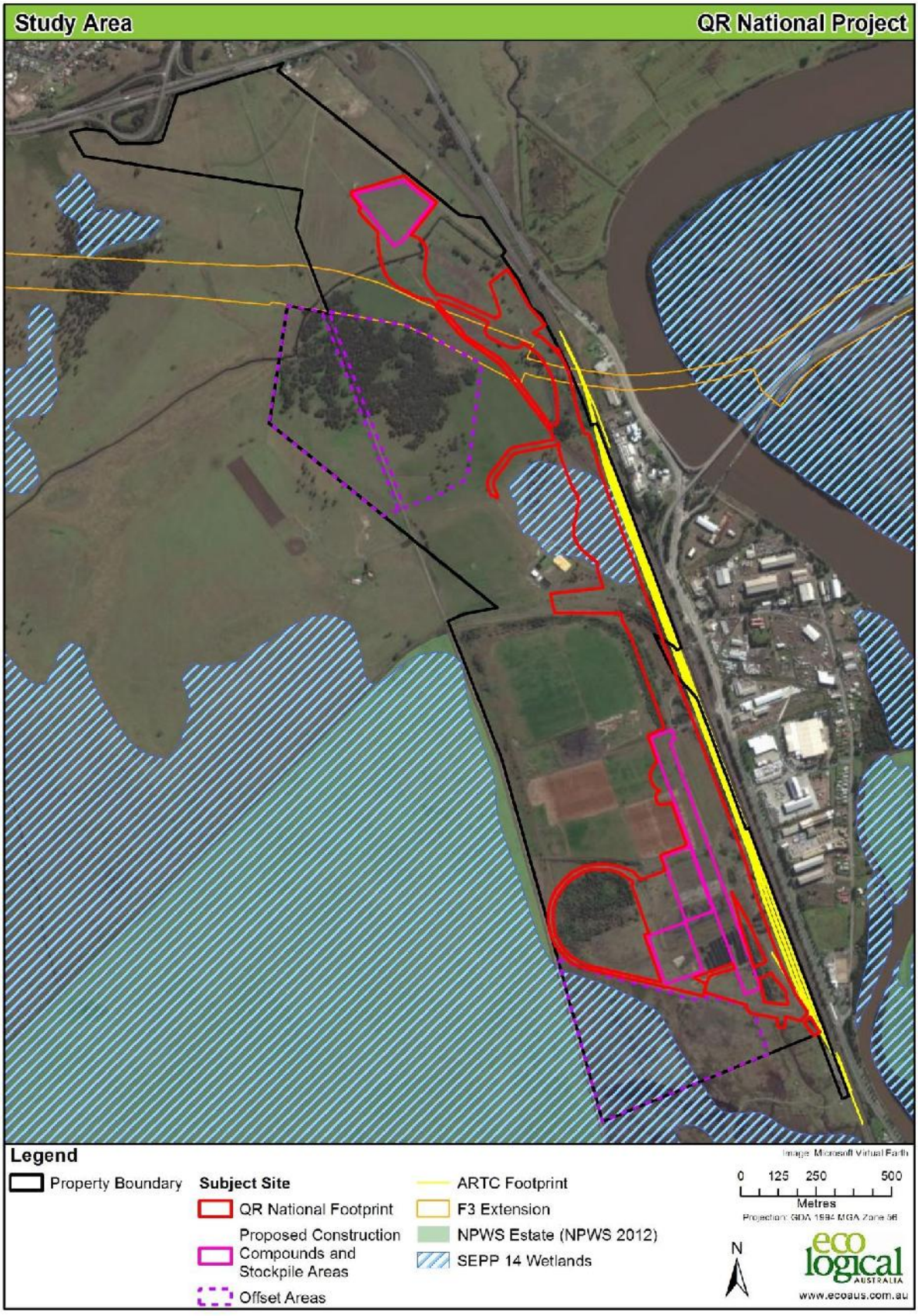

Figure 2: Study area and proposal

2 Planning and Assessment Context

2.1 COMMONWEALTH PLANNING INSTRUMENTS

2.1.1 Environmental Protection and Biodiversity Conservation Act 1999

Approval from the Commonwealth Environment Minister is required under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) if the action (can include a project, development, undertaking or activity) will, or is likely to, have a significant impact on matters considered to be of national environmental significance (NES matters). NES matters relevant to this study include threatened species, ecological communities and migratory (JAMBA/CAMBA) species that are listed under the Act.

The EPBC Act does not define significant impact but identifies matters that are necessary to take into consideration. Additional information is available within EPBC Act Policy Statements that provide background information and guidelines on how to survey for, and assess impacts on, matters of NES. If the matter is referred to the Minister a decision is generally required within 20 days in relation to whether an action requires Commonwealth approval.

So as to seek clarity with regards to EPBC Act approval requirements for NES matters (migratory birds, RAMSAR wetlands, Green and golden bell frog, Grey-headed flying-fox), a referral was submitted to the Commonwealth. The proposed action was deemed to not be a controlled action on 20th March 2012 (EPBC Act referral 2012/6285).

2.2 STATE GOVERNMENT INSTRUMENTS

2.2.1 Environmental Planning and Assessment Act 1979

The proposal is to be assessed under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). For Part 3A matters, the proponent and consent authority must consider all aspects of the environment, including biological, physical, social and economic factors and the principles of ecologically sustainable development, when assessing the impacts of the project.

The Director-Generals Requirements for this project (issued 22 March 2010) identified ecology as a key issue and required that there be assessment of:

- *Flora, fauna and habitat (including rare, threatened and endangered species populations, ecological communities and SEPP 14 wetlands),*
- *Consideration of local, regional, state and corridor impacts (including consideration of the Hunter Central Rivers Catchment Action Plan and the Watagan Ranges to Port Stephens conservation corridor identified in the Lower Hunter Regional Strategy);*
- *Take into account the Draft Guidelines for Threatened Species Assessment (DEC and DPI); and Threatened Biodiversity Survey and Assessment Guidelines for developments and Activities (DEC);*
- *Offsets for native vegetation clearance consistent with the improve or maintain principle; and*
- *Demonstration that the project can be managed to minimise impacts on the Hexham Swamp Rehabilitation Project*

The Draft Guidelines for Threatened Species Assessment (DEC&DPI, 2005) outline guiding principles for the provision of information to "enable decision makers to ensure that developments deliver the following environmental outcomes:

1. *Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation);*
2. *Conserve biological diversity and promote ESD;*
3. *Protect areas of High Conservation Value (including areas of critical habitat);*
4. *Prevent the extinction of threatened species;*
5. *Protect the long-term viability of local populations of a species, population or ecological community; and*
6. *Protect aspects of the environment that are matters of national environmental significance (pursuant to the EPBC Act).*

In order to assess the magnitude of the proposed development and determine whether the above outcomes are achievable, Appendix 3 of the Assessment Guidelines provides guiding assessment questions to identify potential effects of the proposal on threatened species, population or ecological communities or their habitats.

These questions have been addressed in **Appendix C** of this report for each threatened species, population or ecological community that are known, likely, or potential occurrences within the study area. Where a proposal cannot avoid or mitigate impacts on threatened species, populations and ecological communities, according to key thresholds, other measures, including undertaking a suitable and approved offset action, may need to be taken.

2.2.2 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the NSW Environmental Planning and Assessment Act and requires consideration of whether a development or an activity will affect threatened species, populations and ecological communities or their habitat.

In this study area threatened species and endangered ecological communities that are listed under the Act may be relevant. Section 5 provides a summary of the assessment under TSC Act.

2.2.3 SEPP 14 – Coastal Wetlands

State Environmental Planning Policy 14 - Coastal Wetlands (SEPP 14) was introduced to protect coastal wetlands in New South Wales outside of the Sydney Metropolitan area. This report assesses the impacts of the project on the SEPP 14 wetlands in section 5.

2.3 NON-STATUTORY PLANS AND PROJECTS

2.3.1 Lower Hunter Regional Strategy

The Lower Hunter Regional Strategy (LHRS) identifies locations for future residential and employment lands for the period 2006-2031. The Strategy also identifies a regional scale 'Green Corridor' between the Watagan Range and Stockton Bight. Most of the subject site is identified as existing employment land with the surrounding Hexham Swamp forming part of the Green Corridor. Within the Green Corridor, the LHRS states that Local Environmental Plans are to provide for the ongoing role of the biodiversity corridor.

2.3.2 Lower Hunter Regional Conservation Plan

The Lower Hunter Regional Conservation Plan (DECCW 2009) sets out a 25-year program to direct and drive conservation efforts in the Lower Hunter Valley. It is a partner document to the Government's Lower Hunter Regional Strategy that sets out the full range of Government planning priorities, and identifies the proposed areas for growth.

The Conservation Plan identifies a 'Green Corridor' stretching from the Watagan Ranges, through Hexham Swamp to Port Stephens (approximately 14,600 hectares). This corridor provides a highly significant link between southern sandstone ranges and the coastal heaths and wetlands of Port Stephens. It will also involve an expansion of the nationally significant freshwater wetlands of Hexham Swamp Nature Reserve (DECCW 2009).

The nominated 'Green Corridor' lies between Hexham Swamp Nature Reserve and the Kooragang Wetland Rehabilitation Project on Ash Island, and thus is of relevance to the subject site. Given the study area occurs on highly disturbed land on the peripheral edge of the corridor and adjacent to the rail corridor and Hexham industrial lands, the proposed development is considered unlikely to have any significant effects on habitat connectivity, genetic exchange and dispersal capabilities for threatened species, population and Endangered Ecological Communities considered. This is further discussed in the impact assessment chapter.

2.3.3 Hunter Central Rivers Catchment Action Plan

The Hunter-Central Rivers Catchment Action Plan (CAP) was adopted in January 2007. Under the heading of Rivers and Freshwater Wetlands, the CAP contains a number of objectives including:

- Maintaining or improving aquatic habitat
- Maintaining and improving riparian vegetation

The CAP identifies principles for the management of wetland areas including the protection of existing wetlands and restoration of degraded areas. The CAP is not a regulatory document, rather it guides investment of funds towards the management of key natural resources in the catchment. The Hunter Estuary Wetlands which are located adjacent to the site are identified as a high priority wetland in the CAP.

2.3.4 Hexham Swamp Rehabilitation Project

The Hexham Swamp Rehabilitation Project is '*a partnership between private landholders, industry groups, local community and government agencies which aims to restore 1,946 hectares of Hexham Swamp (Hunter Central Rivers CMA website).* Key aspects of the project are the re-opening of floodgates at the mouth of Ironbark Creek in a staged manner to re-introduce tidal waters to Hexham Swamp.

Rehabilitation of the Hexham Swamp area was explored in the Ironbark Creek Total Catchment Management Strategy and has been approved as a Major Project under s75B(2)(b) of the *Environmental Planning and Assessment Act 1979.*

3 Methods

Following is a description of methods that were undertaken to identify potential effects of the proposal on threatened species, population or ecological communities or their habitats.

3.1 INFORMATION GATHERING AND REVIEW

3.1.1 Database Review

The data audit was based on analysis of environmental database searches including the Atlas of NSW Wildlife and the EPBC Act. Searches included a 10 km radius around the site, centred on the study area, to determine the local occurrence of threatened flora and fauna in accordance with state and federal statutory requirements. These searches were carried out on 25 February 2011.

An assessment of likelihood of occurrence was made for threatened flora and fauna identified from the database search. This assessment was based on database or other records, presence or absence of suitable habitat within the study area, results of the field investigations and professional judgement.

The results of these searches and the likelihood of occurrence assessment can be found in **Appendix A**, including maps showing the locations of threatened flora and fauna species within 10km of the study area and the broader region.

3.1.2 Literature Review

Four recent studies have compiled ecological information on the study area, including: EcoBiological (2008), EcoHub Ecological Consultants (2009), and Parsons Brinckerhoff (2012 and 2013). Whilst the EcoBiological and EcoHub reports were not finalised and published, their data from field work has been obtained and utilised in this report.

3.2 FLORA AND FAUNA SURVEY

The survey methods for this project have been designed to supplement the previous surveys with the intention of meeting survey guidelines as it relates to habitat presence and quality (Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities DEC 2004); DECCW (2010) Field Survey Guidelines; DECC (2009) Threatened species survey and assessment guidelines field survey methods for fauna – Amphibians; and the Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act) survey guidelines for Nationally Threatened Species.

Appendix D provides a table that compiles all survey effort for the study area from this and previous flora and fauna studies and compares this effort with the abovementioned survey guidelines. Survey has met OEH requirements in relation to vegetation community mapping, call playback (owls), bats, birds, nocturnal amphibians (spotlighting and play-back) and di-urnal amphibian and reptiles. With regard to vegetation plots and fauna trapping, the survey effort was appropriate for the site, but does not strictly meet the guidelines. For example, two rather than three plots were undertaken in the *Phragmites australis* / *Typha orientalis* wetlands due to the homogeneity of the site. With regard to fauna trapping, the total number of trap nights for the entire site exceeded the survey guidelines, however cage and arboreal trapping was not undertaken in the saltmarsh and *Phragmites australis* wetlands due to lack of suitable habitat for ground-dwelling mammals. ELA believes the survey intensity

and location was appropriate for the site and indeed exceeds the survey requirements in a number of cases.

The following sections describe the supplementary fieldwork undertaken by Eco Logical Australia in 2011.

3.2.1 Vegetation Community Mapping

Vegetation communities within the study area were mapped and defined based on Biometric Vegetation Types. Field work was carried out in January and February 2011. Random meander traverses were used to validate the vegetation communities, their boundaries and condition classes. There was particular focus on delineating the boundaries of Endangered Ecological Communities (EEC) listed under state or federal legislation and investigating SEPP14 wetland within the study area.

3.2.2 Floristic Surveys

In January and February 2011 a total of ten 20x20 m vegetation and biometric plots and five (5) transects were completed. An additional supplementary survey was undertaken by ELA on 28th March 2013. Surveys consisted of recording all flora species present within the plots and encountered along transects.

Vegetation survey proformas were used to collect information, with the data including the date of survey, recorder/s, site number, quadrat size (20 m x 20 m), MGA coordinates (all taken with a GPS using WGS84) and vegetation structure. One or more digital photographs were taken at each site. Within each 0.04 ha floristic plot all vascular plants species were recorded and identified as far as was possible. In some cases a lack of flowering material was a hindrance, with some samples only undergoing identification to the genus level. Samples of unknown species were collected for later identification. Nomenclature followed the Flora of New South Wales (Harden 1992; 1993; 2000; 2002) except where more recent taxonomic changes have taken place.

Biometric data were gathered concurrently with the flora survey quadrats, in accordance with the Biobanking Methodology (DECC 2008a) and Biobanking Assessment Methodology and Credit Calculator Operation Manual (DECC 2009). This involved gathering data within a 20 m x 50 m plot/transect on native species richness, over-storey cover, mid-storey cover, native ground cover, exotic cover, number of trees with hollows, over-storey regeneration and length of logs.

The locations of the vegetation plots and transects are shown in **Figure 3**.

3.2.3 Targeted Threatened Flora Surveys

Targeted threatened flora searches were undertaken for those species considered to potentially occur on the site based on database searches in the locality and habitat on site. In terms of seasonally cryptic species, only species whose optimal period of detection corresponded with the survey timing (i.e. January to February) were adequately surveyed for. The following threatened flora species were targeted:

- *Callistemon linearifolius* (Netted Bottlebrush)
- *Melaleuca biconvexa* (Biconvex Paperbark)
- *Persicaria elatior* (Tall Knotweed)
- *Zannichellia palustris*

The Office of Environment and Heritage (OE&H) have indicated that the following additional species should be considered and justification on the adequacy of survey for these species should be provided

- A*sperula asthenes* (Trailing Woodruff)
- *Lindernia alsenoides* (Noah's False Chick Weed)
- *Maundia triglochinoides*

Asperula asthenes grows in damp sites along river banks from Taree to Bulahdelah. This species is best to be surveyed for during spring, which is outside of the survey season applied to this study. However, survey for the ARTC project (Parsons Brinkerhoff, 2012) which included the majority of the TSF subject site and was undertaken in the appropriate season did not identify this species and concluded that the likelihood of it being present on site was low. ELA concurs with this assessment. ELA staff involved in this project are particularly familiar with *Asperula asthenes* and consider the habitat types on the site as being sub-optimal for the species, particularly in areas with a saline influence. The species is usually recorded from relatively high quality and undisturbed riparian and near riparian areas containing moist forest to rainforest types on alluvium. These habitats are not represented within the study area.

Lindernia alsinoides also grows in swampy sites in sclerophyll forest and coastal heath, mainly north from Bulahdelah, and is most detectable when flowering in November, which is outside of this study's survey period. Survey of the subject site was undertaken by Parsons Brinkerhoff (2012) during the appropriate season for the ARTC project, however the species was not observed. Given the disturbance history of the study area and the nearest record of *Lindernia alsinoides* is over 14km and 66km respectively from the site, this species are not considered potential occurrences. Parsons Brinkerhoff concluded that the likelihood was low and habitat not present. In confirmation of the known habitats for the species, swampy sclerophyll forest and coastal heath, neither of these habitats are present on the impact site. The species has very limited potential of occurring in the sub-optimal conditions presented on site at this time.

Maundia triglochinoides has been recorded approximately 3km from the study area and grows in swamps and shallow fresh water on heavy clay and is detectable for most of the year, with distinct leaf form and venation. The species flowers in November – January and would therefore have been flowering during field survey by ELA in 2011. This species was not detected during surveys, nor was it observed by Parsons Brinkerhoff (2012) in their surveys for the ARTC project on the same land. It is therefore highly unlikely that the species is present on this site. ELA staff are also very familiar with this species and again consider the habitats within the study area as being sub-optimal, particularly in areas with a saline influence. The species prefers generally good to high quality habitat within high quality slow moving freshwater watercourses, with well-established native riparian vegetation, generally moist to wet mesic forest types or fresh water wetland with a treed canopy. These habitats are not represented on this site.

Based on the number surveys undertaken to date (all of which have failed to record any of these species), habitat preferences and the general condition and past disturbance of the site, we consider that *Asperula asthenes, Lindernia alsinoides* and *Maundia trigiochonoides* are highly unlikely to be present at the impact site..

Figures representing the locations of the targeted searches by Parsons Brinkerhoff for these three threatened species are presented in **Appendix H**. Additional information in relation to the survey effort for these species by Parsons Brinkerhoff can be located in Parsons Brinckerhoff (2012) Proposed Hexham Relief Roads Ecological Assessment and Parsons Brinckerhoff (2013). Addendum Assessment of Hexham Relief Roads including Private Access Track and Parsons Brinckerhoff (2013) Response To Submissions for Hexham Relief Roads.

ELA undertook, as part of the specific searches for targeted threatened flora species, 5 specific transects and numerous random meanders across all vegetation and habitat types within the study area (**Appendix D**). Whilst it is acknowledged that not all of the surveys were undertaken in the ideal or appropriate season for these species, surveys by Parsons Brinkerhoff (2013) and Ecobiological (2008) were undertaken in Spring/Summer when these species are detectable.

Ecobiological surveyed between November 2007 and March 2008. This survey period was appropriate for *Asperula asthenes, Lindernia alsinoides* and *Maundia trigiochonoides.* **Figure 14 (Appendix E)** displays the tracks of random meanders undertaken by Ecobiological and clearly shows meanders undertaken along drainage lines and in wetland areas. Ecobiological also comment on previous survey undertaken by Ecotone (2002) in the vicinity Lot 311 DP 583724, Lot 1 DP 1555530 and part of the Pelaw Main Colliery Railway between the Main Northern Railway Line and the Chichester Water Pipeline at Hexham. No threatened flora were recorded during the Ecotone survey.

Parsons Brinkerhoff surveyed for these species in 2012 and 2013 – albeit only the eastern portion of the subject site. The maps of their survey are provided in **Appendix H** of the Ecological Investigations report (ELA 2013). This survey did not record any of the above species. The survey effort required was considered adequate in regard to the large amount of detailed surveys previously carried out by EcoHub, EcoBiological and Parsons Brinkerhoff.

3.2.4 Fauna Surveys

Given the detailed surveys that were undertaken as part of EcoBiological (2008) and EcoHub (2009) fauna surveys by ELA were limited to targeted amphibian surveys in suitable habitat (refer to **Appendix D** for total survey effort). Survey timing was preferentially aligned with periods following rainfall, during periods of moderate to high humidity and low wind speed, with weather conditions around the survey periods provided in **Table 1** below. Surveys were completed on the days and evenings of the 11th, 12th of January 2011 and the 16th, 17th and 18th of February 2011.

Table 1: Weather conditions during the fauna survey (BOM Newcastle University Weather station).

Date	Rainfall (mm)	Temperature (Max daily C°)
7 Jan	18.2	
8 Jan	0	28.8
9 Jan	3	29
10 Jan	3.6	29.5
11 Jan	2	27.8
12 Jan	0.4	30

15 Feb	11.6	25.7
16 Feb	1.4	27.2
17 Feb	0	32.2
18 Feb	41.8	

Nocturnal surveys

Nocturnal amphibian surveys involved 24 person hours searching suitable wetland habitats using 50 watt handheld spotlights. Traverses were generally undertaken on foot, though fauna were opportunistically encountered during vehicular movements.

At several locations call playback surveys were undertaken, consisting of Green and Golden Bell Frog (*Litoria aurea*), Grass Owl (*Tyto capensis*) and Masked Owl (*Tyto novaehollandiae*) call broadcasting for approximately 5 minutes followed by a 5 minute listening period for each call. Spotlights were then used to detect any cryptic species following each call being played. All fauna species encountered or heard calling were recorded. Traverses and call playback locations are shown in Figure 4.

Diurnal surveys

Diurnal amphibian surveys involved traverses in areas of suitable habitat for searching for basking individuals. Traverses are shown in Figure 4.

Opportunistic Observations

Opportunistic observations of species were recorded at all times, including reptiles, frogs, mammals and birds. Opportunistic observations included identification of indirect evidence such as scats and tracks.

Hollow bearing tree surveys

Surveys of hollow bearing trees were not carried out as part of this ELA study, although surveys were carried out previously by EcoBiological in 2008. The EcoBiological surveys targeted the Swamp Oak forest in the northern portion of the study area; the results of this survey are presented in **Appendix E**.

Searches for hollow bearing trees were carried out by ELA as part of this survey as a component of the Biometric data gathering process. This involved gathering hollow tree data within a 20 m x 50 m plot/transect as well as other factors such as native species richness, over-storey cover, mid-storey cover, native ground cover, exotic cover, over-storey regeneration and length of logs.

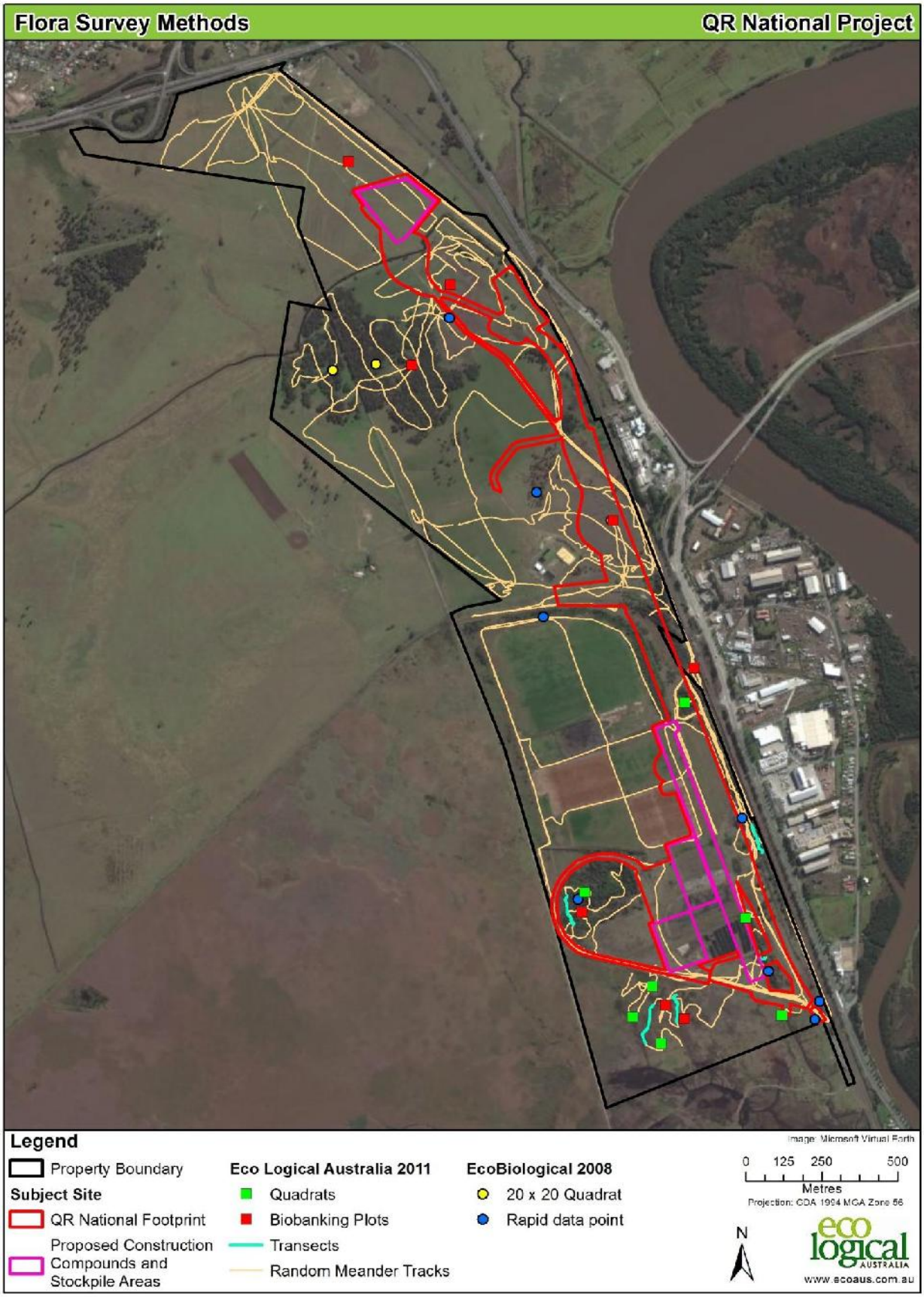

Figure 3: Flora Survey methods.

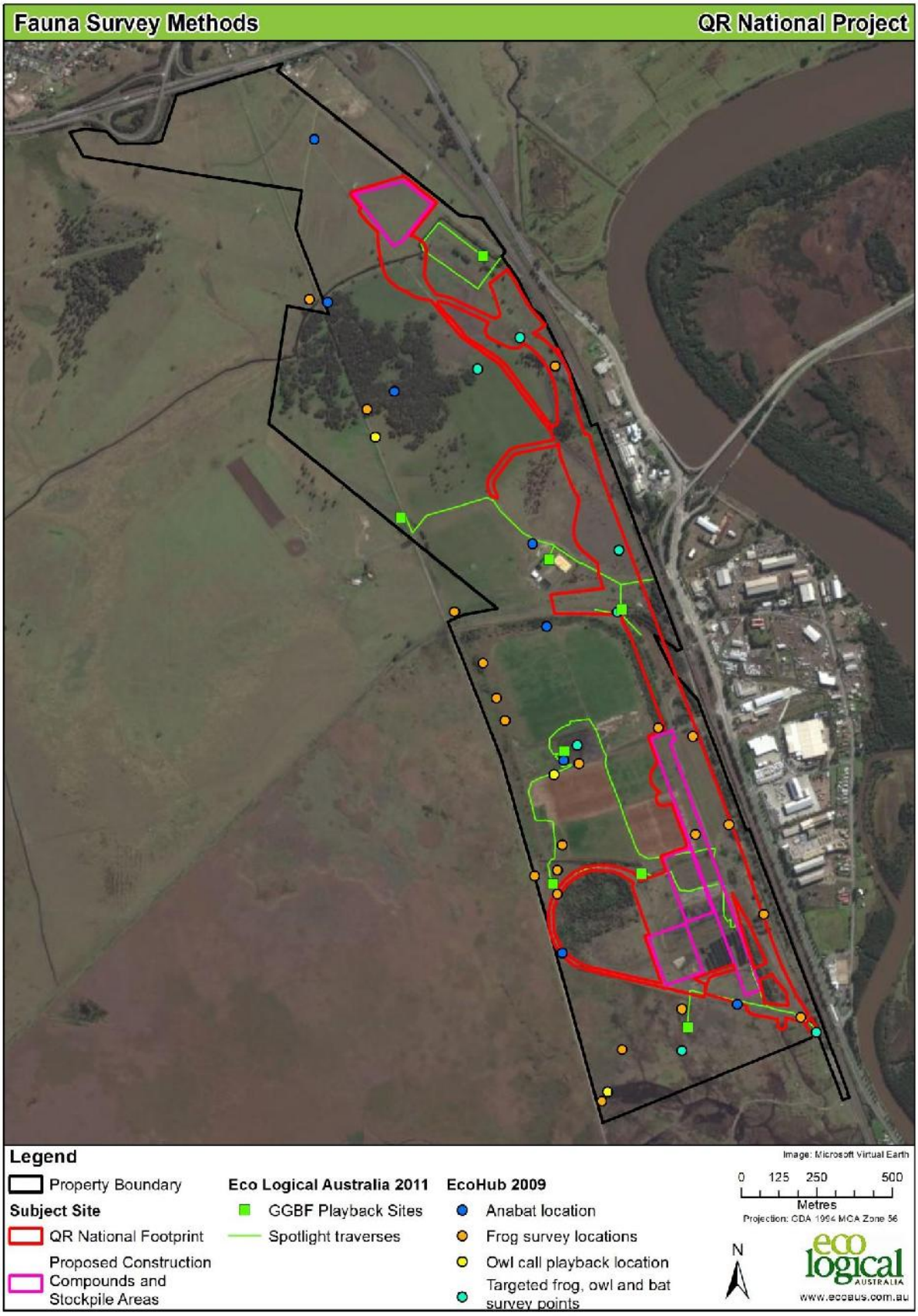

Figure 4: **Fauna Survey Methods**

4 Results

4.1 INFORMATION GATHERING AND REVIEW

4.1.1 Database Review

Appendix A provides a list of the threatened flora and fauna species that have been recorded within 10km of the study area, and maps have also been produced showing the spatial configuration of the threatened species assessed in the likelihood of occurrence table. Those species in **Appendix A** that are considered likely to occur within the study area have been assessed pursuant to the DEC DPI (2005) guidelines.

4.1.2 Literature Review

Ecobiological (2008) Draft Ecological Assessment for Proposed Train Support Facility, Maitland Rd, Hexham, NSW

EcoBiological were commissioned by Aurizon to prepare an assessment of flora, fauna and threatened species for the site of the proposed Hexham Redevelopment Project. Field surveys were conducted between November 2007 and March 2008. Whilst the report was not finalised, the survey methods and results have been utilised for this report.

ECOHUB (2009) Draft Ecological Assessment for Aurizon – Proposed Industrial subdivision, train support facility and intermodal development

ECOHUB (2009) were engaged by Aurizon to undertake an Ecological Assessment pursuant to Part 3A of the EP&A Act for the proposed Train Support Facility and Industrial Subdivision at Hexham, NSW (the industrial subdivision is not part of this proposal and assessment). The purpose of this study was to determine the presence or otherwise of significant species and determine possible impacts of the proposed development.

ECOHUB (2009) conducted additional floristic and fauna surveys and analysis to supplement EcoBiological (2008), as detailed below. ECOHUB (2009) appear to use a combination of LHCCREMS and DECC (2004) flora and fauna survey guidelines.

Parsons Brinckerhoff (2012). Proposed Hexham Relief Roads Ecological Assessment and Parsons Brinckerhoff (2013). Addendum Assessment of Hexham Relief Roads including Private Access Track

Parsons Brinkerhoff was engaged to undertake an ecological assessment in regard to the Hexham Relief Roads Project for incorporation into an EIS. Additionally, an addendum report in regard to the same project was also produced. Further Information was provided by Parsons Brinkerhoff as a response to submissions in regard to the project.

The information provided by the Parsons Brinkerhoff reports was reviewed for reference purposes and in regard to the available information, primarily due to a large proportion of the ecological works being undertaken over the study area. Works undertaken by Parsons Brinkerhoff was in an overlapping range to the previous two studies and the current ELA study. Specifically, the survey results of the Parsons Brinkerhoff report and addendums have provided strategic ecological input into the ELA report. Of

particular note were the detailed surveys and results for the three threatened flora species *Asperula asthenes*, *Maundia triglochiniodes* and *Lindernia alsinoides*, where information is utilised as part of this ELA assessment.

Based on the information provided in the above mentioned reports ELA was able to utilise the information as part of a general background as well as for a gap analysis process and to compare the survey efforts in regard to the necessary field survey requirements.

4.2 FLORA AND FAUNA SURVEY

4.2.1 Vegetation Community Validation

Four biometric vegetation communities were identified, described and mapped during the field survey and corresponded to three respective EEC's (**Table 2**). Vegetation condition varied across the study area. Swamp Oak Swamp Forest had considerable variation in quality due to past disturbance, with some areas being in moderate condition, areas of rehabilitation that contained Swamp Oak (*Casuarina glauca*) and other areas consisting of a predominantly native understorey only and a cleared canopy (Derived Grassland). Areas of Swamp Oak Swamp Forest that comprised rehabilitation were not considered to reflect the description of Swamp Oak Floodplain Forest EEC due to modifications/introduced soil and floristic composition. **Table 2** below provides the vegetation types, corresponding EEC's and the area of each type.

All remnant native vegetation on the site (excluding the rehabilitation plantings of Swamp Oak Swamp Forest) is considered to meet the definition of Groundwater Dependence Ecosystems as described in NSW State Groundwater Dependent Ecosystem Policy (DLWC 2002) due to the likely interaction of the vegetation with shallow water table and periodic inundation of floodwater.

Table 2: Biometric vegetation types and EEC's.

Biometric Vegetation Types	EEC	Area (ha)
Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner	*Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions* (refer to **Figure 3** for actual extent of EEC).	28.65
	Nil (planted and not consistent with the EEC definition).	18.50
Coastal floodplain sedgelands, rushlands and forbs of the North Coast	*Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*	9.69
Phragmites Australia and Typha orientalis coastal freshwater wetlands of the Sydney basin		15.66
Saltmarsh in estuaries of Sydney basin and south east corner	*Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions*	9.24
Disturbed / Cleared Vegetation		172.03
Total		**254**

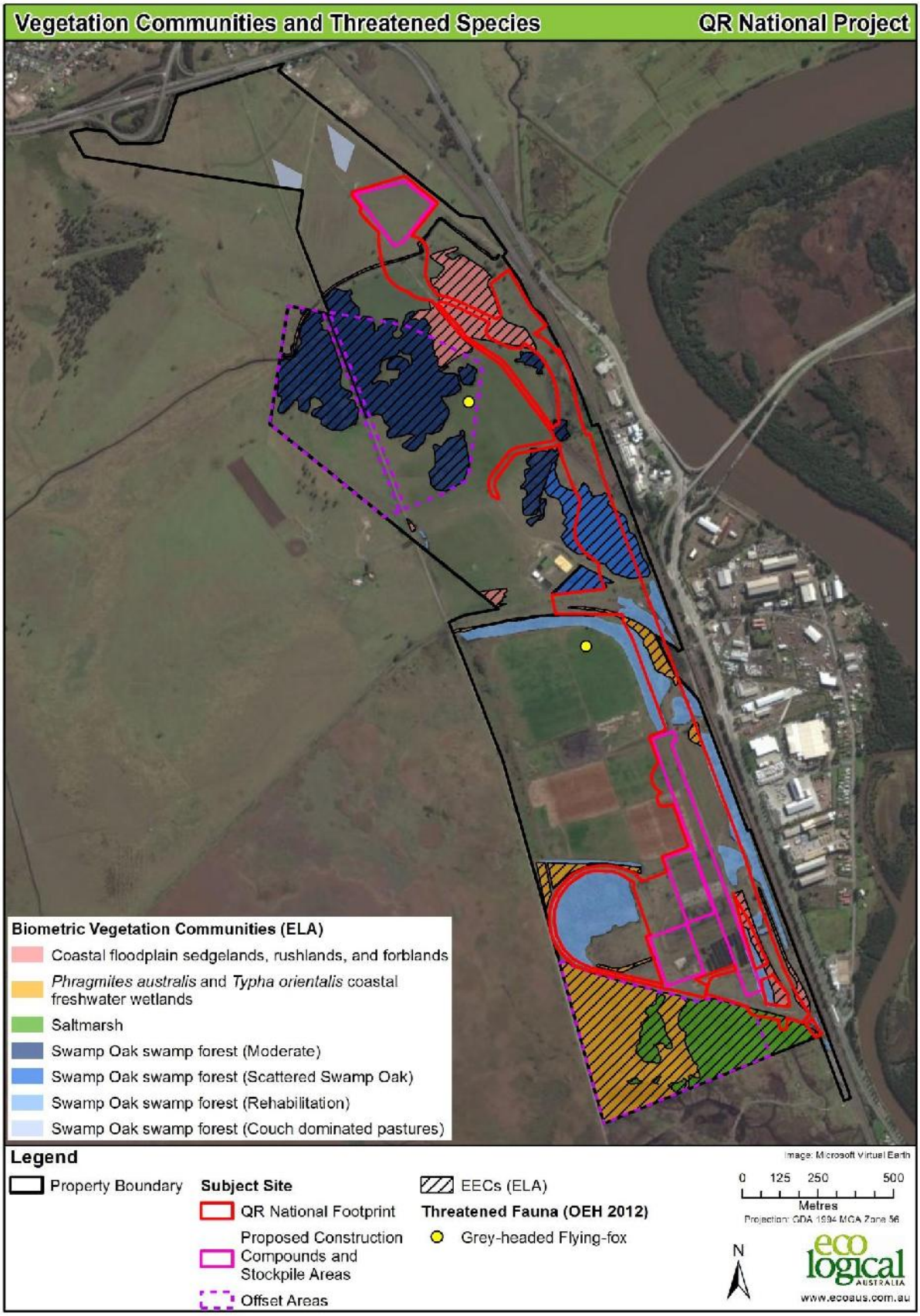

Figure 5: Vegetation communities, Endangered Ecological Communities (EECs) and threatened fauna species encountered during the ELA (2012) surveys.

Coastal floodplain sedgelands, rushlands and forblands of the North Coast - 9.69 ha

This community was scattered throughout the pastures in the northern end of the study area and was also recorded in several constructed drainage lines in the south of the study area (**Figure 4**). Sections of this community were mapped as Freshwater Wetland Complex (Ephemeral Swamps) by Ecobiological (2008).

The shrub layer was absent, and the ground layer was dominated by a mix of native and exotic species. Common native species included *Bolboschoenus caldwellii, Cynodon dactylon* (Common Couch), *Paspalum distichum* (Water Couch) and *Phragmites australis* (Common Reed), while common exotic species included *Aster subulatus* (Wild Aster) and *Pennisetum clandestinum* (Kikuyu).

This community was in moderate condition, being used to graze cattle, and having modified hydrology and simplified floristics.

The floristic and structural elements of remnant patches of this community were consistent with the NSW Scientific Committee's listing *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions,* an EEC listed under the TSC Act.

Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin – 15.66 ha

Several remnants of this community were detected throughout the study area (**Figure 4**; **Plate 1**). It was also present in a large constructed drainage line in the middle of the study area (**Figure 4**).

Phragmites australis was the dominant species throughout this community, while *Bolboschoenus caldwellii* and *Typha orientalis* (Broad-leaved Cumbungi) were also present. Saltmarsh species, including *Juncus kraussii* (Sea Rush), *Paspalum vaginatum* (Salt-water Couch) and *Sarcocornia quinqueflora* (Samphire) were present in the ecotone between the saltmarsh and phragmites rushland communities, making it difficult to determine their precise boundaries. This community was in moderate condition throughout the study area. It was subject to stock grazing and was infested with several exotic species, particularly *Juncus acutus* (Sharp Rush).

The floristic and structural elements of this community were consistent with the NSW Scientific Committee's listing *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*, an Endangered Ecological Community (EEC) listed under the TSC Act.

Plate 1: Phragmites australis and typha orientalis coastal freshwater wetland

Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner – 47 ha
This vegetation community was present in three variations on the site, including remnant forest, areas containing a scattered or absent canopy with native understorey, and rehabilitation areas containing Swamp Oak (**Figure 4**).

Remnant patches of this community were detected on poorly drained soils scattered throughout the northern portion of the study area (**Plate 2**). The canopy was dominated by *Casuarina glauca* (Swamp Oak), with occasional *Melaleuca styphelioides* (Prickly-leaved Tea Tree) also observed. The shrub layer was absent and the dense ground layer was dominated by native and exotic grasses and herbs, including *Aster subulatus*, *Atriplex prostrata, Cirsium vulgare* (Spear Thistle), *Cynodon dactylon*, *Pennisetum clandestinum* and *Persicaria lapathifolia* (Pale Knotweed). Areas without the canopy (**Plate 4**) are considered a derived community.

The rehabilitation area (**Plate 3**) was dominated by planted *Acacia saligna* (Golden Wreath Wattle), *Melaleuca armillaris* (Bracelet Honey-myrtle) and Swamp Oak, as well as a variety of exotic species such as *Chloris gayana* (Rhodes Grass), *Cirsium vulgare* (Spear Thistle), *Lantana camara* (Lantana) and *Verbena bonariensis* (Purpletop). The rehabilitation variant of Swamp Oak Swamp Forest was in poor condition across its range, due to being planted out with a weedy Western Australian species *(Acacia saligna)* and mismanagement of the area effectively leading colonisation of exotic species.

All variants of this community were subject to stock grazing and infestation of the weeds mentioned above.

Considering the floristic assemblage, position in the landscape and observations of surface soil, two of the variants (Moderate condition and Scattered Swamp Oak) of this community were considered to align with the EEC *Swamp Oak Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner*. The remaining variant were not considered to qualify as the EEC due to modifications to soil and/or floristic composition

Plate 2: Remnant Swamp Oak Swamp Forest in the north of the site

Plate 3: Rehabilitation variant of Swamp Oak Swamp Forest

Plate 4 SEPP 14 Wetland area with derived Swamp Oak Swamp Forest

Saltmarsh in estuaries of the Sydney Basin and South East Corner– 9.24 ha
This community was present in the south of the study area (**Figure 4**; **Plate 5**).

Juncus kraussii, Paspalum vaginatum, *Sarcocornia quinqueflora* and *Sporobolus virginicus* were the dominant species throughout this community. *Bolboschoenus caldwellii* and *Phragmites australis* were common in the ecotone between this community and Phragmites australis and Typha orientalis coastal freshwater wetland, making it difficult to determine the precise community boundaries.

This community was in moderate condition throughout its extent. The area was subject to stock grazing and drainage has been modified by a levy. Common exotic species include *Aster subulatus*, *Cotula coronopifolia* (Water Buttons) and *Juncus acutus* .

The floristic and structural elements of this community were consistent with the NSW Scientific Committee's listing *Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions*, an EEC listed under the TSC Act.

Plate 5: Saltmarsh in the southern part of the site

Cleared and exotic

The majority of the study area is comprised of exotic vegetation (**Figure 4**; **Plate 6**). The vegetation community was dominated by a range of exotic grasses and herbs, including Lacy Ragweed, *Axonopus fissifolius* (Narrow-leafed Carpet Grass), Spear Thistle, *Eragrostis curvula* (African Lovegrass) and Kikuyu Grass. Large sections of this community were infested with *Alternanthera philoxeroides* (Alligator Weed), a Class 3 noxious weed in the Newcastle LGA.

Plate 6: Exotic / disturbed Vegetation

4.2.1 Floristic Surveys

A complete species list that resulted from the floristic surveys is provided in **Appendix B**, including species that have been recorded from the previous studies (Ecobiological 2008; EcoHub 2009), with a total of 256 species recorded, including 187 native species.

No threatened flora species were recorded within the study area.

4.2.2 Fauna Surveys

A complete species list that resulted from the fauna surveys is provided in **Appendix B**, including species that have been recorded from the previous studies (Ecobiological 2008; EcoHub 2009), with a total of 168 fauna species recorded, including nine amphibians, 128 avian species, 25 mammal species and six reptile species. The following sections provide a summary of the findings from the current surveys. **Table 3** below provides a summary of all the threatened and migratory species listed under the EPBC Act and TSC Act that have been recorded in the study area during this and the previous studies. Previous reports do not indicate the location where the individuals were recorded within the study area. Due to the absence of this information, an indication of the likely nature of usage of the study area has been provided, based on available habitats within the study area, the species habitat requirements and movement behaviours.

During field survey undertaken by ELA, the *Pteropus poliocephalus* (Grey-headed Flying-Fox) was the only species recorded, which is listed as Vulnerable under TSC Act and the EPBC Act. This record was made during a nocturnal survey. No other threatened or migratory species were recorded by the ELA survey.

Table 3: List of threatened and migratory species recorded within the study area.

SCIENTIFIC NAME	COMMON NAME	TSC Act	EPBC Act	Study reference	Notes and likely habitat usage in the study area
Tyto capensis	Grass Owl	V	-	Ecobiological (2008); EcoHub (2009)	Responded to call playback and flew in to study area. Thought to be resident pair from Ash Island. Study area provides marginal foraging habitat.
Hieraaetus morphnoides	Little Eagle	V	-	Ecobiological (2008)	No location record available. Assumed to use the site as part of foraging range. No nests observed.
Anseranas semipalmata	Magpie Goose	V	M	EcoHub (2009)	No location record available. Assumed to use the site as part of foraging range. Limited marginal habitat available within the study area.
Botaurus poiciloptilus	Australasian Bittern	V	-	EcoHub (2009)	No location record available. Assumed to use the site as part of foraging range. Limited marginal habitat available within the study area.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	EcoHub (2009); Ecobiological (2008) and Current survey	Recorded flying over the study area. No roost habitat available.
Mormopterus norfolkensis	East Coast Freetail-bat	V	-	Ecobiological (2008); EcoHub (2009)	Recorded through ultrasonic call recording. No location available. Some marginal roost potential in hollow bearing trees within Swamp Oak Forest in the north of the study area (in proposed conservation area).
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Ecobiological (2008)	Recorded through ultrasonic call recording. No location available. Some marginal roost potential in hollow bearing trees within Swamp Oak Forest in the north of the study area (in proposed conservation area).
Miniopterus australis	Little Bentwing-bat	V	-	Ecobiological (2008)	Recorded through ultrasonic call recording. No location available. Study area offers forage habitat only.

Myotis adversus	Large-footed Myotis	V	-	Ecobiological (2008)	Recorded through ultrasonic call recording. No location available. Study area offers forage habitat only.
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Ecobiological (2008)	Recorded through ultrasonic call recording. No location available. Some marginal roost potential in hollow bearing trees within Swamp Oak Forest in the north of the study area (in proposed conservation area).
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	EcoHub (2009)	Recorded through ultrasonic call recording. No location available. Study area offers forage habitat only.

4.3 SUMMARY OF BIODIVERSITY VALUES AND CONSTRAINTS TO DEVELOPMENT

The following section presents the biodiversity values present within the study area, including threatened biodiversity (EEC's, threatened species and migratory species) recorded or considered likely occurrences, a summary of general biodiversity, habitat condition and connectivity values.

Table 4: Summary of biodiversity values.

BIODIVERSITY VALUE	**SUMMARY**			
Scientific Name	**Common Name**	**TSC Act**	**EPBC Act**	**Likelihood of Occurrence**
—	*Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions.*	EEC	—	Recorded
—	*Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*	EEC	—	Recorded
—	*Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions*	EEC	—	Recorded
Zannichellia palustris		E	—	Potential
Litoria aurea	Green and Golden Bell Frog	E	V	Potential
Hieraaetus morphnoides	Little Eagle	V	—	Recorded onsite
Anseranas semipalmata	Magpie Goose	V	M	Recorded onsite
Botaurus poiciloptilus	Australasian Bittern	V	—	Recorded onsite
Ephippiorhynchus asiaticus	Black-necked Stork	E	—	Some marginal potential
Irediparra gallinacea	Comb-crested Jacana	V	—	Potential

Ixobrychus flavicollis	Black Bittern	V	—	Potential
Rostratula australis (a.k.a. R. benghalensis)	Painted Snipe (Australian subspecies)	E	V	Potential
Tyto capensis	Grass Owl	V	—	Recorded onsite
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Potential
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	—	Recorded onsite
Miniopterus australis	Little Bent-wing Bat	V	—	Recorded onsite
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	—	Recorded onsite
Mormopterus norfolkensis	East Coast Freetail Bat	V	—	Recorded onsite
Myotis adversus	Large-footed Myotis	V	—	Recorded onsite
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Recorded onsite
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	—	Potential
Scoteanax rueppellii	Greater Broad-nosed Bat	V	—	Recorded onsite
Apus pacificus	Fork-tailed Swift	—	M	Potential
Haliaeetus leucogaster	White-bellied Sea-Eagle	—	M	Recorded onsite
Hirundapus caudacutus	White-throated Needletail	—	M	Potential
Ardea alba	Great Egret	—	M	Potential
Ardea ibis	Cattle Egret	—	M	Potential
Biodiversity	Overall a total of 168 fauna species were recorded, including 9 Amphibian species, 128 Avian species, 25 Mammal species and 6 reptile species. 21 threatened or migratory fauna species have either been recorded or are considered potential occurrences (see above) 268 flora species were recorded across each of the three different studies. Of these 86 were introduced species with additional species considered to have been introduced to the study area through vegetation rehabilitation works. One threatened flora species, *Zannichellia palustris*, listed as endangered is considered a potential occurrence on the site but has not been recorded within			

	the study area. The study area contains five broad vegetation types, with four of these considered to be native vegetation communities in variable condition and covering approximately 32% or 81ha of the study area. Each of these vegetation types are considered to represent three respective EEC's listed under the TSC Act (see above). The remaining study area is classed as either disturbed or a vegetation rehabilitation area.
Habitat condition	The site evidences a long history of industrial and agricultural disturbances, with the spatial representation of the rehabilitation area and disturbed vegetation in **Figure 3** depicting the worst affected areas (75% of the site). The central portion of the study area has been subject to coal stockpiling, excavation works and is essentially an artificial landscape. Much of this area is subject to pasture improvement and cattle grazing, with grazing also extending to the north and into areas mapped as having the native vegetation. Despite this level of disturbance, the site does still contain some ecological values, in the form of the three endangered ecological communities associated with wetlands and habitat for threatened species. With the exception of the Green and Golden Bell Frog and hollow roosting bats, the study area generally constitutes foraging or intermittent refuge habitat. Several surveys for Green and Golden Bell Frog have been conducted within the study area over a three year period, with no results indicating the presence of the species. At best, wetland habitats within the study area (i.e. Coastal floodplain sedgelands, rushlands, and forbs; Phragmites australis and Typha orientalis coastal; and the edges of Coastal Saltmarsh in estuaries of the Sydney Basin) potentially support very occasional and intermittent movements and foraging by Green and Golden Bell Frog, although this has not been confirmed with any sightings. In terms of habitat for hollow obligate Microchiropteran bats (e.g. East Coast Freetail Bat, Large-footed Myotis and Greater Broad-nosed Bat), the area of remnant Swamp Oak swamp forest fringing estuaries in the north of the study area contains 682 hollow bearing trees, with the majority of hollows being in the small (<8cm class) (EcoBiological 2008). None of these hollow bearing trees will be affected by the proposed development.
Connectivity	The study area is positioned in a highly fragmented landscape, which has developed through historic agricultural, infrastructure and industrial land uses. The study area itself is highly fragmented, with small patches of isolated remnant vegetation such as the Swamp Oak Forest and areas of wetland occurring within a mostly disturbed/cleared area. The northern railway line, New England Highway, Pacific Highway and Hexham industrial area form barriers to movement to the east and north. Cleared pasture interspersed with low lying wetland areas occurs to the west. The primary habitat connection to the study area occurs to the southwest, whereby the study area is connected to wetland habitats within Hexham Swamp Nature Reserve. Habitat within the reserve is generally non-woody freshwater or estuarine wetland and is therefore only suitable for a restricted fauna assemblage (i.e. not suitable for forest/woodland dependant species).

4.4 STUDY LIMITATIONS

The floristic audit undertaken recorded as many species as possible and provides a comprehensive but not definitive species list. More species may be recorded during a longer survey over various seasons, however the site has been studied in at least four reports spanning various seasons and three years. The floristic and fauna surveys completed for this study are therefore considered sufficient. For species that were not detectable during the survey period by ELA, results from surveys for the ARTC project by Parsons Brinkerhoff 2012 and 2013 have been utilised and incorporated as necessary.

5 IMPACT ASSESSMENT

The TSF has the potential to have the following impacts on biodiversity:

- Clearing and fragmentation of endangered ecological communities and habitat for threatened species, and
- Changes to hydrology and water quality for groundwater dependent ecosystems

5.1 CLEARING AND FRAGMENTATION OF NATIVE VEGETATION

5.1.1 Clearing of Endangered Ecological Communities

The subject site is highly disturbed, having had a long history of industrial and agricultural land use. Vegetation communities on the site are therefore in a somewhat degraded state. Approximately 12.0 ha of native vegetation will be impacted, of which 7.74 ha met the definition of an Endangered Ecological Community (**Table 5** and **Figure 5**). In addition to the impact on EEC, the adjoining ARTC development will impact on approximately 9.1 ha of EEC, giving a total impact of 16.58 hectares.

The Part 3A *Draft Guidelines for Threatened Species Assessment* (DECC and DPI 2005) identifies matters which are relevant to the assessment of impacts to endangered ecological communities, endangered populations and threatened species. Appendix 3 of DECC and DPI (2005) guidelines lists six questions and associated sub-questions that address the impacts of proposed developments on threatened species, populations, or ecological communities. **Appendix C** of this report provides detailed assessment accounting for the ecological impacts associated with the proposed Train Support Facility for ecological communities recorded or considered likely to occur in the study area (see species and EEC's in **Table 4**). The assessment concludes that due to the degraded nature of the EECs and their distribution in the locality and region, the proposed development will not have a significant impact on these EECs.

Table 5: Extent of impact of TSF (proposed development footprint) on biometric vegetation types and their corresponding EEC

Biometric Vegetation Type	Area Vegetation Community Impacted (ha)	Corresponding EEC	Area EEC impacted (ha)
Coastal floodplain sedgelands, rushlands, and forbs	2.07	Freshwater wetland on coastal floodplain	2.07
Phragmites australis and Typha orientalis coastal	1.32	Freshwater wetland on coastal floodplain	1.32
Saltmarsh in estuaries of the Sydney Basin	0.35	Coastal saltmarsh	0.35
Swamp oak swamp forest fringing estuaries *approx. half of this community meets the definition of an EEC	8.26	Swamp oak forest on coastal floodplain	4.0
Total impacted	**12.0**		**7.74**

5.1.2 Threatened species

In terms of impacts to threatened flora species, *Zannichellia palustris* was the only threatened flora species considered a potential occurrence within the study area. The impact assessment provided in **Appendix C** concludes that, whilst there is some possibility of the species occurring within the study area, the impacts of the proposal are limited to a relatively small area of potential habitat (32ha of *Phragmites australis and typha orientalis* wetland) in which the species has not been observed. The remainder of the *Phragmites australis and Typha orientalis* wetland (approximately 12.8 hectares) on the site will be managed for long term conservation purposes under a Conservation Agreement.

Based on the number surveys undertaken to date, habitat preferences and the general condition and past disturbance of the site, we consider that *Asperula asthenes, Lindernia alsinoides* and *Maundia trigiochonoides* are highly unlikely to be present at the impact site.

With regard to threatened fauna species and their habitats, **Table 4** provides a list of those species considered at least potential occurrences within the study area. The study area generally constitutes foraging or intermittent refuge habitat. Several surveys for Green and Golden Bell Frog have been conducted within the study area over a three year period, with no results indicating the presence of the species. At best, wetland habitats within the study area (i.e. Coastal floodplain sedgelands, rushlands, and forbs; Phragmites australis and Typha orientalis coastal; and the edges of Coastal Saltmarsh in estuaries of the Sydney Basin) potentially support very occasional and intermittent movements and foraging by Green and Golden Bell Frog. With the proposal impacting upon 3.74 ha of this marginal habitat for the species and the retention and conservation management of up to 20.89ha (see section 6.3.3), habitat provision will continue and will be improved for the species within the study area, therefore avoiding a significant impact on the species.

In terms of habitat for hollow obligate Microchiropteran bats (e.g. East Coast Freetail Bat, Large-footed Myotis and Greater Broad-nosed Bat), the area of remnant Swamp Oak Swamp Forest Fringing Estuaries in the north of the study area contains 682 hollow bearing trees, with the majority of hollows being in the small (<8cm class) (EcoBiological 2008). None of these hollow bearing trees will be affected by the proposed development (refer to **Appendix E**) and therefore a significant impact on these species is not likely to occur. Whilst there will be loss of native vegetation and habitat, no threatened species or communities are considered likely to be significantly affected by the proposal.

5.1.3 SEPP 14 wetlands

The study area contains approximately 18.88 ha of SEPP14 Coastal Wetland as shown in **Figure 2** and adjoins Hexham Swamp Nature Reserve (Hunter Wetlands National Park). Wetland number 833 is approximately 10.6 hectares and will have direct impacts of 4.63 hectares (44%). The wetland for the most part comprises of primarily introduced pasture species with intermittent patches of freshwater wetland. Overall from the perspective of a working freshwater wetland the majority of wetland number 833 is in a poor condition. Dominant species are primarily introduced and comprise a dense ground cover of *Pennisetum clandestinum* (Kikuyu), *Cynodon dactylon* (Couch), *Axonopus fissifolius* (Carpet Grass) and *Paspalum dilatatum* (Paspalum). Additionally, numerous clumps and aggregations of invasive weed species are also present including *Juncus acutus*, *Rubus fruticosus* sp.agg. (Blackberry), *Hydrocotyle bonariensis* (Pennywort) and *Aster subulatus* (Wild Aster). Due to historic disturbance regimes such as pasture improvement and grazing, this wetland is considered to be of very low value as a coastal wetland.

The other area of SEPP 14 wetland on the site is in the southern portion where no direct or indirect impacts are expected to occur and indeed this area (12.11 ha) is proposed for protection via a Conservation Agreement as described in section 6.3.3. Given the large extent of wetland in the area and the mitigation measures described in Section 6 of this document, the development of this site is not considered to have a significant impact on the broader wetland complex of the Lower Hunter.

Figure 6 SEPP 14 wetland 833

Figure 7 SEPP 14 wetland 833

5.1.4 Connectivity

The proposal is located within the Watagan to Stockton Corridor identified in the Lower Hunter Regional Strategy (LHRS). The LHRS is a key planning policy and guide to growth in the Lower Hunter Region to 2031 and is the principle document in relation to major landuse issues and development decisions. The LHRS helps guide outcomes in the region by identifying future development areas, population / settlement patterns, major landuse types and the conservation outcomes in regard to the regions biodiversity. The LHRS is closely related to the Lower Hunter Regional Conservation Plan (LHRCP), which provides guidance and promotes key principles and actions in relation to biodiversity conservation.

The lands identified in the Watagan to Stockton Corridor in the Hexham Swamp locality represent part of a broad strategic corridor rather than one designed for a particular species, population or community. The proposal will remove or modify previously disturbed vegetation within the corridor, in a location where the corridor is already significantly fragmented for terrestrial species by the existing railway line, Pacific Highway and the Hunter River. An Offset Strategy will be implemented as part of the overall proposal. The Offset Strategy will seek to improve and enhance approximately 53 hectares of habitat on site and as a result will improve the onsite biodiversity as well as 'stepping stone' connectivity within the corridor for various species of birds and bats. Although some loss of vegetation will occur, the proposal is unlikely to significantly hinder the proposed corridors overall use for conservation purposes in the context of the LHRCP.

5.1.5 Noise and lighting

ELA understands that the site will be utilised on a 24 hour basis and as such exterior lighting will be on during non-daylight hours. All exterior lighting will be directional and mounted in a manner to keep light at specific locations and not escaping or reflecting to areas unnecessarily. The study area currently has artificial light encroaching from the east and north via the Pacific and New England Highway during the evening and through the night. The proposed works would create additional night-time light than is currently apparent, although would not replicate the amount of light emitted from the Highway. The proposed lighting will likely modify the habits of some fauna species including microbats, amphibians and nocturnal birds for foraging purposes due to the potential attraction of insects to the external lighting fixtures during the evening. A potential increase in use by nocturnal species would also in-turn increase the incidence of these species having interactions with mobile plant on the site, although the effects of this are expected to be minor. Overall, there may be additional use of the area by some fauna species during the evening, although it is considered unlikely to be a detrimental impact due to the use of the proposed external lighting scheme.

Operational noise is predicted to be below the relevant guidelines at the closest residential receivers, additionally construction noise levels will also be overall below the relevant guidelines (SLR Consulting Pty Ltd 2012). Increased noise during the day for load testing of locomotives to run at full power over a 60 minute period and maintenance to wagons and locomotives will be generally on a 5 to 6 days a week roster although may be over 7 days if required. Overall noise management will be influenced by Aurizon's Noise Management Practices.

There is potential for calls of birds and animals to be reduced in function when in close proximity to loud and continuous noises (Blickley and Patricelli, 2010). These animal calls, such as distress calls may not be heard by others and as such be susceptible to predation (i.e. small birds). There may also be issues in regard to breeding activity (e.g. frogs) particularly during breeding times when breeding males are calling and unable to breed with external populations creating potential for inability to attract a mate or induce inbreeding. There may also be issues with certain species not wanting to utilise suitable (e.g. wetland) habitat due to the proximity of the noise environment, this in turn can create over-use or crowding of other suitable habitat areas. Although there are potential effects due to construction and operational noise at the facility, is unlikely to have a significant negative impact on the fauna species of the locality.

5.2 CHANGES TO HYDROLOGICAL ENVIRONMENT

As discussed in Chapter 4, native vegetation communities on site are considered to be groundwater dependent ecosystems. These occur not only as terrestrial communities, but also within the two main agricultural drains that flow to Hexham Swamp. The drains contain wetland species such as *Phragmites australis (*dominant*),*

Bolboschoenus caldwellii and *Typha orientalis* (Broad-leaved Cumbungi). No threatened species listed under the *Fisheries Management Act 1994* or *Threatened Species Conservation Act 1995* have been recorded in the drains, nor are they considered likely due to poor habitat condition and the presence of *Gambusia sp.*

Changes to the hydrological and aquatic environment can occur due to:

- Increased rate and volume of run-off from hardstand areas leading to changes in water quality and salinity in estuarine environments
- Ponding or retention of storm/flood water due to construction of buildings or roads.
- Changes to ground water levels due to filling.

5.2.1 Stormwater run-off quantity and quality

An increase in stormwater discharge from the site is anticipated and has been modelled by WorleyParsons (2013) for the Stormwater Management Plan (SMP) which describes the current site hydrology, water quality and changes to these as a result of the development. The SMP identifies five stormwater discharge points (**Figure 8** and **Figure 9**):

- Location 1 - Culvert to Hunter River north of the site.
- Location 2 - Swamp Oak Forest (EEC) north of the site.
- Location 3 - SEPP14 west of HWC water main and North of abandoned railway.
- Location 4 - SEPP14 west of HWC water main within Hexham Swamp and South of abandoned railway.
- Location 5 – Coastal Saltmarsh (EEC) south of the site.

There are no modifications to proposed to tidal zones or channels conveying tidal waters. Run-off from minor rainfall events will be channelled through vegetated swales, gross pollutant traps and water quality control ponds shown in **Figure 8**.

Table 6 Modelling stormwater changes to receiving areas

	Discharge Location	**Change from existing conditions**
1	North	This catchment will have an increase of impervious surfaces from 1% to 1.7% with negligible changes to discharge for low flow events. The peak flow rate for the 1 year event will change from 1.13m^3/s to 1.16 m^3/s – also very minor. The discharge point will go directly to the culvert and not impact on sensitive environments.
2	North to Swamp Oak Forest	Catchment draining to this area will reduce from 30.5 ha to 25.8 ha and impervious surface will increase from 1% to 1.9% of catchment. Expected to be negligible change to peak discharge rates during low flow events. Inundation of the swamp oak forest area predicted to occur in 1 year ARI event rather than 2 year event as is currently the case.
3	West	Catchment draining to this point to increase from 37 ha to 41 ha and impervious surface from 5% to 23%. This area discharges to a low-flow channel that is tidally flushed and receives runoff from a considerably larger catchment (280 ha) therefore hydrologic changes during low flow events likely to be negligible.
4	West	Change in impervious surfaces from 6% down to 4.7% and catchment area decreases from 66.8 ha to 63 ha. Negligible changes flows expected.
5	South to Coastal	Catchment size increases from 32.6 to 33.2 ha and impervious surfaces increases

	saltmarsh	from 9% to 24.2%. There are two outlets for this basin with peak flow rates in a 1 year event decreasing from 0.57 m^3/s to 0.31m^3/s and increasing 0.12m^3/s to 0.43m^3/s. In terms of total discharge, in a 1 year event 11,400m^3 of run-off is expected to reach the saltmarsh compared to an existing discharge or around 3,200m^3. In such events the receiving environments are expected to be dominated by freshwater regardless of the development.

Of the five discharge points, two are discharging to endangered ecological communities: point 2 to the Swamp Oak Forest and point 5 to the Coastal Saltmarsh. With regard to the Swamp Oak Forest a substantial increase in inundation times could have an impact on species composition, however the modelled increase of inundation from every two years to annual inundation is unlikely to result in such a change. As discussed in the following section, this area will be subject to a Vegetation Management Plan and Conservation Agreement that will improve the condition of this area by weed removal.

With regard to the saltmarsh community an increase in freshwater discharge to a saltmarsh environment has the potential to change species composition over time as those saltmarsh species that tolerate freshwater become more dominant. The receiving environment in this case is a 300m man-made cchannel that discharges to a broader saltmarsh area that received freshwater from Hexham Swamp and saline tidal water from a culvert under Maitland Road. Tidal waters inundate the broad saltmarsh area as well as the man-made drain.

The proposed development will increase the catchment draining from the development site from 32.6 to 33.2 ha in area and will increase impervious surfaces from 9% to 24.2%. In effect, this increases the amount of impervious surface by 5 ha from the development site. The effect of this in larger storm events (annual, two-yearly etc) is negligible as the saltmarsh area would become dominated by freshwater run-off regardless of whether the development occurs or not.

ELA initially assumed an impact to saltmarsh of 0.35ha which allowed for the stormwater infrastructure and the area of channel around the discharge point. This impact to saltmarsh was calculated as requiring 7 credits, meaning each hectare impact to saltmarsh would require an offset of 20 credits. The proposal will generate 72 saltmarsh credits via a conservation management plan. In response to OEH concerns about impacts to saltmarsh, ELA has made a more conservative assessment that ssumes all of the saltmarsh in the drainage channel has a change in species composition due to the low flow of typical rainfall events throughout the year. Whilst the channel will still be tidally inundated and therefore most likely still retain saltmarsh species, this more conservative approach was taken to determine whether the saltmarsh credits being generated would account for such a change. The 5m wide channel is approximately 300m long, so assuming all saltmarsh is lost within the channel, an additional impact of 0.15 ha would occur. Offsetting such an impact would require 3 saltmarsh credits (assuming 20 credits required per hectare). As the credit balance was in positive by 72 credits, this impact, although a worse-case scenario, is more than adequately offset with the balance still remaining in the positive by 69 credits.

ELA does not believe there will be changes in species composition due to the development in the brioader saltmarsh area as this will continue to receive freshwater run-off from Hexham swamp (channels under the HWC pipeline) as well as the daily tidal inundation via the culvert under Maitland Road.

Aurizon have advised that monitoring of wetland environments (in particular the coastal saltmarsh in the southern portion of the site) will be undertaken in accordance with a Monitoring Plan to be prepared as part of the Conservation Plan for the offset areas. It is envisaged that the monitoring will include setting up monitoring plots at strategic locations within the saltmarsh area to monitor for any species composition change that may occur.

In terms of water quality, the Stormwater Management Plan (Worley Parsons 2013) contains strategies for achieving water quality targets during the construction and operational phase of the project. The proposed system exceeds to targets for water quality controls by Newcastle DCP (Draft 2011) and will improve key parameters as shown in the table below. The development is therefore not expected to have negative ecological impacts due to stormwater discharge.

Table 7 Improvements to water quality parameters (from table 14 and 16 in Worley Parsons 2013)

	Existing site conditions	Developed site with treatment
Suspended solids (kg/year)	107,000	9250
Total Phosphorus (kg/yr)	72.3	37.3
Total Nitrogen (kg/yr)	268	146
Gross pollutants (kg/yr)	446	162

5.2.2 Retention and dissipation of flood waters

As all ecosystems on the site and the adjoining Hexham Swamp are groundwater dependent, proposed changes to flooding regimes as a result of the development need to be assessed. The effect of the proposal and the adjoining ARTC Relief Road project has been modelled by WBM (2013) to determine the impact on flood water velocity and the afflux of the 1%, 2%, 5% regional flood events. Afflux is essentially the level to which the water rises on the upstream side of a control compared to there being no control.

The main concerns for ecological impacts arise from the effect of changing inundation regimes for vegetation communities as a result of the access road between Tarro Interchange and the Aurizon site. The rail tracks themselves are not of concern as they will be constructed at an elevation lower than the existing rail lines and will therefore have a negligible effect on flood flows. The access road will be constructed at a height that is similar to the existing Woodlands Close and HWC Access Track – which is a reduction i height from the previously submitted proposal. A bridge crossing will be used at Purgatory Creek and culverts used to ensure cross flows under the road.

The Flooding Report (WBM 2013) shows that the road will essentially have no effect on the broader Hexham Swamp area during the large flood events such as the 1% and 2% events as these will overtop the road and inundate the entire area. However during the 5% event, the access road from Tarro Interchange to the Aurizon site does affect afflux to the east of the road by increasing it 0.05m – 0.1m, meaning water it will be 5cm – 10cm deeper than if the road was not constructed. Within this area most of the vegetation is exotic, however there is a patch of Coastal Floodplain Sedgeland vegetation. Increasing the inundation of this are by 5-10cm in a 5% event (i.e., 1 in 20 years) will not lead to a change in this community. The road will not affect the velocity or afflux to the west of the road which is where the Swamp Oak Forest and broader Hexham Swamp area is located.

Indirect impacts to the Swamp Oak Forest in the proposed offset area have also been assessed and determined to be negligible. The portion of the project site draining to this area will reduce from 30.5 ha to 25.8 ha and impervious surface will increase from 1% to 1.9% of catchment (WorleyParsons 2013). This is a change in impervious surface from 0.30 ha to 0.49 ha which is insignificant given the Swamp Oak Forest also receives run-off from the surrounding Hexham Swamp area. Douglas Partners (2013) advise that there are unlikely to be changes to groundwater levels other than in close proximity to the development footprint itself, i.e. within a few metres of the proposed infrastructure.

The proposed development is not anticipated to change surface water flows to the Swamp Oak Forest in the offset area. Changes are expected however for larger events. Flooding regimes to the Swamp Oak Forest are currently

in the vicinity of one full inundation at the site each 24 month period. Due to the additional impervious surfaces from the new rail infrastructure, plus the additional stormwater flows from the retention basin during peak rainfall events, it is likely that the Swamp Oak Forest community and surrounds will be fully inundated on one occasion each 12 month period (Douglas Partners 2013). Stormwater flows are from the south and moving towards the north, flow directions for the northern portion of the site are presented in **Figure 8** (Stormwater discharge locations). Based on the community currently being at least partially inundated on several occasions each year, and that the forest type and associated species (primarily *casuarina glauca*) are tolerant to, and in some cases require inundation (e.g. seed dispersal, aquatic species, etc.) the inundation regime of once each 12 month period is unlikely to provide the community an adverse significant impact.

Freshwater Wetland in the south of the site (west of the saltmarsh) has a species composition dominated by freshwater species. Increases of stormwater volume to this community are not expected to change species composition. Whilst flow rates may increase, the physical impacts of higher flow rates can be managed with appropriate outlet design.

The road construction and associated infrastructure will not affect the velocity or afflux to the west of the road which is where the Swamp Oak Forest and broader Hexham Swamp area is located.

5.2.3 Groundwater

Douglas Partners (2013) have undertaken an investigation into the effects of the proposed development on the groundwater within and adjacent to the subject site. Whilst groundwater is significantly mounded beneath the coal stockpiles, in areas without stockpiling or fill it is near the surface. DP (2013) (chapter 6) describe the likely changes to groundwater in the vicinity of groundwater dependent ecosystems in as follows:

> *The proposed development will be constructed partly over several areas of groundwater dependant ecosystems, some of which are classified as Endangered Ecological Community, and as a consequence the remnant EEC will be left in immediate proximity on one or both sides of the development. Remnant areas on the eastern side of the proposed TSF area (i.e. between TSF and the Great Northern Railway) are likely to be directly affected by the proposed ARTC development.*
>
> *During construction there is some risk of lowering of the water table due to localised dewatering however, such drawdowns can be limited by appropriate detailed design and are not expected to have significant impacts on water table levels outside of the development footprint as potential drawdowns are generally within observed seasonal groundwater level variations.*
>
> *The proposed development may have some long term impact on groundwater levels in close proximity to the development. This is likely to include:*
>
> - *Draw-down of water levels on elevated ground immediately to the west of the southern section of the site due to the proposed longitudinal drain;*
> - *Possible slight decrease in water levels adjacent to formation on northern parts of the site due to the draining effect of the formation and adjacent drain. This can be mitigated to an extent by inclusion of transversely oriented barriers to lateral flow in the formation; and*
> - *Locally increased run-off and therefore groundwater infiltration near the location of the basin outlets.*
>
> *The increased run-off will have little effect on groundwater levels during wet times as the water levels are controlled by surface water controls. In times of intermittent weather the increased run-off may lead to certain areas staying wetter for longer than they may have prior to development. In dryer periods the proposed development will likely have little impact on groundwater levels. There would be some risk of localised pockets receiving less run-off than previously, however, the risk of this is limited as the ground is generally low lying with limited fall, encouraging spreading of the run-off.*
>
> *With regard to specific vegetation communities the following points are made:*

- *Impacts to groundwater levels from the development are expected to be limited to close proximity to the LTTSF development footprint. Impacts on water levels on the western parts of the site in Hexham Swamp to the west and the Hunter River to the east, are expected to be negligible.*
- *The area of Saltmarsh on the southern part of the site may receive additional surface water flows from Basin 03 than would have occurred pre-development;*
- *There are some areas of Swamp Oak located within along the western edge of the proposed development on the southern portions of the site. The presence of the adjacent unlined drain may lead to a reduction in groundwater levels during wetter periods, however, may lead to some increase during drying periods;*

The DP (2013) Report therefore indicates that there will be changes to groundwater levels within the development footprint. ELA has assumed that the vegetation communities within the footprint will be directly impacted and have assessed this impact in section 5.1 of this report with offset measures for these impacts discussed in Chapter 6.

With regard to the indirect impact on retained vegetation within and adjoining the site, the DP (2013) report suggests there may be drawdown on water levels in the elevated coal-stockpile area which contains the rehabilitating Swamp Oak Forest. This patch of vegetation is described in section 4 of this report and contains a mix of native and introduced species dominated by planted *Acacia saligna, melaleuca armillaris* and *Casuarina glauca*, as well as exotics including lantana, Spear thistle and Rhodes grass. The community does not meet the definition of an endangered ecological community and is in poor condition due to the extent of weed invasion. A minor fall in water table is unlikely to have a significant effect on this area. DP (2013) also discuss the Swamp Oak Forest vegetation immediately adjacent to basin 2 where there groundwater may be drained by the rail formation and the drain. DP (2013) however advise that this is likely to be offset by the discharge from the detention basin. The same rational is applied to the Coastal Floodplain Sedgelands immediately downstream of Basin 1.

The DP Report therefore indicates that changes to groundwater are mainly to be restricted to the development footprint. ELA has assessed these in section 5.1. Changes to groundwater away from the development footprint are not likely to be significant and therefore are unlikely to affect native vegetation o the remainder of the site or adjoining lands.

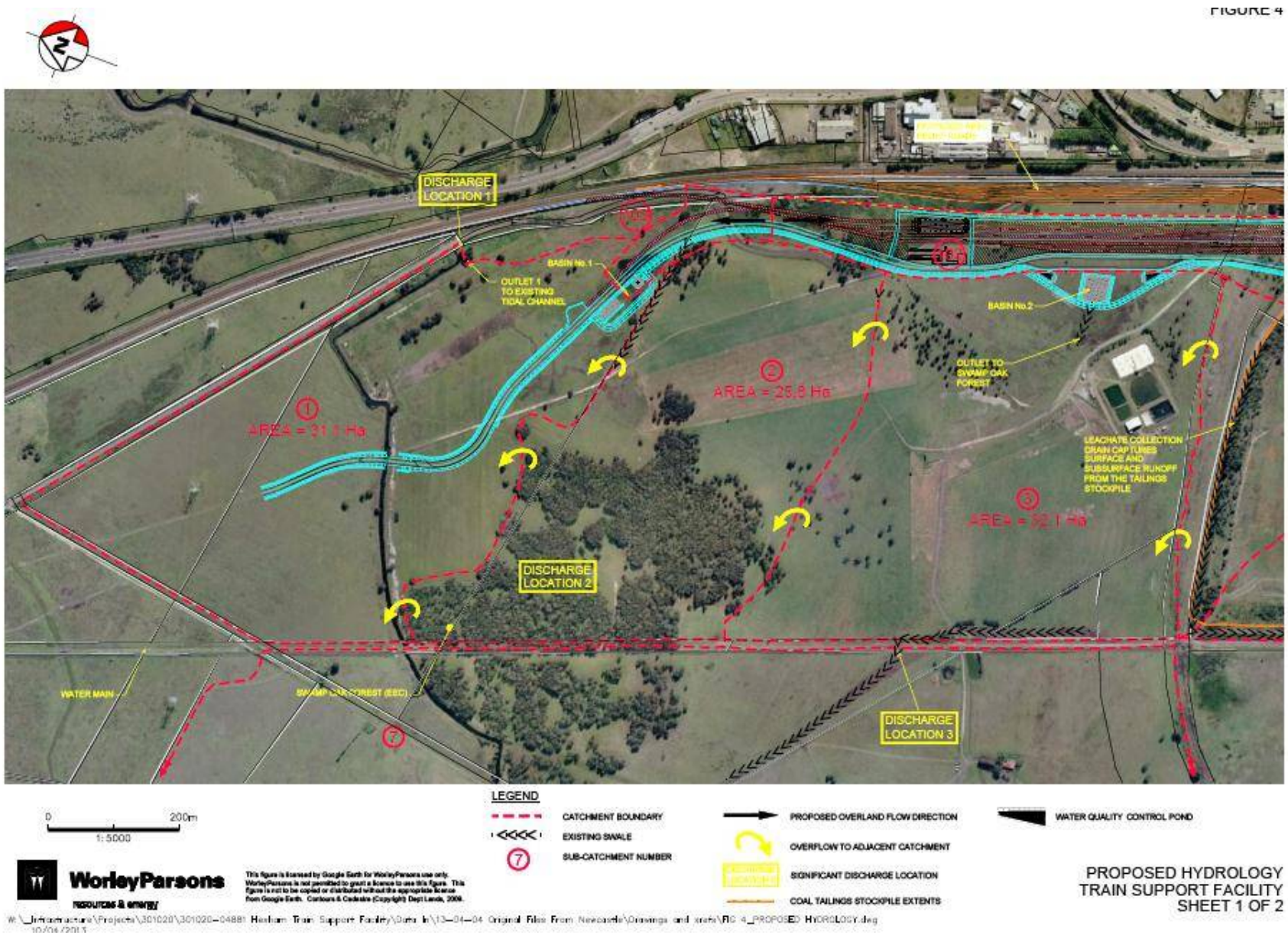

Figure 8 Stormwater discharge locations (north)

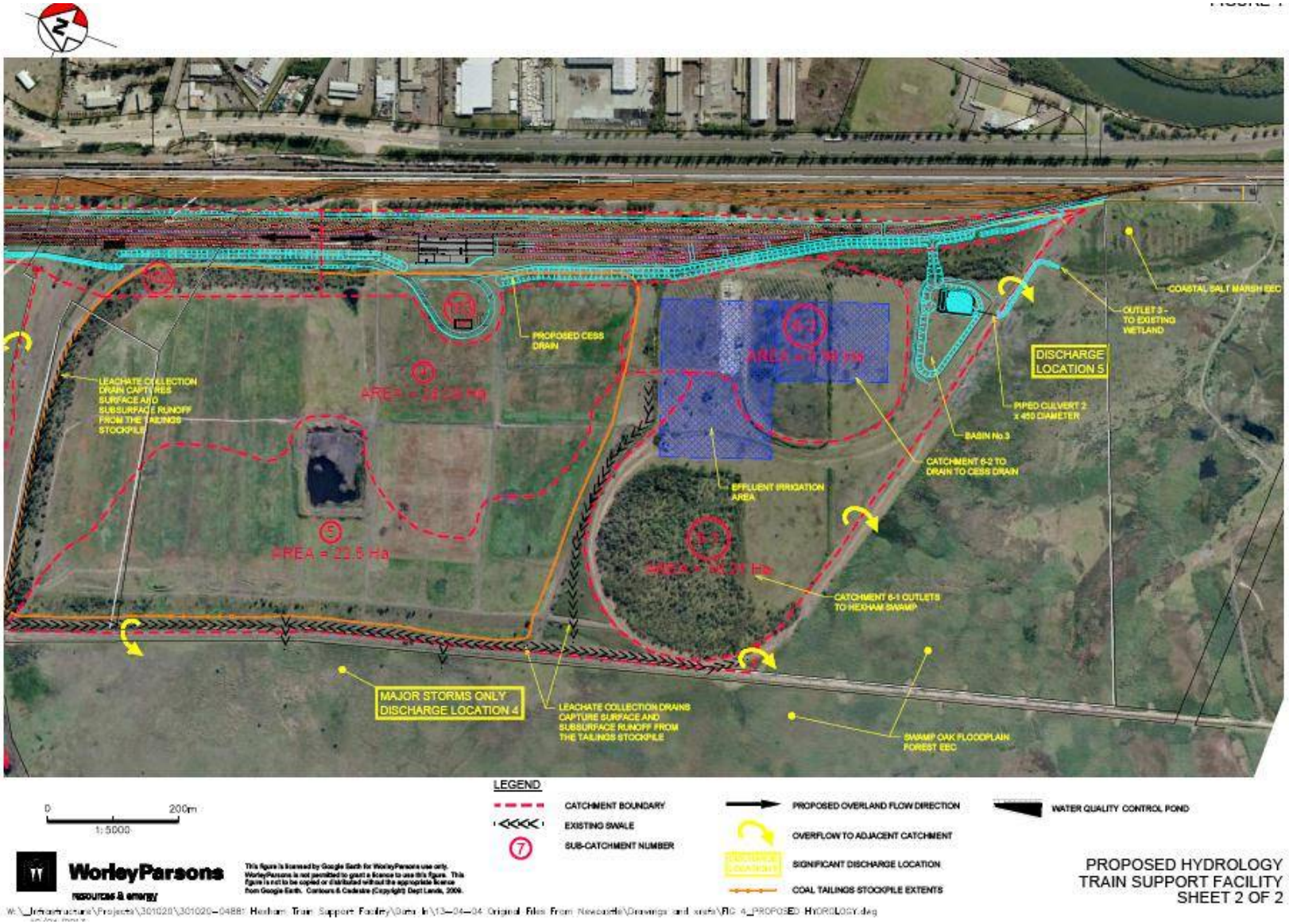

Figure 9 Stormwater discharge locations (south)

6 Avoidance, Mitigation and Offsets

6.1 MEASURES TO AVOID IMPACT

Ecological survey was used to understand the environmental sensitivities of the site prior to design of the TSF and industrial estate. As a result, the TSF is located primarily on the disturbed part of the site and avoids the southern area which contains saltmarsh. Compared to previously submitted project, significant changes have been made regarding impacts to flooding on the site. The tracks and access road have been lowered to significantly reduce the effect of the project on movement of floodwaters between the Hunter River and Hexham Swamp.

6.2 MITIGATIVE MEASURES

The following on-site practices are to be undertaken during the construction phase and will be contained within a Construction Environment Management Plan.

Table 8: Mitigation measures during the pre-construction, construction and operational phases of the Project

ITEM	MITIGATION MEASURE / ECOLOGICAL MANAGEMENT PROCEDURE	TIMING
1. Site-specific environmental induction	Ensure that all staff working on the Project undertake a site-specific environmental induction. The induction should include items such as: • Sensitivity of wetlands, particularly saltmarsh • Site environmental procedures (vegetation management, sediment and erosion control, protective fencing, noxious weeds) • What to do in case of emergency (sediment fence failure, injured fauna) • Key contacts in case of environmental emergency e.g. WIRES, Sydney Wildlife Rescue	Pre-construction and during construction for new staff
2. Identification of clearing limits	Accurately and clearly mark out the limits of clearing and trees/vegetation to be retained. Identify trees close to work areas which are at risk during construction and install protective fencing (temporary fluoro orange 'para-web' fencing or similar) to reduce risk of damage during the construction phases of the development. Do not store materials/vehicles under the drip-line (canopy) of retained vegetation.	Pre-construction
3. Pre clearing survey	Qualified ecologist to conduct pre-clearing surveys of: • hollow bearing trees • freshwater wetlands – with particular focus on Green and Golden Bell Frog. Fauna at risk of injury are to be relocated to suitable habitat a safe distance from the proposed works by a qualified ecologist.	Pre and during construction
4. Clearing of vegetation	Where trees require felling, retain the timber, particularly sections with hollows - as Coarse Woody Debris for enhancement of the Northern	Construction

ITEM	MITIGATION MEASURE / ECOLOGICAL MANAGEMENT PROCEDURE	TIMING
	Offset area Cease work immediately if any previously unknown threatened flora or fauna species are encountered. WIRES should be consulted if any injured fauna are encountered.	
5. Management of erosion and sediment control	Provide appropriate controls to manage exposed soil surfaces and stockpiles to prevent erosion and subsequent sediment discharge into surrounding wetlands. Clearly identify stockpile and storage locations and provide erosion and sediment controls around stockpiles. Stockpiles of topsoil to be stored in windrows no higher than 2m and be maintained free of weeds. Undertake dust suppression where required in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) where there is a risk of increased dust outside of acceptable levels	Pre and during construction
6. Site office and plant storage	Ensure these areas are located in the nominated compound – avoiding all significant native vegetation areas, including EECs.	During construction
7. Weed Management	Establish and implement a Hygiene Protocol for vehicles entering and leaving the site to minimise spread of weeds and other biological risks such as alligator weed.	Pre, post and during construction
8. Monitoring	Develop a monitoring program during construction (including a weekly checklist) to ensure that all mitigation measures proposed have been undertaken. The checklist should include items such as fencing and sediment and erosion control.	Pre, during and post construction

6.3 OFFSET STRATEGY

The Director-General Requirements for this project required the ecological assessment to include consideration of o*ffsets for native vegetation clearance consistent with the improve or maintain principle.* This section describes the policy framework for offsets, the offset strategy proposed and an assessment of how the offset is consistent with the policy framework.

6.3.1 Policy framework

The NSW OEH have adopted *Principles for the use of Biodiversity Offsets in NSW*. A full list of the principles is provided in **Appendix D**.

OEH have also adopted the *Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A Developments* (DECCW 2010). The policy is designed to assist OEH in assessing the adequacy of an offset. To do so, the policy requires the use of the Biobanking Assessment Methodology to calculate the credits required to offset an impact and the credits generated by a proposed offset. The outcome of this assessment is described as meeting one of three outcomes with a Tier 1 being the preferred outcome. The policy notes that proposals assessed as State Significant projects do not have to meet the "improve or maintain" standard which is required under the Biobanking scheme as some projects will not be able to achieve "improve or maintain" but, due to their social or economic benefits, should proceed. The term 'red flag' in the table relates to certain communities or species that are 'red flagged' under the Biobanking Assessment Methodology. This means that the loss and offset of this community or species cannot achieve and improve or maintain outcome. The term 'impacts fully offset' refers to an offset where the credit requirements are fully met.

6.3.2 Offset required

As described in **Table 5**, the project will impact on 12.0 hectares of native vegetation. The credits required to offset the impacts are described in **Table 9**, with the full Credit Report provided in **Appendix F**. The credits required are based on the biometric vegetation type being impacted and the habitat for threatened species that uses these communities. Note that this table does not account for the additional 0.15 hectare impact to saltmarsh in the drainage channel as this change was made after the biiobanking calculations had been run. If this additional area was included, an additional 3 creedits would be required..

Table 9 Credits required

Biometric Vegetation Type	Hectares of impact	Credits required to offset impacts of clearing
Coastal floodplain sedgelands, rushlands, and forblands of the North Coast	2.07	41
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin	1.32	19
Saltmarsh in estuaries of the Sydney Basin and South East Corner	0.35	7
Swamp Oak swamp forest fringing estuaries, Sydney Basin	8.26	320
Total	**12.0**	**387**

6.3.3 Proposed Offset

Aurizon have committed to the protection and management of 53.58 hectares of native vegetation and habitat on-site as shown in **Figure 5**.

Description of vegetation communities

The Northern Offset is dominated by *Casuarina glauca* (Swamp Oak), with occasional *Melaleuca styphelioides* (Prickly-leaved Tea Tree) also observed. The vegetation contains over 600 hollow-bearing trees, although most of these hollows are less than 8cm. The shrub layer is absent and the dense ground layer is dominated by native and exotic grasses and herbs, including *Aster subulatus* (Wild Aster), *Atriplex prostrata, Cirsium vulgare* (Spear Thistle), *Cynodon dactylon* (Common Couch), *Pennisetum clandestinum* (Kikuyu) and *Persicaria lapathifolia* (Pale Knotweed). The area is also heavily grazed. Weed treatment and stock management will therefore be an important management requirement. The Northern offset also contains an area that is currently clear and will require re-establishment of native vegetation to return it to swamp oak swamp forest.

The southern offset area is a combination of saltmarsh patches and *Phragmites australis* and *Typha orientalis* coastal freshwater wetland. These communities were also subject to stock grazing and weed infestation and will therefore require management actions addressing these issues in particular.

Management

Management of the offset sites will be undertaken in accordance with a Conservation Management Plan that will address standard management actions such as weed management, feral animal control, management of retained vegetation, fire management, buffer zones, management of edge effects, management of hydrological changes, habitat enhancement (e.g.; for green and golden bell frog) rehabilitation measures, and monitoring. Of particular relevance for these two sites will be weed management and stock management.

The Conservation Management Plan is to be prepared following confirmation with OEH that the site is suitable for a Conservation Agreement (discussed below). The Northern Offset area will not include the Hunter Water pipeline that runs north-south through the site. The pipeline is on land owned by Hunter Water and is a separate lot to the offset. Access to maintain the pipeline or any other infrastructure will not be inhibited by the Conservation Management Plan.

Security

To meet the NSW Principles for Offsetting, the mechanism or instrument should provide certainty in the long term – i.e., it should 'run with the land' regardless of ownership and should require management in accordance with pre-determined actions. It is also important however to recognise the circumstances of the site and the flexibility that may be required for future state infrastructure such as the proposed extension to the F3. The RMS has released a concept design for the F3 extension which indicates a preferred route passing through the Aurizon site. The proposed offset area avoids the land required for the route.

There are several options available for long term security of offsets:

- Property Vegetation Plans under the NSW Native Vegetation Act 2003
- Biobanking Agreements under the NSW Threatened Species Conservation Act 1995
- Covenants under the NSW Conveyancing Act 1919
- Conservation Agreements under the NSW National Parks and Wildlife Act 1974
- Trust Agreements under the NSW Nature Conservation Trust Act 2001
- Planning Agreement under the NSW EP&A Act 1979

Aurizon initially proposed to use a Conservation Agreement under the NPW Act 1974 following consultation with OEH (see **Appendix G** for correspondence. Recent advice from OEH is that whilst the southern site may be suitable, the northern area is not appropriate for a Conservation Agreement. Aurison intends to discuss this matter further with OEH, however Aurizon ackneoledges that is a Conservation Agreement is not suitable for the northern site, Aurizon can instead use an alternative legal agreement to secure the conservation outcome in this area. For example a Planning Agreement under the EP&A Act can provide legal security to the obligation to manage the offset area for conservation purposes. This will be investigated and then incorporated into the Conservation Management Plan for the site.

Credits generated

The Biobanking Assessment Methodology has been used to calculate the credits generated by the proposal. These are contained in the **Table 10**.

Table 10 Credits generated by Offsets

		Development			Offset			Balance
Veg code	Vegetation name	Area (ha)	Credits required	Credits/ha	Area (ha)	Credits generated	Credits/ha	
HU532	Coastal floodplain sedgelands,	2.07	41	20	0.61	5	8	-36
HU673	Phragmites australis and Typha orientalis coastal freshwater	1.32	19	14	12.8	130	10	111

HU606	Saltmarsh	0.35	7	20	7.48	72	10	65
HU635	Swamp Oak swamp forest	8.26	320	39	32.69	240	7	-80
		12	387		53.58	447		60

6.3.4 Evaluation of Offset Strategy

An evaluation of the impacts and offsets has been undertaken using the Biobanking Assessment Methodology (DECC 2008). An explanation of some of the information used in the assessment (assessment circles, connectivity) in contained in **Appendix H**. **Table 10** provides a summary of credits required to offset the loss of native vegetation as well as the number of credits generated by the proposed offsets. The outcome is that credit requirements are met for two out of the four biometric vegetation communities, with an over-all credit surplus of 60. The Coastal floodplain sedgelands, rushlands and forblands, which is 36 credits short is offset by the surplus credits for the Phragmites australis BVT, both being of similar vegetation class. The Swamp Oak community is in greater deficit however this is unavoidable in a design sense. The better quality patches of this vegetation type are protected within the offset area and the poorer quality are impacted by the project. In terms of the *OEH Interim Policy on Assessing Impacts and Offsets of Part 3A Development*, achieving an "improve or maintain" outcome by the project is not possible as red-flagged EECs are being impacted. A Tier 2 outcome was not possible because of the design requirements of the project and the lack of additional Swamp Oak Forest to rehabilitate. A Tier 3 outcome is however achieved given the over-all surplus of credits generated by the project and an offset ratio of more than 4:1 (i.e., 53 ha offset to 12 ha impact). The offsets are also consistent with the OEH Principles for Offsetting as described in **Table 11**. In conclusion the Offset Strategy represents a positive outcome.

Table 11 Comparison to OEH Offsetting Principles

Impacts must avoided first by using prevention and mitigation measures	The TSF project undertook avoidance where possible and has proposed mitigation measures.
All regulatory requirements must be met	The project is to be assessed under Part 3A of the EP&A Act and will therefore meet regulatory requirements.
Offsets must never reward ongoing poor performance	Aurizon does not have a record of poor performance.
Offsets should complement other government programs	The two offset sites are within the Hexham Swamp area which has been subject to significant rehabilitation funding over the past decade. The protection and management of 53 hectares will complement this program.
Offsets must be underpinned by sound ecological principles	The offsets will provide for in-situ conservation and will be undertaken in accordance with a Conservation Management Plan
Offsets should aim to result in a net improvement in biodiversity over time	Offsets will deliver an over-all credit surplus and will be managed in accordance with a management plan so that biodiversity values are improved over time.
Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs	Offsets will be secured via a Conservation Agreement under the NP&W Act or similar.

Offsets should be agreed prior to the impact occurring	Offsets are proposed as part of the Environmental Assessment.
Offsets must be quantifiable and the benefits reliably estimated	The offsets have been calculated in line with the Biobanking assessment method.
Offsets must be targeted	Offsets targeted Swamp Oak Forest and Phragmites Australis communities to the maximum extent possible on the site.
Offsets must be appropriately located	Offsets are located on the same site as the development.
Offsets must be supplementary	No management obligations for these communities currently exist on the site.
Offsets and their actions must be enforceable through development consent conditions, license conditions, conservation agreements or a contract.	A Conservation Agreement under the NP&W Act is proposed.

7 Conclusion

This report documents the results of flora and fauna surveys, including previous investigations that have been completed for the Aurizon Train Support Facility at Hexham, NSW. Surveys were completed in 2007 and 2008 by EcoBiological (2008) and EcoHub (2009), with Eco Logical Australia undertaking supplementary surveys in January and February 2011. The combined efforts of survey are considered adequate and have been adapted from the Threatened Biodiversity and Assessment Guidelines (DEC 2004).

Three EEC's occur in the study area: *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions; Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*; and *Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions.*

No threatened flora species were recorded within the study area, though *Zannichellia palustris* was considered a potential occurrence.

Eleven threatened fauna species were recorded within the study area and an additional 6 threatened fauna species were considered likely to occur. Six Migratory species listed under the EPBC Act are also considered likely to occur.

The majority of the area proposed to be affected on the site comprises cleared/disturbed land or rehabilitation, containing both native and non-endemic species. However, there will be an impact to approximately 12.0 hectares of native vegetation, 7.74 hectares of which is considered to be endangered ecological community. These losses are caused by direct impact of clearing. The magnitude of this impact has been assessed in **Appendix C**, with the result being that no threatened species or communities are considered likely to be significantly affected by the proposal.

Indirect impacts such as changes to hydrological regimes were also assessed, however surface and groundwater analysis indicates that there will be only very minor changes away from the areas being filled for development and therefore it is not expected that there will be changes to the remaining GDEs.

A Biobanking Assessment on the proposed development and proposed offset lands was completed to determine if sufficient credits would be generated on the offset lands to achieve the 'improve or maintain' outcome according to the Methodology. The proposal will achieve a mitigated loss however the project will ultimately generate more credits than are being impacted.

Statutory considerations that have been addressed include impacts on SEPP14 Coastal Wetland with approximately 4.63 ha of degraded SEPP14 wetland being directly affected.

A referral of the project under the EPBC Act has been made, and has been determined by SEWPaC to not be a controlled action.

In conclusion, whilst the project will have ecological impacts, those impacts are to disturbed vegetation and habitat. The provision of an on-site conservation outcome more than adequately mitigates this impact.

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Appendix A: Threatened Flora and Fauna Likelihood of Occurrence

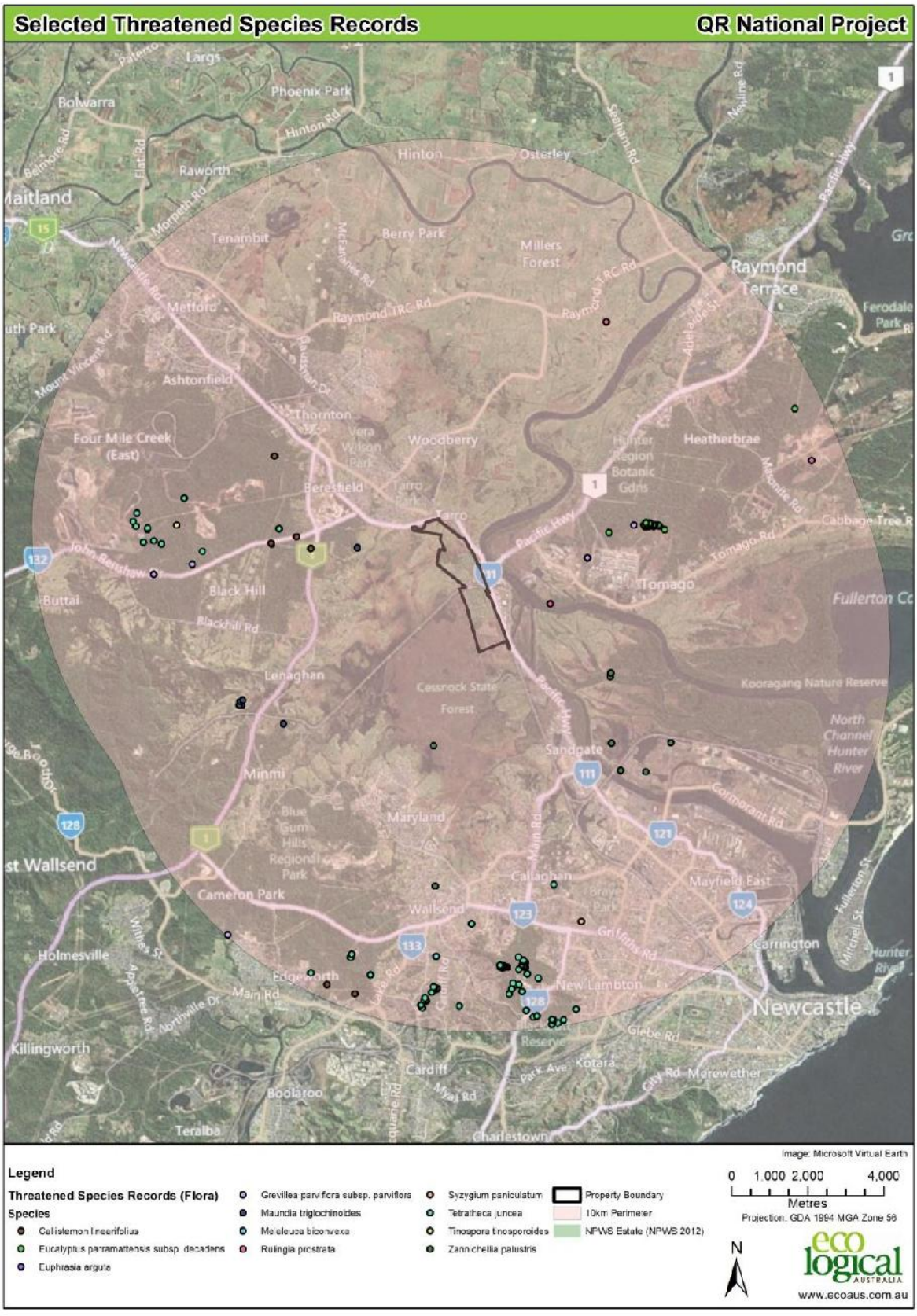

Figure 10: Threatened flora species recorded within 10km of the study area and a figure showing the nearest records of *Lindernia alsinoides* and *Asperula asthenes*.

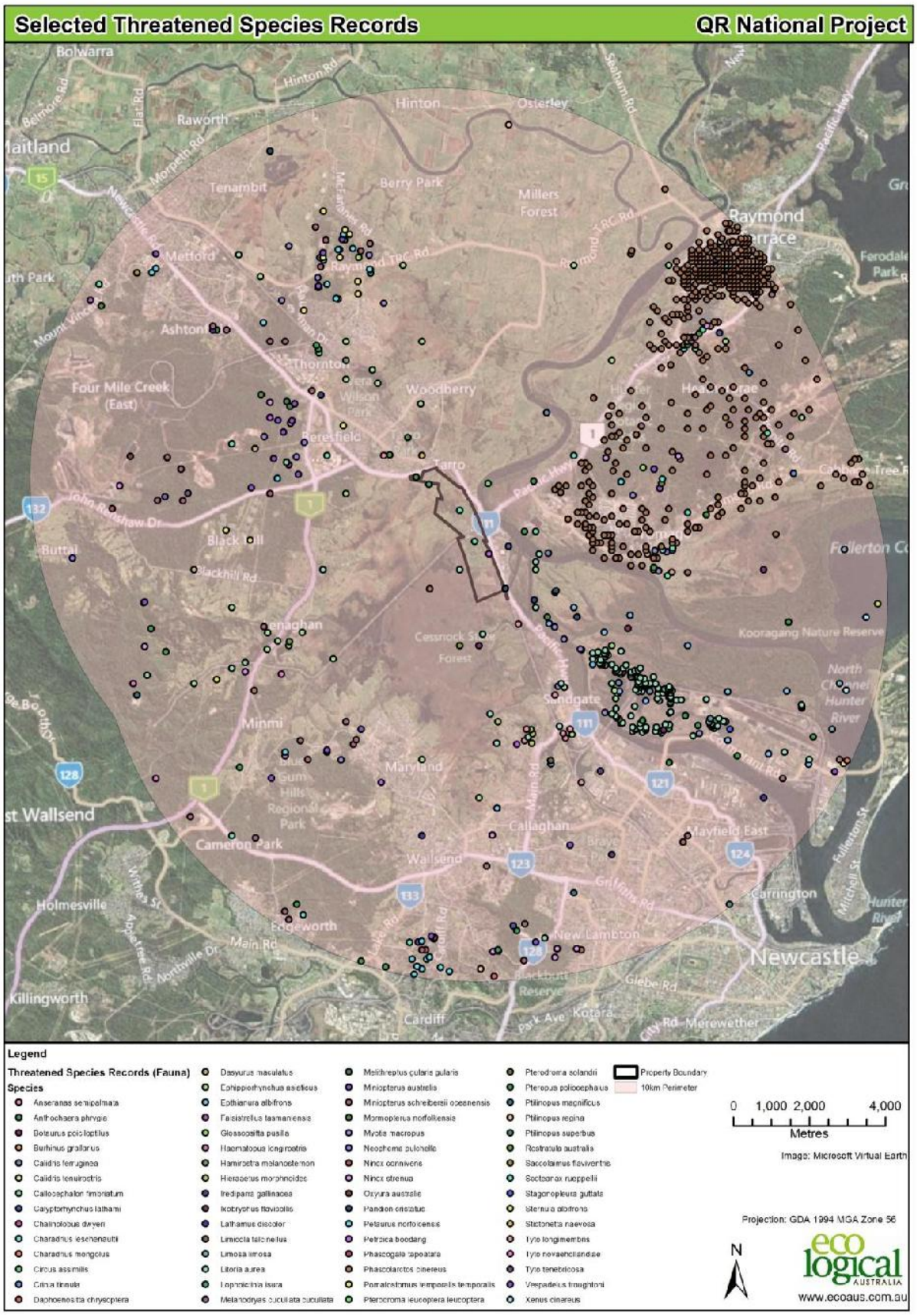

Figure 11: Threatened fauna species recorded within 10kmof the study area.

An assessment of likelihood of occurrence was made for threatened flora species identified from the database search. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal site, results of the field survey and professional judgement. The terms for likelihood of occurrence are defined below:

- "yes" = the species was or has been observed on the site
- "likely" = a medium to high probability that a species uses the site
- "potential" = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "unlikely" = a very low to low probability that a species uses the site
- "no" = habitat on site and in the vicinity is unsuitable for the species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Allocasuarina defungens	Dwarf Heath She-oak	E	E	Found only in NSW from the Nabiac area, north-west of Forster, to Byron Bay on the NSW north coast (DECC 2007). *A. defungens* is a straggly oak about 2m high with blue-green foliage found in heath on sand (sometimes clay and sandstone soils), and swamp sclerophyll forest margins (DECC 2007). The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (DECC 2007).	No
Asperula asthenes	Trailing Woodruff	V	V	Asperula asthenes occurs only in NSW, in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area (DEC 2005). It grows in damp sites often along river banks (Harden 1993).	Unlikely. The site has had a long history of disturbance and there are no nearby records.
Callistemon linearifolius	Netted Bottlebrush	V	-	Grows in dry sclerophyll forest on the coast and adjacent ranges (DECC 2007). *C. linearifolius* has been recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (DECC 2007).	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Cryptostylis hunteriana	*Leafless Tongue Orchid*	V	V	It is known from a range of vegetation communities including swamp-heath and woodland (DECC 2007). The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (DECC 2007). Bell (2001) has identified Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland as potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (DECC 2007; Bell 2001).	Unlikely
Eucalyptus parramattensis spp. *decadens*	Drooping Red Gum	V	V	There are two separate meta-populations of Drooping Red Gum. The Kurri Kurri meta-population is bordered by Cessnock—Kurri Kurri in the north and Mulbring—Abedare in the south (DECC 2007). Large aggregations of the sub-species are located in the Tomalpin area. The Tomago Sandbeds meta-population is bounded by Salt Ash and Tanilba Bay in the north and Williamtown and Tomago in the south (DECC 2007). Drooping Red Gum generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high (DECC 2007). It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland (DECC 2007). Often where this species occurs, it is a community dominant. Flowers from November to January.(DECC 2007).	No
Grevillea parviflora subsp. *parviflora*	Small Flower Grevillea	V	V	Occurs on sandy clay loam soils, often with lateritic ironstone gravels (DECC 2007). Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine-grained sandstones. Soil landscapes include Lucas Heights and Berkshire Park (DECC 2007). Often occurs in open, slightly disturbed sites such as along tracks. Flowering has been recorded between July to December as well as April-May (DECC 2007).	No
Lindernia alsinoides	Noah's False Chickweed	E	-	Lindernia alsinoides occurs north from Bulahdelah, including Shannon Creek, near Grafton, where it grows in damp paperbark swamp with Melaleuca alternifolia and Melaleuca quinquenervia (DEC 2005).	Unlikely. The site has had a long history of disturbance and there are no nearby records

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Maundia triglochinoides	*Maundia triglochinoides*	V	-	Restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct (DEC 2005). Maundia triglochinoides is an aquatic herbaceous plant found in swamps or shallow fresh water on heavy clay on the north and central NSW coast.	Unlikely and not found despite searches at the appropriate time of year.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Associated with damp habitats, such as Coastal Narrabeen Moist Forest, Riparian Melaleuca Swamp Woodland (LMCC 2001). This species may occur in dense stands forming a narrow strip adjacent to watercourses, in association with other *Melaleuca* species or as an understorey species in wet forest (NSW Scientific Committee 1998). Flowering occurs over just 3-4 weeks in September and October (DECC 2007).	No
Persicaria elatior	Tall Knotweed	V	V	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (DECC 2007).	No
Pterostylis gibbosa	Illawarra Greenhood	E	E	Associated with seasonally hard setting clay soils with approximately 1000mm of rainfall (NPWS 1997). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum *Eucalyptus tereticornis*, Wollybutt *E. longifolia* and White Feather Honey-myrtle *Melaleuca decora*. Near Nowra, the species grows in an open forest of Spotted Gum *Corymbia maculata*, Forest Red Gum and Grey Ironbark *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark *E. crebra*, Forest Red Gum and Black Cypress Pine *Callitris endlicheri.* The Illawarra Greenhood is a deciduous orchid that is only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. The leaf rosette grows from an underground tuber in late summer, followed by the flower stem in winter and flowers in spring.	Unlikely
Rulingia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum (*Eucalyptus pauciflora*) Woodland at Rose Lagoon; Blue leaved Stringybark (*E. agglomerata*) Open Forest at Tallong; and in Brittle Gum (*E. mannifera*) Low Open Woodland at Penrose; Scribbly Gum (*E. haemostoma*)/ Swamp Mahogany (*E. robusta*) Ecotonal Forest at Tomago (DECC 2007). Associated native species may include *Imperata cylindrica*, *Empodisma minus* and *Leptospermum continentale* (*ibid*). Appears to respond positively to some forms of disturbance (eg. some Victorian records are from gravel road surfaces and the Tomago population is on an area previously subject to sandmining); however, there are conflicting reports about the response of the species to fire (*ibid*).	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Tetratheca juncea	Black-eyed Susan	V	V	Occurs on predominantly low nutrient soils with a dense grassy understorey of grasses although it has been recorded in heathland and moist forest (DECC 2007). It is associated with dry open forest or woodland habitats dominated by Corymbia gummifera, E. capitellata, E. haemastoma and Angophora costata (Payne 1993). Themeda australis is generally the dominant ground cover (Payne 1993). T. juncea also displays a preference for southern aspect slopes, although is slopes with different aspects (DECC 2007). Flowers July to December.	Unlikely
Zannichellia palustris		E	—	*Zannichellia palustris* inhabits shallow, still to slowly moving, waterbodies which contain either fresh or brackish waters (NSW Fisheries 2002, Greenwood 2001). The species appears to prefer ephemeral habitats which dry out completely. Winning (1992) suggests the species prefers fresh to brackish water adjacent to tidal estuaries, as both known populations occurred in previously estuarine areas which had been separated from tidal flows by control structures.	Potential
FROGS					
Litoria aurea	Green and Golden Bell Frog	E	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2007). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DECC 2007). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–Eleocharis sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1993). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish *(Gambusia holbrooki)* (DECC 2007).	Potential

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Littlejohn's Tree Frog has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria (DECC 2007). It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. I t appears to be restricted to sandstone woodland and heath communities at mid to high altitude (NSW Scientific Committee 2000). It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer (NSW Scientific Committee 2000). It hunts either in shrubs or on the ground. Breeding is triggered by heavy rain and can occur from late winter to autumn, but is most likely to occur in spring when conditions are favourable. Males call from low vegetation close to slow flowing pools. Eggs and tadpoles are mostly found in slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools (DECC 2007).	Unlikely
Mixophyes balbus	Stuttering Frog	E	V	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DECC 2007) that are generally characterised by deep leaf litter or thick cover from understorey vegetation (Ehmann 1997). Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans (Ehmann 1997) or still water environments (NSW Scientific Committee 2002).	Unlikely
Mixophyes iteratus	Giant Barred Frog	E	E	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, wet sclerophyll forests and swamp sclerophyll forest (DECC 2007; Ehmann 1997). This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997). This species is not known from riparian vegetation disturbed by humans (NSW Scientific Committee 1999). During breeding eggs are kicked up onto an overhanging bank or the streams edge (DECC 2007).	Unlikely
DIURNAL BIRDS					
Anthochaera Phrygia *(aka Xanthomyza phrygia)*	Regent Honeyeater	E	E & M	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*Casuarina cunninghamiana*) (Garnett 1993). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have been observed to be utilised (NPWS 1997). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Anseranas semipalmata	Magpie Goose	V	M	Activities centred on terrestrial sedge-dominated wetlands; mainly those on floodplains of rivers (Marchant & Higgins 1993; Simpson & Day 1999).	Yes. Recorded on site by EcoHub(2009)
Botaurus poiciloptilus	Australasian Bittern	V	-	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1993). Reedbeds, swamps, streams, estuaries (Simpson & Day 1999).	Yes. Recorded on site by EcoHub(2009)
Calidris ternuirostris	Great Knot	V	-	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (DECC 2007). Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms (Morris 1989; Higgins & Davies 1996).	Unlikely
Callocephalon fimbriatum	Gang-gang Cockatoo	V-E2	-	During summer in dense, tall, wet forests of mountains and gullies, alpine woodlands (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).	Unlikely
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).	Unlikely
Charadrius leschenaultii	Greater Sand Plover	V	-	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores (DECC 2007)	Unlikely
Charadrius mongolus	Lesser Sand Plover	V	M	Favours coastal areas including beaches, mudflats and mangroves where they forage (DECC 2007). They may be seen roosting during high tide on sandy beaches or rocky shores (DECC 2007).	Unlikely
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).	Some marginal potential

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Haematopus longirostris	Pied Oystercatcher	V	-	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries (Marchant & Higgins 1993, Simpson & Day 1999).	Unlikely
Hamirostra melanosternon	Black-breasted Buzzard	V	-	Open forests, riverine woodlands, scrubs and heathlands (Simpson and Day 1999).	Unlikely
Irediparra gallinacea	Comb-crested Jacana	V	-	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	Potential
Ixobrychus flavicollis	Black Bittern	V	-	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007).	Potential
Lathamus discolor	Swift Parrot	E	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts (Blakers et al. 1984; Schodde and Tidemann 1986; Forshaw and Cooper 1981). Hence, in this region, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (DECC 2007).	Unlikely
Limicola falcinellus	Broad-billed Sandpiper	V	M	The eastern form of the Broad-billed Sandpiper breeds in northern Siberia before migrating southwards in winter to Australia (DECC 2007). In Australia, Broad-billed Sandpipers over-winter on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast (DECC 2007). In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary (DECC 2007). There are few records for inland NSW (DECC 2007). Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat (DECC 2007). Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons (DECC 2007). Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches.	Unlikely
Limosa limosa	Black-tailed Godwit	V	-	Primarily found along the coast on sandspits, lagoons and mudflats (DECC 2007). The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes (Pizzey and Knight 1997; Higgins & Davies 1996).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Hieraaetus morphnoides	Little Eagle	V	-	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland and forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (BIB, 2006).	Yes. Recorded on site.
Lophoictinia isura	Square-tailed Kite	V	-	In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, DECC 2007). May be recorded inland along timbered watercourses (DECC 2007). In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt (*Eucalyptus logifloria*), Spotted Gum (*E. maculata*), or Peppermint Gum (*E. elata, E. smithii*) (DECC 2007).	Unlikely
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Predominantly associated with box-ironbark association woodlands and River Red Gum (NSW Scientific Committee, 2001). Also associated with drier coastal woodlands of the Cumberland Plain and the Hunter, Richmond and Clarence Valleys (NSW Scientific Committee, 2001).	Unlikely
Neophema pulchella	Turquoise Parrot	V	-	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (DECC 2007). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	Unlikely
Oxyura australis	Blue-billed Duck	V	-	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DECC 2007). The species is completely aquatic, swimming low in the water along the edge of dense cover (DECC 2007). It will fly if disturbed, but prefers to dive if approached (DECC 2007). Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (DECC 2007). Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECC 2007).	Unlikely
Pandion haliaetus	Osprey	V	-	Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). Osprey generally prefer emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).	Unlikely
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (NSW Scientific Committee 2001). This species avoids very wet areas (Blakers et al. 1984).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Pterodroma leucoptera leucoptera	Gould's Petrel	V	-	Marine	Unlikely
Pterodroma solandri	Providence Petrel	V	-	Marine	Unlikely
Ptilinopus magnificus	Wompoo Fruit-Dove	V	-	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Marchant and Higgins 1999; DECC 2007). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Marchant and Higgins 1999; DECC 2007).	Unlikely
Ptilinopus superbus	Superb Fruit-Dove	V	-	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms (DECC 2007). It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees (ibid.). Part of the population is migratory or nomadic (ibid.). At least some of the population, particularly young birds, moves south through Sydney, especially in autumn (ibid.). Breeding takes place from September to January (ibid.). Will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984).	Unlikely
Rostratula australis (a.k.a. R. benghalensis)	Painted Snipe (Australian subspecies)	E	V	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECC 2007). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (ibid.). Breeding is often in response to local conditions; generally occurs from September to December (DECC 2007). Roosts during the day in dense vegetation (NSW Scientific Committee 2004). Forages nocturnally on mud-flats and in shallow water (DECC 2007). Feeds on worms, molluscs, insects and some plant-matter (ibid.).	Potential
Stagonopleura guttata	Diamond Firetail	V	-	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (DECC 2007). It is often found in riparian areas and sometimes in lightly wooded farmland (DECC 2007). Appears to be sedentary, though some populations move locally, especially those in the south (DECC 2007).	Unlikely
Sterna albifrons	Little Tern	E	-	Almost exclusively coastal, preferring sheltered areas (DECC 2007), however may occur several kilometres inland in harbours, inlets and rivers (Smith 1990). Australian birds breed on sandy beaches and sand spits (Simpson & Day 1999).	Unlikely
Stictonetta naevosa	Freckled Duck	V	-	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DECC 2007).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Xanthomyza phrygia	Regent Honeyeater	E	E, M	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*Casuarina cunninghamiana*) (Garnett 1993). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have been observed to be utilised (NPWS 1997). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Unlikely
Xenus cinereus	Terek Sandpiper	V	M	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east (DECC 2007). The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary (DECC 2007). In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries (DECC 2007). Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools (DECC 2007). Generally roosts communally amongst mangroves on dead trees, often with related wader species (DECC 2007).	Unlikely
NOCTURNAL BIRDS					
Ninox connivens	Barking Owl	V	-	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by Melaleuca species in the tropics (DECC 2007). It usually roosts in dense foliage in large trees such as River She-oak (*Allocasuarina cunninghamiana*), other Casuarina and Allocasuarina, eucalypts, Angophora, Acacia and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Unlikely
Ninox strenua	Powerful Owl	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Tyto novaehollandiae	Masked Owl	V	-	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DECC 2007) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	Unlikely
Tyto capensis	Grass Owl	V	—	Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey and Knight, 1997). The Grass Owl nests on the ground within dense tall grass, sedges, reeds and even sugarcane plantations (Pizzey and Knight, 1997). The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland (Pizzey and Knight, 1997).	Yes. Recorded on site.
Tyto tenebricosa	Sooty Owl	V	-	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).	Unlikely
MAMMALS (EXCLUDING BATS)					
Dasyurus maculatus *Dasyurus maculatus maculatus*	Spotted-tailed Quoll Spotted-tailed Quoll (SE Mainland Population)	V -	- E	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007j), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	Unlikely
Petaurus norfolcensis	Squirrel Glider	V	-	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	Unlikely
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	Preferred habitat is Dry Open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (DECC 2007).	Unlikely
Phascolarctos cinereus	Koala	V	V	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis	Unlikely
Potorous tridactylus *Potorous tridactylus tridactylus*	Long-nosed Potoroo Long-nosed Potoroo (SE Mainland Population)	V -	- V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Unlikely
Pseudomys novaehollandiae	New Holland Mouse	-	V	Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 ha to 1.4 ha (TSSC, 2010).	Unlikely
MAMMALS (BATS)					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	Potential
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Prefers moist habitats with trees taller than 20m (DECC 2007). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DECC 2007).	Yes. Recorded on site.
Miniopterus australis	Little Bent-wing Bat	V	-	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (DECC 2007). Breeding occurs in caves, usually in association with M. schreibersii (Environment Australia 2000, DECC 2007).	Yes. Recorded on site.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	Potential
Mormopterus norfolkensis	East Coast Freetail Bat	V	-	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).	Yes. Recorded on site.
Myotis adversus	Large-footed Myotis	V	-	Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, as long as they are close to water (Churchill 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains (Churchill 1998). However the species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998).	Yes. Recorded on site.
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Yes. Recorded on site.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	Potential

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Yes. Recorded on site.
Vespadelus troughtoni	Eastern Cave Bat	V	-	Inhabit tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). Has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	Unlikely
MIGRATORY TERRESTRIAL SPECIES LISTED UNDER EPBC ACT					
Apus pacificus	Fork-tailed Swift	-	M	Sometimes travels with Needletails. Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas (Simpson & Day 1999).	Potential
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993).	Potential
Hirundapus caudacutus	White-throated Needletail	-	M	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1993).	Potential
Merops ornatus	Rainbow Bee-eater	-	M	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Doyle 1988). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (ibid). Nest is a chamber a the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (*ibid*).	Unlikely
Monarcha melanopsis	Black-faced Monarch	-	M	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Myiagra cyanoleuca	Satin Flycatcher	-	M	Wetter, denser forest, often at high elevations (Simpson & Day 2004).	Unlikely
Rhipidura rufifrons	Rufous Fantail	-	M	The Rufous Fantail is a summer breeding migrant to southeastern Australia (Morcombe, 2004). The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe, 2004). Open country may be used by the Rufous Fantail during migration (Morcombe, 2004).	Unlikely
Xanthomyza phrygia	Regent Honeyeater	E	E, M	SEE DIURNAL BIRDS ABOVE	SEE DIURNAL BIRDS ABOVE
MIGRATORY WETLAND SPECIES LISTED UNDER EPBC ACT					
Actitis hypoleucos	Common Sandpiper	—	M	In Australia, the Common Sandpiper is found in coastal or inland wetlands, both saline and fresh. It is found mainly on muddy edges or rocky shores. During the breeding season in the northern hemisphere, it prefers freshwater lakes and shallow rivers. (BIB, 2006)	Unlikely
Ardea alba	Great Egret	-	M	The Great Egret is common and widespread in Australia (McKilligan, 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan, 2005).	Yes. Recorded on site.
Ardea ibis	Cattle Egret	-	M	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan, 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan, 2005).	Yes. Recorded on site.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Anseranas semipalmata	Magpie Goose	V	M	Now confined to northern Australia, principally the Fitzroy River and east Kimberley, WA, northern Northern Territory, coastal Cape York Peninsula and patchily through eastern Queensland. Small numbers have returned to north-east New South Wales, and re-introduced successfully to Victoria, where populations expanding in south-west and on the Gippsland Plain, and South Australia (Marchant and Higgins, 1990, P. Menkhorst). Magpie Geese live in shallow swamps and associated grassland, feeding on seeds or tubers and green grass (Frith and Davies, 1961, Whitehead and Tschirner, 1992, Wilson, 1997). During the wet season, the geese usually nest in extensive colonies. They move hundreds of kilometres to perennial swamps in the dry season (Frith and Davies, 1961, Bayliss, 1989, Bayliss and Yeomans, 1990).	Yes. Recorded by EcoHub (2009).
Arenaria interpres	Ruddy Turnstone	-	M	Frequents beaches along the coast of NSW (DNR 2000). Flies from Siberia or Alaska to Australia in August - September each year (*ibid*).	Unlikely
Calidris acuminata	Sharp-tailed Sandpiper	-	M	It prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewerage treatment ponds, flooded grasslands, mudflats, mangroves, rocky shores and beaches.	Unlikely
Calidris canutus	Red Knot	—	M	Red Knots are widespread around the Australian coast, less in the south and with few inland records. Small numbers visit Tasmania and off-shore islands. It is widespread but scattered in New Zealand. They breed in North America, Russia, Greenland and Spitsbergen. Red Knots are a non-breeding visitor to most continents. (BIB, 2006)	Unlikely
Calidris ferruginea	Curlew Sandpiper	-	M	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes (Morcombe, 2004).	Unlikely
Calidris ruficollis	Red-necked Stint	—	M	The Red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland. In Australia, Red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores. They may also be seen in saltworks, sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats, flooded paddocks or damp grasslands. They are often in dense flocks, feeding or roosting. (BIB, 2006)	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Charadrius bicinctus	Double-banded Plover	—	M	In Australia, the Double-banded Plover is found mainly on the east coast and Tasmania and is a regular visitor to Norfolk and Lord Howe Islands. It has been recorded occasionaly in Western Australia. It is widespread throughout New Zealand. The Double-banded Plover is found on coastal beaches, mudflats, sewage farms, river banks, fields, dunes, upland tussock grasses and shingle. (BIB, 2006)	Unlikely
Charadrius mongolus	Lesser Sand Plover	V	M	SEE DIURNAL BIRDS ABOVE	Unlikely
Gallinago hardwickii	Latham's Snipe	-	M	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Marchant and Higgins 1999). Occupies a variety of vegetation around wetlands (Marchant and Higgins 1999) including wetland grasses and open wooded swamps (Simpson and Day 1999).	Unlikely
Heteroscelus brevipes	Grey-tailed Tattler	–	M	Grey-tailed Tattlers breed in Siberia and on passage are seen along the East Asian-Australasian Flyway (the migration route to Australia). When non-breeding they are found in China, Philipines, Taiwan, Vietnam, Malay Peninsula, Indonesia, New Guinea, Micronesia, Fiji, New Zealand and Australia. They are more commonly seen in the north of Australia. Grey-tailed Tattlers are usually seen in small flocks on sheltered coasts with reefs and rock platforms or with intertidal mudflats. They are also found in intertidal rocky, coral or stony reefs, platforms and islets that are exposed at high tide, also shores of rock, shingle, gravel and shells and on intertidal mudflats in embayments, estuaries and coastal lagoons, especially those fringed with mangroves. (BIB, 2006)	Unlikely
Limicola falcinellus	Broad-billed Sandpiper	V	M	SEE DIURNAL BIRDS ABOVE	Unlikely
Limosa lapponica	Bar-tailed Godwit	-	M	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. Breeds in Northern Russia, Scandinavia, NW Alaska (DEH 2005a).	Unlikely
Limosa limosa	Black-tailed Godwit	-	M	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats (DEH 2005a). Often found inland in small numbers (ibid). Breeds in Iceland, Nth Atlantic, Europe, Russian and China (*ibid*).	Unlikely
Numenius madagascariensis	Eastern Curlew	-	M	Intertidal coastal mudflats, coastal lagoons, sandy spits (DEH 2005a). Breeds in Russia, NE China (*ibid*).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Numenius minutus	Little Curlew, Little Whimbrel	-	M	The Little Curlew is known to breed in Siberia, with migrants arriving after early April. Southern migration begins in September following the Chinese coast and, after a staging in Mongolia, continues to Northern Australia and New Guinea (Barter 2002). Outside of the breeding season, the species inhabits grasslands, open plains, parklands and mud-flats of Northern Australia (Simpson and Day 1999).	Unlikely
Numenius phaeopus	Whimbrel	-	M	Intertidal coastal mudflats, river deltas and mangroves, occasionally sandy beaches (DEH 2005a). Breeds Siberia and Alaska (*ibid*.).	Unlikely
Pluvialis fulva	Pacific Golden Plover	-	M	Breeds North Siberia, Alaska (DEH 2005a). Mainly coastal, beaches, mudflats and sandflats and other open areas such as recreational playing fields in Australia (*ibid*.).	Unlikely
Pluvialis squatarola	Grey Plover	—	M	The Grey Plover breeds around the Arctic regions and migrates to the southern hemisphere, being a regular summer migrant to Australia, mostly to the west and south coasts. It is generally sparse but not uncommon in some areas. It is occasionally found inland. The Grey Plover is almost entirely coastal, being found mainly on marine shores, inlets, estuaries and lagoons with large tidal mudflats or sandflats for feeding, sandy beaches for roosting, and also on rocky coasts. (BIB, 2006)	Unlikely
Rostratula benghalensis (a.k.a. R. Australis)	Painted Snipe	-	M	See: *Rostratula australis*	Unlikely
Xenus cinereus	Terek Sandpiper	V	M	SEE DIURNAL BIRDS ABOVE	Unlikely

Disclaimer: Data extracted from the Atlas of NSW Wildlife and EPBC Protected Matters Report are only indicative and cannot be considered a comprehensive inventory. 'Migratory marine species' and 'listed marine species' listed on the EPBC Act (and listed on the SEWPaC protected matters report) have not been included in this table, since they are considered unlikely to occur within the study area due to the absence of marine habitat.

E = Endangered; E2 = Endangered Population; V = Vulnerable; M = Migratory.

Appendix B: Flora and Fauna Species List

Flora Species List:

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Acanthaceae	*Brunoniella australis*	Blue Trumpet	-	-			**x**
Adiantaceae	*Pellaea falcata*	Sickle Fern	-	-	TR1		
Adiantaceae	*Cheilanthes sieberi*		-	-	TR4		
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair	-	-			x
Aizoaceae	*Tetragonia tetragonioides*	New Zealand Spinach	-	-	oppo	x	
Alismataceae	*Alisma plantago-aquatica*	Water Plantain	-	-	oppo	x	
Amaranthaceae	*Alternanthera philoxeroides**	Alligator Weed	-	-	oppo	x	
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	-	-	oppo	x	
Anacardiaceae	*Schinus areira**	Pepper Tree	-	-	TR1		
Apiaceae	*Hydrocotyle bonariensis**		-	-	oppo		
Apiaceae	*Apium prostratum*	Sea Celery	-	-	oppo		
Apiaceae	*Daucus glochidiatus*	Native Carrot	-	-		x	
Apiaceae	*Centella asiatica*	Pennywort	-	-			x
Apiaceae	*Actinotus minor*	Lesser Flannel Flower	-	-			x

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Apiaceae	*Hydrocotyle peduncularis*		-	-			x
Apiaceae	*Hydrocotyle laxiflora*	Stinking Pennywort	-	-			x
Apiaceae	*Xanthosia tridentata*	Rock Xanthosia	-	-			x
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax	-	-			x
Arecaceae	*Phoenix dactylifera**	Date Palm	-	-	oppo		
Asclepiadaceae	*Araujia sericifera**	Moth Vine	-	-	Q6		
Asclepiadaceae	*Gomphocarpus fruticosus**	Narrow-leaved Cotton Bush	-	-		x	
Asteraceae	*Erechtites valerianifolia**	Brazilian Fireweed	-	-	oppo		
Asteraceae	*Euchiton sp.**		-	-	Q7		
Asteraceae	*Senecio madagascariensis**	Fireweed	-	-	TR1, TR2, TR4, TR5, Q1, Q2, Q5, Q6, Q7	x	
Asteraceae	*Cirsium vulgare**	Spear Thistle	-	-	TR1, TR2, TR4, TR5, Q1, Q5, Q6, Q7	x	x
Asteraceae	*Tagetes minuta**	Stinking Roger	-	-	TR1, TR4	x	
Asteraceae	*Hypochaeris radicata**	Catsear	-	-	TR1, TR4		x
Asteraceae	*Conyza sp.**		-	-	TR1, TR4, TR5, Q1, Q5, Q6, Q7		
Asteraceae	*Bidens pilosa**	Cobbler's Pegs	-	-	TR1, TR5, Q6, Q7	x	
Asteraceae	*Aster subulatus**	Wild Aster	-	-	TR2, Q1, Q2, Q5, Q6		x
Asteraceae	*Cotula coronopifolia**	Water Buttons	-	-	TR3, Q2	x	

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Asteraceae	*Ambrosia tenuifolia**	Lacy Ragweed	-	-	TR4, TR5, Q1, Q2	x	
Asteraceae	*Ageratina adenophora**	Crofton Weed	-	-		x	
Asteraceae	*Ambrosia psilostachya**	Perennial Ragweed	-	-		x	
Asteraceae	*Cassinia arcuata*	Sifton Bush	-	-		x	
Asteraceae	*Conyza albida**	Tall Fleabane	-	-		x	
Asteraceae	*Conyza bonariensis**	Flaxleaf Fleabane	-	-		x	
Asteraceae	*Galinsoga parviflora**		-	-		x	
Asteraceae	*Heterotheca grandiflora**	Telegraph Weed	-	-		x	
Asteraceae	*Senecio linearifolius*		-	-		x	
Asteraceae	*Taraxacum officinale**	Dandelion	-	-		x	
Asteraceae	*Eclipta platyglossa*		-	-		x	
Asteraceae	*Hypochaeris radicata**	Catsear	-	-		x	
Asteraceae	*Lagenifera stipitata*	Blue Bottle-daisy	-	-			x
Azollaceae	*Azolla pinnata*		-	-		x	
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	-	-	oppo		
Brassicaceae	*Capsella bursa-pastoris**	Shepherd's Purse	-	-		x	
Campanulaceae	*Wahlenbergia gracilis*	Australian Bluebell	-	-	TR1	x	
Casuarinaceae	*Casuarina glauca*	Swamp Oak	-	-	TR1, TR4, Q5, Q6	x	
Casuarinaceae	*Allocasuarina littoralis*	Black Sheoak	-	-			x

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Ceratophyllaceae	*Ceratophyllum demersum*	Hornwort	-	-		x	
Chenopodiaceae	*Sarcocornia quinqueflora*		-	-	TR2, Q1, Q2		
Chenopodiaceae	*Atriplex prostrata**		-	-	TR2, Q2	x	
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	-	-	TR5, Q5		
Chenopodiaceae	*Einadia trigonos*	Fishweed	-	-		x	
Clusiaceae	*Hypericum gramineum*	Small St John's Wort	-	-		x	x
Commelinaceae	*Commelina cyanea*	Native Wandering Jew	-	-	oppo		
Convolvulaceae	*Ipomoea purpurea**	Common Morning Glory	-	-		x	
Crassulaceae	*Bryophyllum delagoense **	Mother of millions	-	-	oppo	x	
Cunoniaceae	*Ceratopetalum gummiferum*	Christmas Bush	-	-			x
Cyperaceae	*Bolboschoenus caldwellii*		-	-	TR2, TR3, Q1, Q2, Q3, Q4	x	
Cyperaceae	*Cyperus polystachyos*		-	-	TR4	x	x
Cyperaceae	*Isolepis inundata*		-	-		x	x
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-sedge	-	-		x	x
Cyperaceae	*Eleocharis minuta*		-	-		x	
Cyperaceae	*Cyperus congestus**		-	-		x	
Cyperaceae	*Baumea articulata*	Jointed Twig-rush	-	-			x
Cyperaceae	*Cyperus sesquiflorus*		-	-			x
Cyperaceae	*Baumea rubiginosa*		-	-			x
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge	-	-			x

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Cyperaceae	*Lepidosperma laterale*		-	-			x
Cyperaceae	*Schoenoplectus mucronatus*		-	-			x
Cyperaceae	*Ptilothrix deusta*		-	-			x
Dennstaedtiaceae	*Hypolepis glandulifera*		-	-		x	
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	-	-			x
Dennstaedtiaceae	*Histiopteris incisa*	Bat's Wing Fern	-	-			x
Dicksoniaceae	*Calochlaena dubia*	Common Ground Fern	-	-	TR3		x
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower	-	-			x
Droseraceae	*Drosera peltata*		-	-			x
Epacridaceae	*Astroloma humifusum*	Native Cranberry	-	-			x
Epacridaceae	*Epacris pulchella*		-	-			x
Euphorbiaceae	*Homalanthus populifolius*		-	-		x	
Euphorbiaceae	*Euphorbia peplus**	Petty Spurge	-	-		x	
Euphorbiaceae	*Ricinus communis**	Castor Oil Plant	-	-		x	
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	-	-		x	
Euphorbiaceae	*Amperea xiphoclada*		-	-			x
Fabaceae (Faboideae)	*Trifolium repens**	White Clover	-	-	TR4, TR5, Q6	x	
Fabaceae (Faboideae)	*Trifolium fragiferum**	Strawberry Clover	-	-		x	
Fabaceae (Faboideae)	*Gompholobium latifolium*	Golden Glory Pea	-	-			x

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Fabaceae (Faboideae)	*Pultenaea paleacea*		-	-			x
Fabaceae (Faboideae)	*Bossiaea obcordata*	Spiny Bossiaea	-	-			x
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	-	-			x
Fabaceae (Faboideae)	*Glycine microphylla*		-	-			x
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	-	-	TR1, TR4, TR5, Q6, Q7	x	
Fabaceae (Mimosoideae)	*Acacia longifolia* subsp. *longifolia*	Sydney Golden Wattle	-	-		x	
Fabaceae (Mimosoideae)	*Acacia baileyana*	Cootamundra Wattle	-	-		x	
Fabaceae (Mimosoideae)	*Acacia longifolia*		-	-			x
Fabaceae (Mimosoideae)	*Acacia suaveolens*	Sweet Wattle	-	-			x
Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle	-	-			x
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses	-	-			x
Gentianaceae	*Centaurium erythraea**	Common Centaury	-	-	TR5, Q1, Q5	x	
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern, Tangle Fern	-	-			x
Goodeniaceae	*Goodenia heterophylla*		-	-			x
Goodeniaceae	*Goodenia paniculata*		-	-			x

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Haloragaceae	*Gonocarpus tetragynus*		-	-			x
Haloragaceae	*Gonocarpus teucrioides*	Raspwort	-	-			x
Haloragaceae	*Gonocarpus micranthus* subsp. *micranthus*		-	-			x
Iridaceae	*Patersonia sericea* var. *sericea*		-	-			x
Iridaceae	*Romulea rosea* var. *australis**	Onion Grass	-	-		x	
Juncaceae	*Juncus kraussii*		-	-	TR2, TR3, Q1		
Juncaceae	*Juncus acutus**		-	-	TR2, TR3, Q1, Q2, Q3, Q4	x	
Juncaceae	*Juncus subsecundus*		-	-	TR4, Q5		x
Juncaceae	*Juncus continuus*		-	-		x	
Juncaceae	*Juncus planifolius*		-	-			x
Juncaceae	*Juncus prismatocarpus*		-	-			x
Juncaginaceae	*Triglochin striatum*	Streaked Arrowgrass	-	-	oppo		
Juncaginaceae	*Triglochin microtuberosum*		-	-		x	
Lauraceae	*Cinnamomum camphora**	Camphor Laurel	-	-	TR5		
Lauraceae	*Cassytha glabella*		-	-			x
Lemnaceae	*Lemna* sp.		-	-	oppo		
Lemnaceae	*Spirodela punctata*		-	-		x	
Liliaceae	*Lilium formosanum**	Tiger Lily	-	-		x	

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Lindsaeaceae	*Lindsaea linearis*	Screw Fern	-	-			x
Lobeliaceae	*Pratia purpurascens*	Whiteroot	-	-			x
Lomandraceae	*Lomandra glauca* subsp. *glauca*		-	-			x
Lomandraceae	*Lomandra obliqua*		-	-			x
Lomandraceae	*Lomandra confertifolia* subsp. *rubiginosa*		-	-			x
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*		-	-			x
Lomandraceae	*Lomandra longifolia* var. *longifolia*		-	-			x
Malaceae	*Cotoneaster* sp.*		-	-	oppo		
Malvaceae	*Malva* sp.*		-	-	TR1, TR4		
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne	-	-	TR4, TR5, Q7	x	
Malvaceae	*Modiola caroliniana**	Red-flowered Mallow	-	-		x	
Malvaceae	*Hibiscus sp.**		-	-		x	
Marsileaceae	*Marsilea hirsuta*		-	-	oppo	x	
Meliaceae	*Melia azedarach*	White Cedar	-	-	Q7	x	
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark	-	-	oppo	x	x
Myrtaceae	*Corymbia maculata*	Spotted Gum	-	-	oppo	x	x
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	-	-	oppo	x	
Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved Paperbark	-	-	oppo	x	
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree	-	-	oppo	x	

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Myrtaceae	*Eucalyptus acmenoides*		-	-	oppo		
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany	-	-	TR1	x	
Myrtaceae	*Angophora costata*	Sydney Red/Rusty Gum	-	-	TR1		x
Myrtaceae	*Melaleuca armillaris*	Bracelet Honey-myrtle	-	-	TR1, TR4, Q5, Q6, Q7		
Myrtaceae	*Kunzea ambigua*	Tick Bush	-	-		x	x
Myrtaceae	*Eucalyptus botryoides*	Bangalay	-	-		x	
Myrtaceae	*Eucalyptus viminalis*	Ribbon Gum	-	-		x	
Myrtaceae	*Leptospermum laevigatum*	Coast Teatree	-	-		x	
Myrtaceae	*Lophostemon confertus*	Brush Box	-	-		x	
Myrtaceae	*Melaleuca hypericifolia*	Hillock bush	-	-		x	
Myrtaceae	*Callistemon citrinus*	Crimson Bottlebrush	-	-		x	
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany	-	-		x	
Myrtaceae	*Melaleuca* sp.		-	-		x	
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush	-	-			x
Myrtaceae	*Eucalyptus capitellata*	Brown Stringybark	-	-			x
Myrtaceae	*Melaleuca decora*		-	-			x
Myrtaceae	*Eucalyptus haemastoma*	Broad-leaved Scribbly Gum	-	-			x

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Myrtaceae	*Eucalyptus pilularis*	Blackbutt	-	-			x
Myrtaceae	*Melaleuca nodosa*	Ball Honeymyrtle	-	-			x
Myrtaceae	*Melaleuca sieberi*		-	-			x
Myrtaceae	*Melaleuca thymifolia*		-	-			x
Myrtaceae	*Corymbia gummifera*	Red Bloodwood	-	-			x
Myrtaceae	*Syncarpia glomulifera*	Turpentine	-	-			x
Myrtaceae	*Leptospermum polygalifolium* subsp. *cismontanum*		-	-			x
Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree	-	-			x
Myrtaceae	*Angophora inopina*	Charmhaven Apple	V	V			x (unsubstantiated record – considered a typo. error)
Najadaceae	*Najas browniana*	Waternymph	-	-		x	
Oleaceae	*Ligustrum sinense**	Small-leaved Privet	-	-		x	x
Onagraceae	*Ludwigia peploides subsp. montevidensis*	Water Primrose	-	-	oppo		
Orchidaceae	*Cryptostylis subulata*	Large Tongue Orchid	-	-			?
Osmundaceae	*Todea barbara*	King Fern	-	-			x
Oxalidaceae	*Oxalis exilis*		-	-			x
Phormiaceae	*Dianella caerulea* var. *caerulea*		-	-			x
Phytolaccaceae	*Phytolacca octandra**	Inkweed	-	-	TR4	x	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	-	-	oppo		
Pittosporaceae	*Billardiera scandens*	Appleberry	-	-			x
Plantaginaceae	*Plantago lanceolata**	Lamb's Tongues	-	-	Q7TR1, TR5, Q1, Q6	x	

Family	Scientific Name	Common Name	TSC Act/ NPWS Act	EPBC Act	ELA 2011	Ecobiological	Eco Hub
Poaceae	*Lachnagrostis filiformis*		-	-	oppo	x	
Poaceae	*Hordeum leporinum**	Barley Grass	-	-	oppo	x	
Poaceae	*Lolium perenne**	Perennial Ryegrass	-	-	oppo	x	
Poaceae	*Pennisetum clandestinum**	Kikuyu Grass	-	-	oppo	x	
Poaceae	*Echinochloa crus-galli**	Barnyard Grass	-	-	oppo		
Poaceae	*Eragrostis curvula**	African Lovegrass	-	-	oppo		
Poaceae	*Paspalum distichum*	Water Couch	-	-	oppo		
Poaceae	*Sporobolus virginicus*		-	-	Q2		
Poaceae	*Setaria gracilis**	Slender Pigeon Grass	-	-	Q7		
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	-	-	TR1		x
Poaceae	*Melinis repens**	Red Natal Grass	-	-	TR1, Q7	x	
Poaceae	*Cynodon dactylon*	Common Couch	-	-	TR1, TR2, TR4, TR5, Q1, Q2, Q5, Q7	x	
Poaceae	*Chloris gayana**	Rhodes Grass	-	-	TR1, TR4, TR5, Q6, Q7	x	
Poaceae	*Phragmites australis*	Common Reed	-	-	TR2, TR3, TR5, Q1, Q2, Q3, Q4	x	
Poaceae	*Paspalum vaginatum*	Salt-water Couch	-	-	TR3		
Poaceae	*Echinopogon caespitosus*	Bushy Hedgehog-grass	-	-	TR4		
Poaceae	*Axonopus fissifolius**	Narrow-leafed Carpet Grass	-	-	TR4, Q5		
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass	-	-	TR4, Q5		

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Poaceae	*Ehrharta erecta**	Panic Veldtgrass*	-	-	TR4, TR5, Q5		
Poaceae	*Paspalum dilatatum**	Paspalum	-	-	TR5, Q1	x	x
Poaceae	*Andropogon virginicus**	Whisky Grass	-	-		x	x
Poaceae	*Briza maxima**	Quaking Grass	-	-		x	
Poaceae	*Chloris truncata*	Windmill Grass	-	-		x	
Poaceae	*Deyeuxia quadriseta*		-	-		x	
Poaceae	*Holcus lanatus**	Yorkshire Fog	-	-		x	
Poaceae	*Isachne globosa*	Swamp Millet	-	-		x	
Poaceae	*Poa labillardieri*	Tussock	-	-		x	
Poaceae	*Setaria verticillata**	Whorled Pigeon Grass	-	-		x	
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	-	-		x	
Poaceae	*Sporobolus africanus**	Parramatta Grass	-	-		x	
Poaceae	*Chloris virgata**	Feathertop Rhodes Grass	-	-		x	
Poaceae	*Panicum effusum*	Poison or Hairy Panic	-	-			x
Poaceae	*Axonopus affinis**	Narrow-leaved Carpet Grass*	-	-			x
Poaceae	*Entolasia stricta*	Wiry Panic	-	-			x
Poaceae	*Panicum simile*	Two-colour Panic	-	-			x
Poaceae	*Themeda australis*	Kangaroo Grass	-	-			x
Poaceae	*Imperata cylindrica*	Blady grass	-	-			x
Poaceae	*Microlaena stipoides* var. *stipoides*		-	-			x
Poaceae	*Austrostipa pubescens*		-	-			x

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Polygonaceae	*Persicaria decipiens*	Spotted Knotweed	-	-	oppo	x	x
Polygonaceae	*Persicaria lapathifolia*	Pale Knotweed	-	-	oppo	x	
Polygonaceae	*Persicaria orientalis**	Princes Feathers	-	-	oppo		
Polygonaceae	*Rumex crispus**	Curled Dock	-	-	TR2	x	
Polygonaceae	*Persicaria hydropiper*	Water Pepper	-	-		x	
Portulacaceae	*Portulaca* sp.*		-	-	TR4, Q7		
Portulacaceae	*Portulaca pilosa**		-	-		x	
Primulaceae	*Anagallis arvensis**	Scarlet/Blue Pimpernel	-	-	TR5		
Proteaceae	*Grevillea robusta*	Silky Oak	-	-	TR5	x	
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*	Coastal Banksia	-	-		x	
Proteaceae	*Grevillea sp.*		-	-		x	
Proteaceae	*Grevillea sericea*		-	-			x
Proteaceae	*Hakea dactyloides*	Finger Hakea, Broad-leaved Hakea	-	-			x
Proteaceae	*Lambertia formosa*	Mountain Devil	-	-			x
Proteaceae	*Lomatia silaifolia*	Crinkle Bush	-	-			x
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	-	-			x
Proteaceae	*Petrophile pulchella*	Conesticks	-	-			x
Proteaceae	*Banksia oblongifolia*	Fern-leaved Banksia	-	-			x
Proteaceae	*Banksia serrata*	Old-man Banksia	-	-			x
Proteaceae	*Isopogon anethifolius*		-	-			x
Proteaceae	*Persoonia levis*	Broad-leaved Geebung	-	-			x

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Proteaceae	*Banksia spinulosa* var. *collina*		-	-			x
Ranunculaceae	*Ranunculus inundatus*	River Buttercup	-	-	oppo	x	
Ranunculaceae	*Clematis aristata*	Old Man's Beard	-	-	oppo		x
Ranunculaceae	*Ranunculus plebeius*		-	-		x	
Ranunculaceae	*Clematis glycinoides*	Headache Vine	-	-		x	
Restionaceae	*Lepyrodia scariosa*		-	-			x
Rosaceae	*Rubus fruticosus* sp. agg.*	Blackberry complex	-	-	oppo	x	x
Rubiaceae	*Opercularia varia*	Variable Stinkweed	-	-			x
Rubiaceae	*Pomax umbellata*		-	-			x
Rutaceae	*Boronia polygalifolia*		-	-			x
Rutaceae	*Zieria smithii*	Sandfly Zieria	-	-			x
Sapindaceae	*Cupaniopsis anacardioides*	Tuckeroo	-	-	TR1	x	
Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	-	-			x
Scrophulariaceae	*Mimulus repens*	Creeping Monkey-flower	-	-	oppo	x	
Scrophulariaceae	*Verbascum virgatum**	Green Mullein	-	-		x	
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsparilla	-	-			x
Solanaceae	*Solanum nigrum**	Black-berry Nightshade	-	-	TR4	x	
Solanaceae	*Solanum mauritianum**	Wild Tobacco Bush	-	-	TR4, TR5, Q6	x	
Sterculiaceae	*Lasiopetalum ferrugineum* var.		-	-			x

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	ferrugineum						
Thymelaeaceae	*Pimelea linifolia subsp. linifolia*		-	-			x
Tremandraceae	*Tetratheca ericifolia*		-	-			x
Typhaceae	*Typha orientalis*	Broad-leaved Cumbungi	-	-	oppo	x	
Verbenaceae	*Lantana camara**	Lantana	-	-	TR1, TR4, TR5, Q5, Q6, Q7	x	
Verbenaceae	*Verbena bonariensis**	Purpletop	-	-	TR1, TR5, Q5, Q6, Q7	x	
Verbenaceae	*Phyla nodiflora**	Carpet Weed	-	-		x	
Verbenaceae	*Verbena rigida**	Veined Verbena	-	-		x	
Violaceae	*Viola hederacea*		-	-			x
Vitaceae	*Cissus antarctica*	Water Vine	-	-			x
Xanthorrhoeaceae	*Xanthorrhoea latifolia* subsp. *latifolia*		-	-			x

* denotes exotic species

Fauna Species List derived from the current survey ELA (2011), EcoBiological (2008) and EcoHub (2009)

CLASS NAME	SCIENTIFIC NAME	COMMON NAME	TSC Act	EPBC Act	ELA (2011)	EcoBiological (2008)	EcoHub (2009)
Amphibia	*Limnodynastes peronii*	Brown-striped Frog	-	-	cp5	x	x
Amphibia	*Litoria peronii*	Peron's Tree Frog	-	-	CP5, CP6,	x	x
Amphibia	*Limnodynastes tasmaniensis*	Spotted Grass Frog	-	-	cp5, cp9	x	x
Amphibia	*Litoria dentata*	Bleating Tree Frog	-	-	cp5, cp9, cp11	x	x
Amphibia	*Litoria fallax*	Eastern Dwarf Tree Frog	-	-	CP6, CP7, CP11	x	x
Amphibia	*Litoria caerulea*	Green Tree Frog	-	-		x	x
Amphibia	*Crinia signifera*	Common Eastern Froglet	-	-			x
Amphibia	*Litoria latopalmata*	Broad-palmed Frog	-	-			x
Amphibia	*Litoria tyleri*	Tyler's Tree Frog	-	-			x
Aves	*Anas castanea*	Chestnut Teal	-	-	opp	x	x
Aves	*Anas superciliosa*	Pacific Black Duck*	-	-	opp	x	x
Aves	*Grallina cyanoleuca*	Magpie-lark	-	-	opp	x	x
Aves	*Hirundo neoxena*	Welcome Swallow	-	-	opp	x	x
Aves	*Vanellus miles*	Masked Lapwing	-	-	opp	x	x
Aves	*Elseyornis melanops*	Black-fronted Dotterel	-	-	opp		x
Aves	*Acrocephalus australis*	Australian Reed-Warbler	-	-	opp		
Aves	*Anthus australis*	Australian Pipit (Richard's - novaeseelandiae)	-	-	opp		
Aves	*Acanthiza nana*	Yellow Thornbill	-	-		x	x
Aves	*Acridotheres tristis*	Common Myna*	-	-		x	x
Aves	*Acrocephalus stentoreus*	Clamorous Reed-Warbler	-	-		x	x
Aves	*Anas gracilis*	Grey Teal	-	-		x	x
Aves	*Anthus novaeseelandiae*	Richard's Pipit	-	-		x	x
Aves	*Ardea alba*	Great Egret	-	-		x	x

CLASS NAME	SCIENTIFIC NAME	COMMON NAME	TSC Act	EPBC Act	ELA (2011)	EcoBiological (2008)	EcoHub (2009)
Aves	*Ardea intermedia*	Intermediate Egret	-	-		x	x
Aves	*Ardea pacifica*	White-necked Heron	-	-		x	x
Aves	*Calidris acuminata*	Sharp-tailed Sandpiper	-	-		x	x
Aves	*Cisticola exilis*	Golden-headed Cisticola	-	-		x	x
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-		x	x
Aves	*Corvus coronoides*	Australian Raven	-	-		x	x
Aves	*Cracticus nigrogularis*	Pied Butcherbird	-	-		x	x
Aves	*Cracticus torquatus*	Grey Butcherbird	-	-		x	x
Aves	*Cygnus atratus*	Black Swan	-	-		x	x
Aves	*Elanus axillaris*	Black-shouldered Kite	-	-		x	x
Aves	*Circus aeruginosus*	Marsh Harrier	-	-			x
Aves	*Eolophus roseicapillus*	Galah	-	-		x	x
Aves	*Falco berigora*	Brown Falcon	-	-		x	x
Aves	*Gallinula tenebrosa*	Dusky Moorhen	-	-		x	x
Aves	*Gymnorhina tibicen*	Australian Magpie	-	-		x	x
Aves	*Haliaeetus leucogaster*	Sea Eagle	-	M		x	x
Aves	*Himantopus himantopus*	Black-winged Stilt	-	-		x	x
Aves	*Malurus cyaneus*	Superb Fairy-wren	-	-		x	x
Aves	*Megalurus gramineus*	Little Grassbird	-	-		x	x
Aves	*Megalurus timoriensis*	Tawny Grassbird	-	-		x	x
Aves	*Neochmia temporalis*	Red-browed Finch	-	-		x	x
Aves	*Ocyphaps lophotes*	Crested Pigeon	-	-		x	x
Aves	*Pachycephala pectoralis*	Golden Whistler	-	-		x	x
Aves	*Phalacrocorax melanoleucos*	Little Pied Cormorant	-	-		x	x
Aves	*Phalacrocorax sulcirostris*	Little Black Cormorant	-	-		x	x
Aves	*Platalea regia*	Royal Spoonbill	-	-		x	x
AVes	*Platycercus eximus*	Eastern Rosella	-	-		x	x
Aves	*Porphyrio porphyrio*	Purple Swamphen	-	-		x	x