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survey & assessment

Ecological Assessment for the Northbank Enterprise Hub:

Lot 1001 DP1127780 Tomago Road, Tomago NSW.

Ecological Assessment:

**Northbank Enterprise Hub, Lot 1001 DP1127780,
Tomago Road, Tomago NSW.**

August 2012

Report prepared for Northbank Enterprise Hub Pty Ltd with instruction from ADW Johnson Pty Ltd.

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Certification

I certify that this Threatened Species Assessment, prepared by **ecobiological** has been produced in accordance with the requirements of Part 3A of the Environmental Planning & Assessment Act 1979 and the Draft Guidelines for Threatened Species Assessment (DEC 2005a), and with regard to the requirements notified by the Director General of the Department of Environment, Climate Change & Water (DECCW 2010).

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Threatened Species Assessment



Executive Summary

ecobiological was commissioned by Northbank Enterprise Hub Pty Ltd (formerly known as WEPL Investments Pty Ltd) with instruction from ADW Johnson Pty Ltd to undertake an ecological assessment for the proposed Northbank Enterprise Hub on Lot 1001 DP1127780 Tomago Road, Tomago NSW.

A list of threatened ecological communities, flora and fauna and migratory/marine species reported from the local area was compiled from data obtained from the National Parks and Wildlife Service (NPWS) Atlas of NSW Wildlife, from the Director General's Requirements and from a variety of other databases and reports. Field surveys were conducted between October 2009 and November 2011.

Flora

A total of 111 plant species (of which 51 were exotic species) were recorded within three defined natural vegetation communities, one regenerating natural vegetation community, one artificial wetland community and one highly disturbed grassland community. The Swamp Mahogany – Paperbark Swamp Forest, Swamp Oak Rushland Forest, Swamp Oak Rushland Forest - Regeneration and Freshwater Wetland Complex communities constitute Threatened Ecological Communities (TECs) under the NSW TSC Act. The Constructed Freshwater Wetland Complex (within the artificial drainage lines) does not constitute a TEC. No threatened flora or ROTAP-listed species were recorded in the study area.

Fauna

A total of 84 species of fauna were recorded across the study area, including nine threatened species listed as vulnerable under the NSW TSC Act (Grey-headed Flying-fox *Pteropus poliocephalus*, Eastern Grass Owl *Tyto longimembris*, Southern Myotis *Myotis macropus*, Eastern Bentwing-bat *Miniopterus oceanensis*, Little Bentwing-bat *Miniopterus australis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Yellow-bellied Sheath-tail-bat *Saccolaimus flaviventris* and Greater Broad-nosed Bat *Scoteanax rueppellii*). The Grey-headed Flying-fox is also listed as vulnerable under the Commonwealth EPBC Act 1999.



Ramsar and SEPP 14 Wetlands

The flooding and hydrology of runoff from smaller storm events are those which have the most potential for impact on aquatic ecology and flora and fauna outside the development area. Assessment and site design has been completed on flooding and hydrological pathways by BMT WBM and ADW Johnson to mimic post development conditions to be the same as pre development conditions for all smaller storm events. Work detailed in the wetland interface strategy of the EA report demonstrates how this has been determined and achieved, negating the risk of impact on aquatic ecology and flora and fauna.

It is considered by **ecobiological** that provided the measures to avoid hydrological change are put in place as detailed in the wetland interface strategy and BMT WBM reporting, there will be no significant hydrological impacts on the adjoining wetland reserves.

Wildlife movement / connectivity

The study area lies near a north-south corridor (Richardson Road) which also runs in an east-west direction to the north of the proposal. This corridor links the Tomago sand beds / Tilligerry area with the Hunter Wetlands National Park as identified in Scotts (2003).

The development of the 239.7 ha site along with the surrounding developments along Tomago Road would likely pose some impediment to flora and fauna dispersal. The proposed conservation lands to the south and southeast on Lot 1002 will continue to provide an east-west corridor however, the proposed development of Lot 1001 will sever a portion of the north-south corridor.

Management and Monitoring Plans

Management plans for the clearing of vegetation, proposed landscaping of the site and for the protection of the adjoining Ramsar and SEPP 14 wetlands against weed invasion, significant alterations to hydrology, disturbance of acid sulphate soils, surface run-off and groundwater are proposed. A monitoring plan to document the ongoing status of retained habitat (Freshwater Wetland Complex and Swamp Oak Forest), a proposed Overflow Wetland Rehabilitation Area, landscaped watercourses and the adjoining Ramsar Wetland / National Park interface is also proposed.



Groundwater and stormwater management plans include monitoring of indirect hydrology impacts on the adjoining Lot 1002, Tomago Wetland Rehabilitation Project, national parks estate and Ramsar wetland.

Key Thresholds

Justification for the proposed development based on the following Key Thresholds is provided below:

- **Actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts**

Avoidance and mitigation measures

A 12.5 ha portion of Freshwater Wetland Complex in the northeast of the site will be conserved and will provide a minimum 380 m buffer from the adjoining Ramsar wetland. There is future potential for this area to be rehabilitated to Saltmarsh habitat as part of the Tomago Wetland Rehabilitation Project (TWRP) (however, this would be subject to a separate assessment). A 3.4 ha area of Swamp Oak Forest along the southern boundary (a small portion of which is mapped as SEPP 14 wetland) will also be retained and improved through weed control. Creation of a 10 ha Overflow Wetland Rehabilitation Area in the southwest corner of the site is also proposed. This area would be rehabilitated to establish a Freshwater Wetland Complex community, and create valuable wildlife habitat (particularly for amphibian and waterbird species). Proposed stormwater and groundwater management includes the construction of a partial bund along the site's southern boundary and management of existing discharge points to allow adaptive management of water from the site into adjoining lands.

A Wetland Management and Monitoring Plan will be prepared as part of the site Construction Environmental Management Plan (CEMP) to manage potential impacts on the adjoining Ramsar wetland, national parks estate and the TWRP as well as monitoring of retained vegetation, the Overflow Wetland Rehabilitation Area and landscaped watercourses.

Compensatory Offsets

An Offset Package which will include both on-site and off-site offset lands is currently being developed in consultation with the NSW Office of Environment & Heritage (OEH). Appropriate conservation mechanisms and management plans for these areas will be determined in due course.



- **Reduce the long-term viability of a local population of the species, population or ecological community**

The impact assessments found that the proposal was unlikely to reduce the long-term viability of local populations of the listed Threatened Ecological Communities, flora and fauna considered. With regard to the Eastern Grass Owl, a regional survey was undertaken by **ecobiological** in 2011 and identified seven 'groups' within the region including one utilising the study area. While the proposal is likely to result in the loss of one 'group' from the study area, it is unlikely to reduce the long-term viability of the local population of Eastern Grass Owls. However, further habitat loss in the locality and any unforeseen impacts upon conserved land may put the local population under extreme pressure for medium to long term survival.

- **Accelerate the extinction of the species, population or ecological community or place it at risk of extinction**

The impact assessments found that the proposal was unlikely to significantly accelerate the extinction of the listed Threatened Ecological Communities, flora and fauna species considered. With regard to the local Eastern Grass Owl population recorded on and surrounding the study area, the 2011 regional survey identified that Grass Owls were still utilising the study area for foraging.

The results of the survey show that the local population is viable (seven 'groups' throughout the region) and that there is suitable habitat throughout the region. As such the proposal, while likely to result in the loss of one 'group' from the study area is unlikely to place the local population of Eastern Grass Owls at risk of extinction. Detailed discussion of what is known of this species occurrence in the locality and region is provided in sections 1.8 and 4.2.3.

- **Adverse impacts on critical habitat**

No listed critical habitat occurs on the study area.



Definitions

Abundance – a quantification of the population of the species or community.

Arboreal – living in a tree or trees. Contrasted with *terrestrial*, living on the ground; *aquatic*, living in water; *amphibious*, living on land and in the water.

Conservation status – regarded as the degree of representation of a species or community in formal conservation reserves.

Distribution – the overall area in which a species is known to occur. It is not implied, and is very rarely the case, that a species occurs in all parts of the area defined by its distribution.

Diurnal – pertaining to the day. An animal that is active by day is said to be diurnal.

Habitat – an area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community and includes any biotic or abiotic component. The habitat of a species is usually far less in extent than distribution indicated on a map.

Jaw sheaths – used here in reference to the hard, black sheath of keratin (similar to fingernails or horn) over the upper and lower jaw cartilage in tadpole mouthparts.

Life cycle – the series or stages of reproduction, growth, development, aging and death of an organism.

Nocturnal – pertaining to the night. An animal that is active by night is said to be nocturnal.

Opportunistic – used, in reference to diet, to denote the eating of any of a wide variety of foods, depending upon their availability. In respect of reproduction, it refers to a pattern of breeding that is linked with irregular favourable conditions (particularly unpredictable rainfall in arid areas) rather than to season.

Papillae – small, nipple-like, fleshy projections around a tadpole's oral disk.

Range – this term has the same meaning as *distribution*, which is a better term.

Rapid Data Point – field survey method used in vegetation mapping.



Riparian – pertaining to the banks of a river or stream.

Risk of extinction – the likelihood that the local population will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the viability of that population.

Sclerophyll – pertaining to plants with tough leaves. Here used mainly to distinguish between two major types of eucalypt forest: *dry sclerophyll* forest which is open and *wet sclerophyll* forest which has a closed canopy. The two types intergrade.

Spiracle – referred to here as the external tube which expels water used for respiration from the gills of tadpoles.

Study area – refers to the area of investigation.

Subspecies – an interbreeding population within a species, differing measurably from one or more other populations and usually geographically separate from these.

Terrestrial – living on the ground.

Threatening process – a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. The definition is not limited to key threatening processes.



Abbreviations

DECCW Department of Environment, Climate Change & Water (now **Office of Environment & Heritage**)

EEC Endangered Ecological Community

EPBC Act *Environment Protection and Biodiversity Conservation Act 1999*

GIS Geographic Information System

GPS Global Positioning System

ha hectares

km kilometres

KTP Key Threatening Process

LGA Local Government Authority

NPWS National Parks and Wildlife Service

OEH NSW Office of Environment & Heritage

RDP Rapid Data Point (field survey method used in vegetation mapping)

ROTAP Rare or Threatened Australian Plants

SEPP State Environment Planning Policy

SEWPaC Commonwealth Department of Sustainability, Environment, Water, Population and Communities

sp. Species (singular)

spp. Species (plural)

subsp. Subspecies

TEC Threatened Ecological Community

TSC Act *Threatened Species Conservation Act 1995*

var. variety



Table of Contents

Certification	iii
Executive Summary	iv
Definitions.....	viii
Abbreviations.....	x
1. Introduction	1
1.1. Scope	1
1.2. Regional and local context.....	1
1.3. Description of the proposal	2
1.4. Site background.....	3
1.5. Consideration of other reports in the determination of potential impacts	3
1.5.1. Flooding and hydrology issues	4
1.5.2. Noise and vibration issues.....	4
1.6. Historical background	5
1.7. Geology and soils	11
1.8. Review of past ecological reports.....	11
1.9. Legislation	13
1.9.1. Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act).....	15
1.9.2. NSW Threatened Species Act 1995 (TSC Act)	15
1.9.3. Port Stephens Comprehensive Koala Plan of Management.....	16
1.9.4. SEPP 14 Coastal Wetlands.....	16
1.9.5. SEPP 44 Koala Habitat assessment	16
1.9.6. SEPP 71 Coastal Protection.....	17
1.9.7. Ramsar Wetlands.....	18
1.9.8. NSW Groundwater Dependent Ecosystem Policy.....	19
1.9.9. NSW Wetlands Management Policy	19
1.9.10. Lower Hunter Regional Conservation Plan.....	19
1.9.11. Key habitats and corridors	20
2. Methods.....	22
2.1. Review of databases and literature	22
2.2. Weather conditions and survey activities	22
2.3. Flora.....	25
2.3.1. Floristic diversity	25
2.3.2. Flora survey limitations	26
2.3.3. Vegetation community mapping	26
2.3.4. Vegetation community significance.....	26



2.4.	Fauna	29
2.4.1.	Fauna survey techniques	29
2.4.2.	Fauna survey limitations	29
2.4.3.	Fauna habitat value assessment	33
2.5.	Regional Grass Owl survey	36
2.5.1.	Database search targeting the Eastern Grass Owl.....	36
2.5.2.	Habitat determination and site selection	36
2.5.3.	Individual survey	37
2.5.4.	Synchronised survey of confirmed sites.....	37
2.6.	Port Stephens Comprehensive Koala Plan of Management.....	39
2.7.	Groundwater and wetland policies	40
2.7.1.	Groundwater dependent ecosystems.....	40
2.7.2.	Wetlands	41
3.	Results and discussion.....	43
3.1.	Threatened species database search	43
3.2.	Assessment of likelihood of occurrence	49
3.2.1.	Migratory and marine species	49
3.3.	Flora.....	56
3.3.1.	Vegetation community types.....	56
3.3.2.	Vegetation community significance.....	68
3.4.	Fauna	68
3.4.1.	Terrestrial fauna habitat values	68
3.4.1.1.	Hollow-bearing trees	69
3.4.1.2.	Amphibian fauna habitat values.....	71
3.4.1.3.	Migratory bird habitat values.....	72
3.4.2.	Fauna species composition	74
3.4.2.1.	Threatened fauna species	75
3.4.3.	Regional Eastern Grass Owl survey results	77
3.4.3.1.	Mapping of potential habitat.....	77
4.	Impact evaluation.....	80
4.1.	Direct and indirect impacts.....	80
4.1.1.	Impact on adjoining Tomago Wetland Rehabilitation Project, National Parks estate and Ramsar wetland.....	84
4.2.	NSW TSC Act Assessments of Significance	88
4.2.1.	Threatened ecological community assessment	88
4.2.2.	Threatened flora assessment	92
4.2.3.	Threatened fauna assessment.....	100
4.3.	Commonwealth EPBC Act assessments.....	132
4.3.1.	Threatened flora assessment	132



4.3.2.	Threatened fauna assessment.....	134
4.3.3.	Migratory and/or marine species assessment.....	140
4.4.	Port Stephens CKPoM assessment	143
4.5.	SEPP 14 assessment	148
4.6.	SEPP 44 assessment	148
4.7.	SEPP 71 assessment	148
4.8.	Ramsar wetland assessment.....	149
4.9.	Groundwater Dependent Ecosystems assessment	152
4.10.	NSW Wetlands Policy assessment.....	155
4.11.	Corridor assessment.....	156
5.	Mitigation.....	158
5.1.	Compensatory (environmental offset) strategies.....	158
5.2.	Long-term management strategies.....	160
5.2.1.	Minimising impact on SEPP 14 and Ramsar listed wetlands....	
		160
5.2.2.	Retaining integrity of habitat and minimising harm.....	160
5.2.3.	Flora and fauna management and monitoring plans.....	161
5.2.3.1.	Pre-clearing surveys.....	161
5.2.3.2.	Management plans	161
5.3.	Recommendations for future development.....	168
5.4.	Statement of Commitments.....	168
6.	Conclusion.....	169
7.	References.....	171
	Appendix 1: Flora species recorded in the study area.....	179
	Appendix 2: Fauna species recorded in the study area	184
	Appendix 3: Survey efforts compared to OEH guidelines.....	187
	Appendix 4: Contributions and qualifications of ecobiological staff	
		193
	Appendix 5: Licensing matters relating to the survey.....	194

List of Figures

Figure 1: Locality map.7

Figure 2: Study area and surrounding landscape.8



Figure 3: Development footprint.....	9
Figure 4: Study area (1954 aerial photograph).	10
Figure 5: Key habitat and corridors in relation to the subject site.....	21
Figure 6: Flora survey effort over vegetation mapping.	28
Figure 7: Fauna survey effort over vegetation mapping.....	35
Figure 8: Grass Owl survey locations	38
Figure 9: Vegetation communities.....	58
Figure 10: Vegetation community and fauna habitat significance.	70
Figure 11: Threatened fauna locations.....	76
Figure 12: Grass Owl confirmed sightings.	78
Figure 13: Grass Owl survey locations and potential habitat.....	79
Figure 14: Ecological constraints map.	87
Figure 15: Port Stephens CKPoM mapping	146
Figure 16: Revised Koala habitat mapping	147
Figure 17: On-site offsets and mitigation measures	159

List of Tables

Table 1: Schedule of activities and weather conditions during the survey period.....	23
Table 2: Minimum and maximum daily temperatures and total rainfall for the fauna survey period.....	24
Table 3: Attributes and weighting of the scoring system for vegetation community significance assessment.	27
Table 4: Attributes and weighting of the scoring system for fauna habitat value.	34
Table 5: Grass Owl records within the Newcastle Region.....	36



Table 6: Preferred Koala tree species in Port Stephens LGA.....	39
Table 7: Threatened flora species and ecological communities recorded from preliminary database search and literature review.....	44
Table 8: Threatened fauna species identified from preliminary database search and literature review.....	46
Table 9: Migratory and/or marine species identified from preliminary database search and literature review.....	48
Table 10: Likelihood of occurrence of subject matters in the study area.....	51
Table 11: Area (ha) of vegetation communities mapped on study area.	57
Table 12: Threatened fauna species recorded in the study area.	75
Table 13: Results of the simultaneous Grass Owl survey.....	77
Table 14: Direct and indirect impacts of the proposed development.....	80
Table 15. GDEs present on study area.....	153
Table 16. Vulnerability of GDEs on study area.....	153

List of Plates

Plate 1: Photograph of typical Swamp Mahogany – Paperbark Swamp Forest on the study area.	59
Plate 2: Photograph of typical Swamp Oak Rushland Forest on the study area.	61
Plate 3: Photograph of Swamp Oak Rushland Forest - Regeneration on the study area.....	63
Plate 4: Photograph of typical Freshwater Wetland Complex on the study area.	65
Plate 5: Photograph of Exotic Grasslands on the study area.	67



Plate 6: Isolated small mangrove within the rocky revetment along the Hunter River frontage of the study area.	73
Plate 7: Clustered mangroves around one of the two floodgates entering the Hunter River.	73
Plate 8: Steep sided drainage channel on the study area dominated by <i>T. orientalis</i> and <i>P. australis</i>	74
Plate 9: Regrowth <i>E. tereticornis</i> and <i>E. robusta</i> strips along the north eastern edge of the study area (adjoining Tomago Road).	144
Plate 10: Regrowth <i>E. tereticornis</i> and <i>E. robusta</i> strips and isolated trees along the north eastern edge of the study area (adjoining Tomago Road).	145
Plate 11: Old growth <i>Melaleuca quinquenervia</i> clump in the north-eastern corner of the study area.	145



1. Introduction

1.1. Scope

ecobiological was commissioned by Northbank Enterprise Hub Pty Ltd with instruction from ADW Johnson Pty Ltd to conduct an ecological assessment for a proposed industrial and business subdivision on Lot 1001 DP1127780 Tomago Road, Tomago NSW. The location of the study area is shown in **Figure 1**.

The objectives of the study were to identify dominant vegetation communities, faunal habitats, protected and threatened flora and fauna species and communities within the study area.

1.2. Regional and local context

The study area (or site) is approximately 239.7 hectares in size, and is situated in Tomago (NSW), off Tomago Road. The site is located approximately 8 km south west of Raymond Terrace, 12 km northwest of the Newcastle CBD and 1.3 km from Fullerton Cove to the east. The study area is generally of flat topography, low lying and subject to flooding. The site is predominantly covered in pasture grasses for grazing, and agriculture has been a long term use of the site. A number of small drainage channels off the Hunter River extend through a portion of the site. Four single dwellings and associated sheds were located towards the northern boundary of the site (however, these have recently been demolished under Council approval). The study area forms part of a State Significant Site under *Schedule 3* of SEPP (Major Development) 2005. The site is zoned *IN1 General Industrial* under the SEPP.

The study area is bound to the north by Tomago Road and the heritage-listed Tomago House and Chapel. The Tomago Aluminium Smelter is located further north west along Tomago Road. The site is bound to the north east by the remainder of the Northbank Enterprise Hub Pty Ltd landholding which has a Part 3A Approval (07-0086) for a 'WesTrac' Facility and industrial subdivision. It is intended that the proposal will be designed to integrate with the existing approved development. The site is bound to the east by conservation lands including Ramsar Wetland and to the south by conservation land including SEPP 14 Wetland. The Hunter River extends adjacent to the western boundary of the site. Further west of the Hunter River is Kooragang Island which contains significant



development associated with coal transportation by rail and port.

The extent of vegetation, infrastructure, waterways, mapped wetlands and protected areas on and adjoining the study area is shown in **Figure 2**.

1.3. Description of the proposal

The proposed development is for the following:

- To fill the majority of the site to the 1:100 year flood level (fill area approximately 3.7 million cubic metres).
- A staged subdivision of the land for the purpose of an industrial and business park estate. The design of the subdivision is intended to provide flexibility for future occupants of the site (currently unknown).
- The provision of two (2) new intersections from Tomago Road and a new internal road network to access all allotments.
- The provision of new servicing to the land including the relocation of the existing power lines that traverse the site along a portion of the Tomago Road frontage.
- New drainage and water quality management infrastructure.
- Site design for maintaining the same hydrological pathways and flow regime post development to adjoining wetland reserves. Proposed site drainage has been specifically designed to ensure that there is no potential for adverse environmental impacts on the wetlands to the south and south east of the site.
- 380 m buffer to common boundary with Ramsar Wetland.
- The provision of an Overflow Wetland Rehabilitation Area at the southern section of the site.
- New landscaping throughout the site including public open space areas at the south western (Riverside Park), north western (adjacent to Tomago house) and southern sections of the site. A public open space area towards the southern boundary, to be known as 'Gunners Park' has been designed to retain four (4) former WWII anti-aircraft gun emplacements and an underground command post.

At this time no specific use of the land is proposed and the future uses would be subject to separate future approval. The subdivision layout and proposed lots are shown in **Figure 3**.



The total developable area of the site is approximately 154 ha. Portions of the site will be landscaped and rehabilitated to create riparian zones, environmental and landscaped watercourses and two portions of threatened ecological communities (Swamp Oak Forest and Freshwater Wetland Complex) will be retained within an Environmental Zone.

1.4. Site background

Northbank Enterprise Hub identified Tomago as being an ideal location to house their substantial tenant WesTrac. Northbank Enterprise Hub first purchased adjoining lands to the east from the Hunter Development Corporation and obtained approval to establish WesTrac and an industrial subdivision on 7 August 2009 (Project Approval 07_0086). The WesTrac facility has now been constructed and is operational.

During the process of obtaining the existing approval over the lands to the north east Northbank Enterprise Hub became keen to secure Lot 1001 and was ultimately successful in purchasing the land from HDC in February 2010 (ADW Johnson 2010a).

A Development Application (DA 363/2010) has been approved by Port Stephens Council for demolition of the four (4) existing dwellings on site which has been completed. Currently Northbank Enterprise Hub maintains the site in suitable condition for grazing.

1.5. Consideration of other reports in the determination of potential impacts

In defining the study area (area of potential impact) for environmental investigation all impacts, both direct and indirect, must be considered. Two such impacts; changes in hydrology and noise / vibration disturbance could potentially impact on the adjoining wetland reserves thereby requiring the need to extend the study area (area of consideration) into these areas. Reports have been prepared addressing flooding and hydrology issues (BMT WBM 2012a, 2012b, 2012c) and noise and vibration issues (Spectrum Acoustics, 2012) and these have been considered by **ecobiological**.



1.5.1. Flooding and hydrology issues

The flooding and hydrology of runoff from smaller storm events are those which have the most potential for impact on aquatic ecology and flora and fauna outside the development area. Assessment and site design has been completed on flooding and hydrological pathways by BMT WBM and ADW Johnson to mimic post development conditions to be the same as pre development conditions for all smaller storm events. Work detailed in the wetland interface strategy of the EA report demonstrates how this has been determined and achieved, negating the risk of impact on aquatic ecology and flora and fauna.

BMT WBM has also completed higher level peak storm event based modelling on minor/major design storms locally and regionally for the Hunter River, however the recurrence of these events are not expected to result in impacts on aquatic ecology and flora and fauna.

It is considered by **ecobiological** that provided the measures to avoid hydrological change are put in place as detailed in the wetland interface strategy and BMT WBM reporting, there will be no significant hydrological impacts on the adjoining wetland reserve.

1.5.2. Noise and vibration issues

An assessment of potential noise impacts on surrounding lands was prepared by Spectrum Acoustics (2012). The assessment has found that cumulative noise levels from the project and other existing/approved industries in the area are not expected to exceed the cumulative industrial noise criteria.

It is a requirement of OEHL that potential noise and vibration impacts on migratory bird populations be considered. There would be negligible vibration levels from both construction and operation activities, although the report findings suggest possible construction noise levels of up to 55-60 dB(A) and operational noise levels of up to 60-65 dB(A) in the Ramsar lands. Consideration of studies conducted at Sydney Airport highlighting the difficulties in removing unwanted bird colonies using gas guns (not to mention the aircraft noise itself) suggest that noise levels of up to 65 dB(A) from the project site are unlikely to disturb bird colonies within the adjoining Ramsar lands (Spectrum Acoustics, 2012). The report concluded that the project could proceed without impacting on the acoustical amenity of nearby residents, provided the recommendations in the report are adopted. Noise emission levels would also be far too low to significantly



disturb migratory bird colonies within the adjoining Ramsar lands (Spectrum Acoustics, 2012). A minimum buffer of 380 m from any future development will be provided by the retention of 12.5 ha of Freshwater Wetland Complex in the northeast of the site.

Regarding natural noise sources: maximum noise levels from within a bird colony itself; nearby birds such as galahs; frogs and insects such as crickets and cicadas would regularly exceed 65-70 dB(A) at the site of a nesting bird within the wetland habitat (Spectrum Acoustics, 2012). These considerations suggest that 65 dB(A) is a relatively low level of noise impact compared with what might currently be experienced by birds within the Ramsar lands, and is certainly much less than the level of noise that would be experienced by established bird colonies near coastal airports (Spectrum Acoustics, 2012). It is unlikely that migratory bird colonies would be disturbed within the Ramsar lands. In addition it is considered that opportunity exists to manage noise impacts from future users through mitigation and management measures if deemed necessary at the time. It is also noted that any future proposed development will be subject to individual assessment as part of the development application process. Recommendations have been made in regard to this in Section 5.3 of this report.

1.6. Historical background

The site of the proposed Northbank Enterprise Hub is located on lands which were acquired by barrister Richard Windeyer in the late 1830s. Windeyer planned to develop a grand rural estate but his death and poor financial situation left his widow and son with only their home, Tomago House, and a fraction of the family's original land. Maria Windeyer successfully managed her Tomago property until her death in 1878 when ownership passed to her only child, William. In 1939 the Tomago Estate was subdivided and sold, but the family retained ownership of Tomago House for some years thereafter. As a result of the 1939 subdivision, the portion of the Tomago Estate which now comprises the study area was divided into eight farms ranging in size from 50 acres to 324 acres (Hunter History Consultants 2010).

During World War II, Tomago House, together with some buildings on the surrounding farms, was occupied by the military authorities. Following the Japanese attack on Newcastle in June 1942, the decision was made to construct an anti-aircraft battery on one of the farms immediately to the east of Tomago House. The battery complex included four brick and



concrete gun emplacements with associated underground command centre, and three ammunition shelters which were erected close by. The entire complex still stands in the open fields, an access road which was also constructed at the time providing a clear indication of the battery's location (Hunter History Consultants 2010).

During the post-war period, industrial development in the Tomago area increased. Numerous small industries were established, as well as large industries such as Courtaulds, followed by Tomago Aluminium which made a significant impact on the landscape and the environment. Fallout from the aluminium smelter led to the departure of dairy farmers from the study area. A proposal to establish a steel mill on the land was unsuccessful, and the site is now the subject of the Northbank Enterprise Hub proposal (Hunter History Consultants 2010).

An aerial photograph was obtained for the study area and surrounds from 1954. This image was orthorectified and the study area boundary overlaid in a GIS (**Figure 4**). The site has been almost entirely cleared or modified prior to the 1950s and has very little remnant native vegetation remaining with the exception of some large Melaleucas in the northwest corner along Tomago Road. Historical and ongoing water management practices and use of the study area for dairy farming and other agricultural pursuits have modified the hydrology of the site through the installation of deep, steep-sided drains feeding into the Hunter River and adjoining conservation lands. Formerly the majority of the study area contained Swamp Mahogany – Paperbark Swamp Forest, as mapped by the Lower Hunter Central Coast Estimated Pre-1750 Vegetation Map (HCCREMS, 2003).

The Swamp Oak Forest in the north east of the site has regenerated and expanded in size over the years, as has a strip along the central southern section of the study area which links with conservation lands to the south.

Figure 1 - Locality map



Legend / Notes

 Study Area

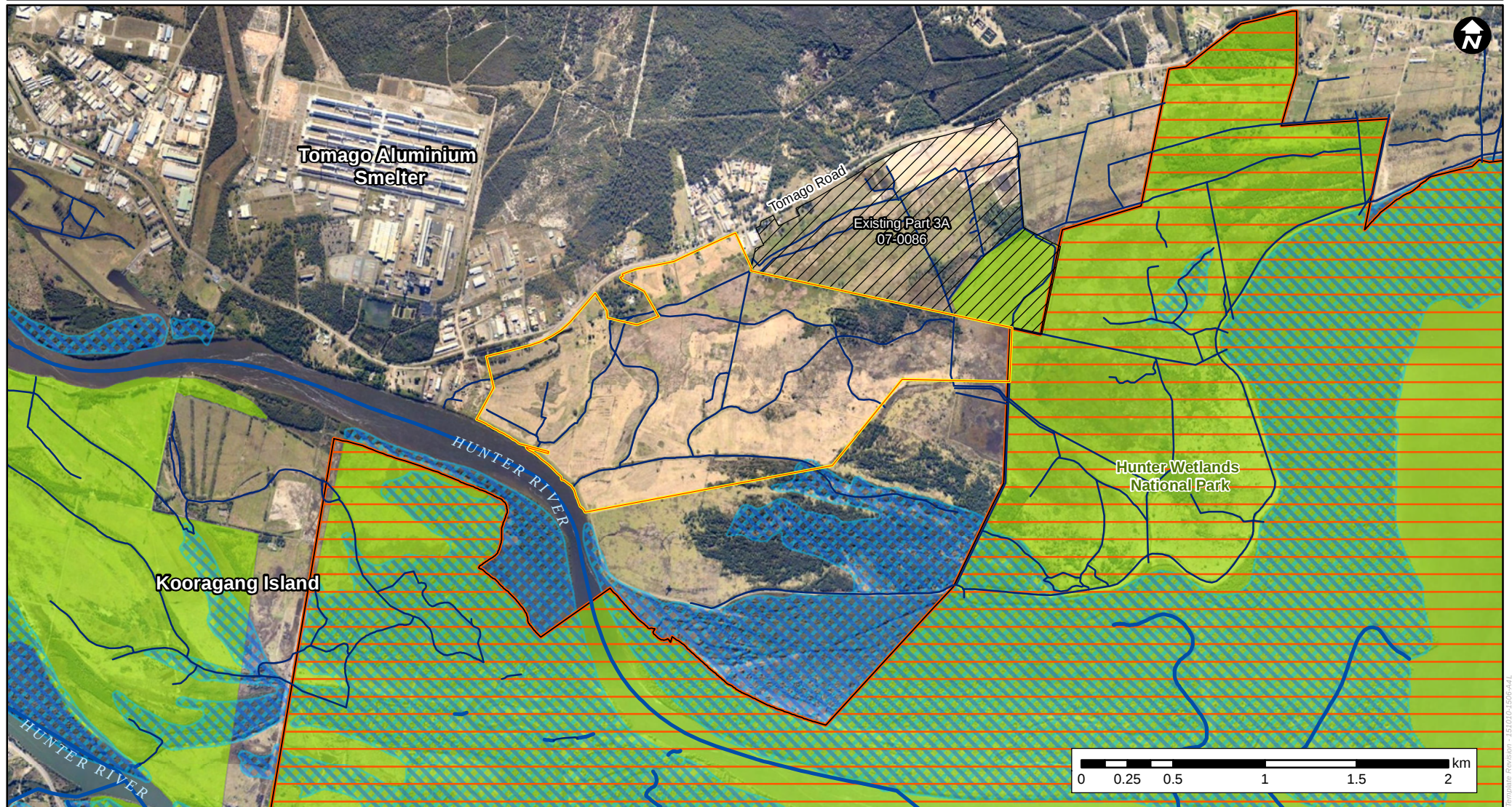


Map Projection:
WGS 1984

Data Sources:
OpenStreetMap - 2010
ecobiological - 2010

Project Ref:	350-694
Plot Date:	06/12/2010 0954
Revision:	JRN 001

Figure 2 - Study area and surrounding landscape



Legend / Notes

- Study Area
- Perennial waterway
- MP07-0086 Approval
- Non-perennial waterway
- Coastal Wetlands (SEPP 14)
- Ramsar Wetlands
- NPWS Estate



Project Ref: 350-694
Plot Date: 21/08/2012
Revision: GJ 002

Map Projection:
 NSW Lamberts Conformal Conic

Data Sources:
 OpenStreetMap - 2010
 ecobiological - 2010
 DECCW - 2010
 NSW Dept. of Planning - 2006

Figure 3 -Development Footprint



Legend / Notes

- | | |
|------------------|--|
| Study Area | Environmental & Landscaped Watercourses |
| Roads | Environmental Zone |
| Building Sites | Constructed Drainage Lines - Riparian Zone |
| Landscaped Areas | |

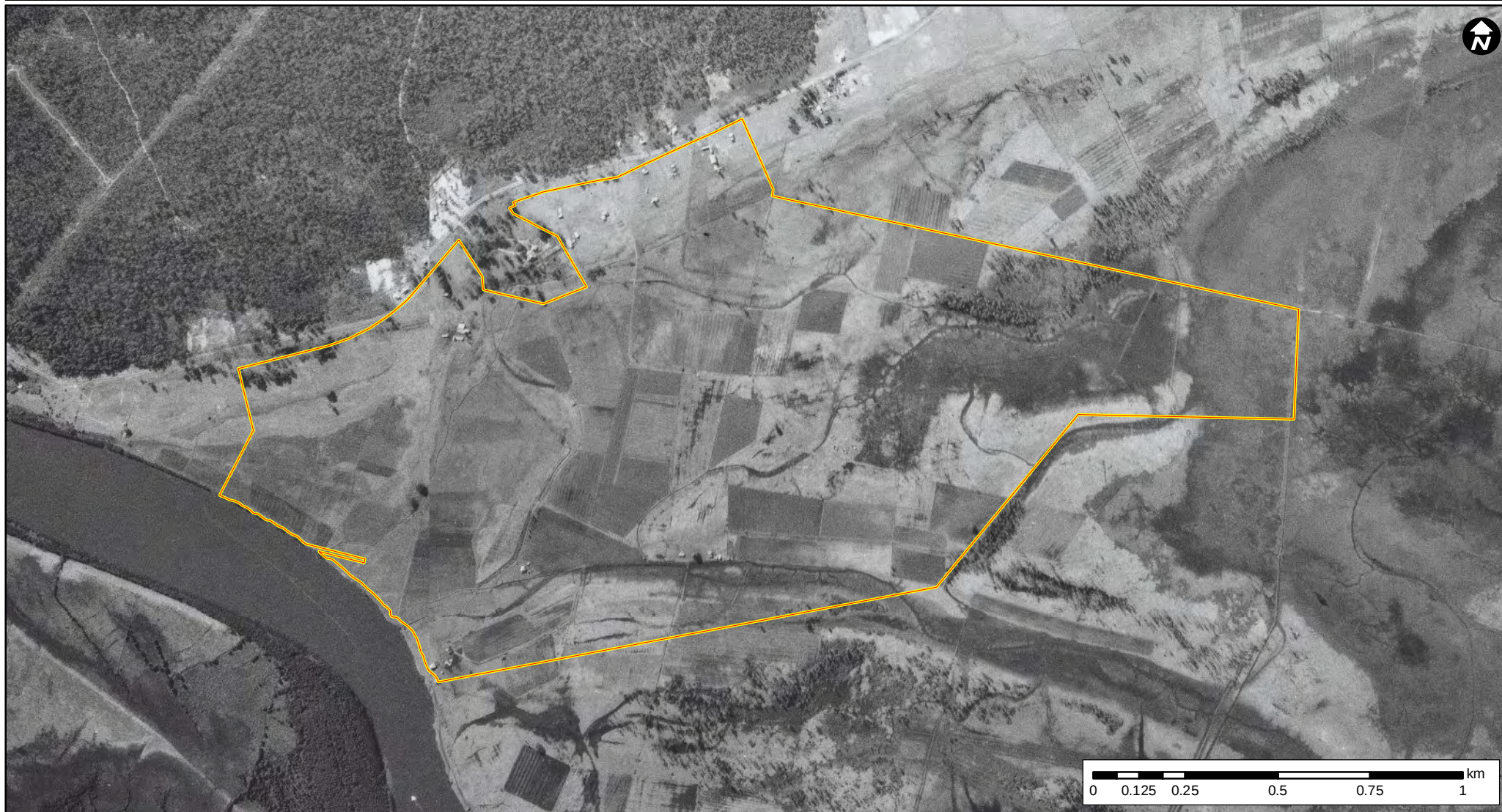


Map Projection:
NSW Lamberts Conformal Conic

Data Sources: 2010
Suters - 2012
ecobiological - 2010
DECCW - 2010
LPI - 2006

Project Ref:	350-694
Plot Date:	06/12/2010 1123
Revision:	JRN 001

Figure 4 - Study area (1954 aerial photo)



Legend / Notes

Study Area



Map Projection:
NSW Lamberts Conformal Conic

Data Sources:
ecobiological - 2010
LPI - 2010

Project Ref:	350-694
Plot Date:	06/12/2010 1031
Revision:	JRN 001



1.7. Geology and soils

The study area is comprised of two soil types – Bobs Farm and Tea Gardens landscapes. The former occurs over the majority of the study area while the latter occurs as a thin strip along Tomago Road.

The Bobs Farm landscape is broad, flat, swampy Holocene estuarine plain with slope gradients <1% and an elevation of 1-3m ASL. The estuarine plain is often bounded to the north and south by Pleistocene transgressive dune fields and to the east by Holocene sand plains and dunes. The soils consist generally of up to 30cm of black strongly pedal organic-rich loam which overlies 20 to >80cm of grey saturated plastic clay which in turn may occasionally overlie >50cm of saturated greyish yellow brown massive sandy clay loam. Total soil depths exceed 300cm.

The Tea Gardens landscape is characterised by Pleistocene beach ridges and swales on the Tomago Coastal Plain consisting of marine and Aeolian quartz sands. Local relief of the ridges rarely exceeds 1m and has slope gradients of <5%. Elevation is generally 5-8m but near the inner barrier depression elevations are as low as 2m ASL. The ridges are generally well drained but the swales are often waterlogged for periods of the year and the watertable is generally <100cm below the surface. The soils consist of deep (often >300cm) imperfectly drained Humus Podzols on the ridges with poorly drained Peaty Humus Podzols in the swales (Murphy, 1995).

1.8. Review of past ecological reports

ecobiological undertook a Threatened Species Assessment (ecobiological 2007) on Lot 1 DP597372, Lot 1 DP1003492, Lot 161 DP774440 and Lot 513 DP585256 Tomago Road, Tomago for Redlake Enterprises Pty Ltd during 2006 and 2007. This site adjoins Lot 1001 to the north east and has an approved WesTrac facility in the process of construction (see **Figure 2**).

Results of the field surveys showed that the subject site supported 101 plant species within three plant communities, two of which form Endangered Ecological Communities. An estimated 102 trees supported potential fauna habitat hollows; one Koala feed tree was present; 99 species of fauna were recorded, including six threatened species (Eastern Freetail Bat *Mormopterus norfolkensis*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Little Bentwing-bat *Miniopterus australis*, Grey-headed Flying-fox *Pteropus poliocephalus*, Eastern Grass Owl *Tyto longimembris* and Wallum Froglet *Crinia tinnula*. The Threatened Species Assessment revealed that minimal



impact on any threatened species would occur as a result of the proposed development.

Both endangered ecological communities present on the subject site were proposed to be removed; however an impact assessment revealed that this was unlikely to have any long-term impact on the endangered ecological communities within their known regional distribution.

Additionally, **ecobiological** was commissioned by Redlake Enterprises to undertake a detailed research project on the Grass Owl (*Tyto longimembris*) after it was detected on the subject site. This was due to little information being known on the species in the region. This species was found to utilise the subject site for foraging. Several roosts for the population were located off the subject site to the east, south and west (one of these roost sites occurs on Lot 1001 and was used as a secondary roost location during a prolonged period of wet weather). This study was conducted both on the subject site and in the locality.

Two Grass Owl roost sites were located within the wider study area. The primary roost site to the southeast of the subject site within the Ramsar wetland was used by the owls for a 7-month period. The secondary roost to the southwest of the subject site (on Lot 1001) was used for a 2-month period when the Ramsar wetland was inundated with water during heavy rainfall periods in late August 2006. Once the water had receded from the wetlands, the Grass Owls returned to the primary roost site (ecobiological 2007). Grass Owls from the local population were observed and recorded throughout the survey period from January to November 2006 indicating that the Grass Owls inhabit the site and are active throughout the year.

Recordings of between two and three individual Grass Owls was the norm during ecobiological's surveys of the subject site and of the two roost locations. However, a maximum of 6 individuals were recorded using the main roost site to the southeast of the subject site on one occasion.

A determination of local population size was hindered by the absence of Grass Owl records from the NSW Wildlife Atlas within a 5-kilometre radius of the subject site. One confirmed sighting to the southwest of the subject site within Hunter Wetlands National Park (L. Penman pers. comm.) was known of prior to ecobiological's 2006 study. A roadkill specimen was also collected in 1997 from the Nelson Bay Road just north of Williamtown (HBOC Unusual Record Report #111).



As an alternative to determining local population size, survey work focussed on finding other populations of Grass Owls in the wider region to provide an overall population spread. The spread of Grass Owl populations in the surrounding region was determined through two (2) surveys at six (6) observation points, playing owl calls simultaneously to recording the time and number of owls that responded. The six locations were chosen from anecdotal evidence of Grass Owl sightings, the confirmed record of a Grass Owl road kill near Williamtown, records from the NPWS Wildlife Atlas and the identification of potential habitat in the surrounding region. The regional surveys conducted by **ecobiological** identified an additional four Grass Owl locations with at least 12 individuals recorded between the five locations (see section 4.2.3 for further information).

Grass Owls presumed to be those resident to the Ramsar wetland roost site, were observed to utilise a minimum of 785 hectares of surrounding land for foraging (97 ha of which occurred on the subject site representing 12% of the observed foraging area), with a maximum of six individuals recorded using the primary roost site at one time. At least three nests within the primary roost site were observed to be utilised by the Grass Owls at any given time with >7 nests (utilised and unutilised) being observed within the primary roost area (ecobiological 2007). While the subject site was found to represent approximately 12% of the recorded foraging area for the local population, the loss of this habitat was considered unlikely to affect the life cycle of the Grass Owl such that a local population would be placed at risk of extinction.

1.9. Legislation

The following Legislation, Agreements, Acts, Policies, Guidelines and Strategies were taken into consideration in the preparation of this report. Further explanation of the main Acts and Policies affecting the proposed subdivision is given in sections 1.9.1 to 1.9.10.

International

- Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention);
- Japan – Australia Migratory Bird Agreement (JAMBA);
- China – Australia Migratory Bird Agreement (CAMBA);
- Republic of Korea – Australia Migratory Bird Agreement (RoKAMBA).



Commonwealth

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

State

- Environmental Planning and Assessment Act 1979 (EP&A Act);
- NSW Threatened Species Conservation Act 1995 (TSC Act);
- NSW Threatened Species Conservation Amendment Act 2002;
- NSW Threatened Species Conservation (Biodiversity Banking) Regulation 2008;
- National Parks and Wildlife Act 1974 (NP&W Act);
- Native Vegetation Act 2003 (NV Act);
- Water Management Act 2000 (WM Act);
- Noxious Weeds Act 1993 (NW Act);
- NSW Groundwater Dependent Ecosystem Policy;
- NSW Wetlands Management Policy;
- Key Habitats and Corridors for Forest Fauna (NPWS Occasional Paper 32 – Scotts 2003);
- State Environmental Planning Policy (SEPP) 14 Coastal Wetlands;
- State Environmental Planning Policy (SEPP) 44 Koala Habitat Protection;
- State Environmental Planning Policy (SEPP) 71 Coastal Protection;
- Draft Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC 2005a);
- DEC Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities, Working Draft 2004;
- DECC Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECC 2009a);
- DECC BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECC 2009b).

Regional and Local

- Lower Hunter Regional Conservation Plan (DECC 2009c);
- Port Stephens Council Comprehensive Koala Plan of Management 2002;
- Lower Hunter Central Coast Regional Environmental Management Strategy (Murray *et al.* 2002a, 2002b) Survey Guidelines.



1.9.1. Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)

Under the EPBC Act assessment an approval is required for actions that are likely to have a significant impact on matters of national environmental significance. An action includes a project, development, undertaking, activity, or series of activities. When a person proposes to take an action they believe may need approval under the EPBC Act, they must refer the proposal to the Australian Government Minister for the Environment. The Act identifies eight matters of national environmental significance:

- 1) World Heritage properties;
- 2) National heritage places;
- 3) Wetlands of international importance (Ramsar);
- 4) Listed threatened species and communities;
- 5) Migratory species listed under international agreements;
- 6) Commonwealth marine areas;
- 7) Great Barrier Reef Marine Park; and
- 8) Nuclear actions.

A referral for the development was prepared by ADW Johnson (2010b). The Commonwealth Minister for the Environment declared the project to be a controlled action under section 75 of the EPBC Act to be assessed under Public Environment Report (PER) (referral decision, EPBC 2010/5660).

1.9.2. NSW Threatened Species Act 1995 (TSC Act)

Schedules 1 and 2 of the TSC Act contain lists of flora and fauna species and communities, which have been determined by the NSW Scientific Committee as being under threat of serious decline that could ultimately lead to extinction. The TSC Act, pursuant to section 5A of the EP& A Act provides for a seven-part test of significance and impact to be applied to any of these listed species or communities that are found in an area subject to proposed development. Schedule 3 of the TSC Act contains a list of 'key threatening processes' deemed to be processes that have a negative impact on threatened species, populations or communities.

Threatened species and key threatening processes have been considered in section 4 of this report.



1.9.3. Port Stephens Comprehensive Koala Plan of Management

The study area is located within the Port Stephens Local Government Area. The Port Stephens Comprehensive Koala Plan of Management (CKPoM) applies to all development applications on land within the LGA of Port Stephens. It aims to ensure the long-term sustainability of any local Koala populations. Compliance with the provisions of the CKPoM will constitute compliance with the provisions of SEPP 44 Koala Habitat Protection.

1.9.4. SEPP 14 Coastal Wetlands

SEPP 14 ensures that coastal wetlands are preserved and protected in the environmental and economic interests of the State. GIS mapping was used to map the location of SEPP 14 Coastal Wetlands occurring in the locality of the study area. Mapped SEPP 14 wetlands occur in a small area along the southern boundary of the study area and extend further to the south, east and west. SEPP 14 wetlands within the site boundary will be retained within a proposed landscaped watercourse and environmental zone.

The proposed filling and development of non-SEPP 14 wetland areas and drainage lines across the study area must ensure appropriate mitigation strategies such as sedimentation and erosion control are implemented to protect the nearby SEPP 14 wetlands occurring on and adjoining the study area.

1.9.5. SEPP 44 Koala Habitat assessment

The aim of this SEPP is to, as far as possible, preserve Koala habitat in the state. The study area contains suitable feed tree species for the Koala. As such, this SEPP must be considered.

SEPP 44 encourages the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

Potential impacts of the project on Koala habitat are addressed in section 4.4 and 4.6.



1.9.6. SEPP 71 Coastal Protection

SEPP 71 aims to protect sensitive coastal zones. The objectives of SEPP 71 can be summarised as follows:

- Manage the coastal zone in accordance with ecologically sustainable development principles;
- Ensure that coastal cities, towns, centres, villages, hamlets, and their communities thrive by protecting the natural and cultural attributes that attract people to the coast to live, work, and recreate;
- Protect and manage the coast in a coordinated manner so the community and future generations can enjoy its natural, scenic and cultural beauty;
- Ensure that existing public access to the coastal foreshore is retained – and new opportunities for public access are provided – in accordance with the natural and cultural attributes of the area; and,
- Ensure that development is appropriate for the coastal environment.

The definition of a sensitive coastal location under SEPP 71 include:

- Land within 100m of any of the following:
 - A declared Ramsar wetland within the meaning of the Environment Protection and Biodiversity Conservation Act 1999 of the Commonwealth,
 - Land reserved or dedicated under the National Parks and Wildlife Act 1974,
 - Land to which State Environmental Planning Policy No 14 - Coastal Wetlands applies.

As already highlighted, mapped SEPP 14 wetland occurs as a small patch along the southern boundary of the study area, extending as a much larger expanse to the south, east and west. The eastern boundary of the study area also adjoins the Hunter Wetlands National Park which forms part of the Hunter Estuary Wetlands Ramsar site (ID 24). Measures to reduce impacts on and conserve animals, plants and their habitats, particularly within the adjoining Ramsar Wetland, are addressed in section 4 and 5 of this report.



1.9.7. Ramsar Wetlands

Under the EPBC Act, a Ramsar wetland (considered of international importance) is either an Australian wetland on the list of Wetlands of International Importance kept under the Ramsar Convention (Ramsar, Iran, 1971), or a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister. Ramsar wetlands are recognised as a matter of national environmental significance under the EPBC Act's assessment and approval provisions.

A Ramsar wetland of international importance (ID 24) which forms part of Hunter Wetlands National Park is located adjacent to the eastern boundary of the study area where there is about 300 metres of common boundary. A 12.5 ha area containing Freshwater Wetland Complex vegetation will be retained in the northeast corner of the site and will provide a minimum 380 m buffer between the development footprint and the Ramsar wetland.

Under Chapter 2, Part 3, Division 1, Section 16 of the EPBC Act it is stated that

"A person must not take an action that:

- a) has or will have a significant impact on the ecological character of a declared Ramsar wetland; or*
- b) is likely to have a significant impact on the ecological character of a declared Ramsar wetland."*

Where a significant impact is likely to occur as a consequence of a proposed action or development a referral to the Department of Sustainability, Environment, Water, Population and Communities may be required in which case the Environment Minister would make a decision as to whether or not the level of impact is properly defined and is or is not tolerable.

Considering the nature of the proposal, the provision of a minimum 380 m buffer and proposed mitigation measures, it is unlikely that the project will have a significant impact on the ecological character of a declared Ramsar wetland. Potential indirect impacts could be in the form of altered hydrology, weed invasion and run-off leading to siltation, excess nutrient, chemical and acid sulphate pollution. A number of recommendations as outlined under section 5 of this report have been made in regard to these potential indirect impacts and provided that the recommendations are adopted in full, it is considered that no adverse impacts on the Ramsar wetland will occur.



1.9.8. NSW Groundwater Dependent Ecosystem Policy

This policy states; *"...(it) is specifically designed to protect our valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these ecosystems are maintained or restored for the benefit of present and future generations."*

The policy gives guidance on how these GDEs may be identified and managed through a range of tools.

1.9.9. NSW Wetlands Management Policy

This policy states; *"It is the policy of the NSW Government to promote the conservation, sustainable management and wise use of NSW wetlands by all stakeholders for the benefit of present and future generations."*

Adoption of the NSW Wetlands Policy means that the Government, in its decision-making, will give explicit consideration to the biophysical requirements of wetlands with the goal of ensuring their sustainable management.

This policy must be addressed as several mapped (SEPP 14) wetlands occur within the locality (**Figure 2**), and without appropriate mitigation, have the potential to be indirectly impacted from the proposal. Forested wetland communities also occur within the study area and immediate surrounds.

1.9.10. Lower Hunter Regional Conservation Plan

The Lower Hunter Regional Conservation Plan (LHRCP) (DECC 2009c) 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.

One of the proposed new reserves relevant to this assessment is a new '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 (DECC 2009c).

The wetland habitats of the Hunter River estuary, Lake Macquarie and Port Stephens, as well as the habitat corridor from the Watagan Ranges to Port Stephens are of exceptional significance (DECC 2009c). This is one of only



a few remaining vegetated links between the Great Dividing Range and the east coast. This corridor is highly significant and allows for fauna movement such as seasonal migration and juvenile dispersal.

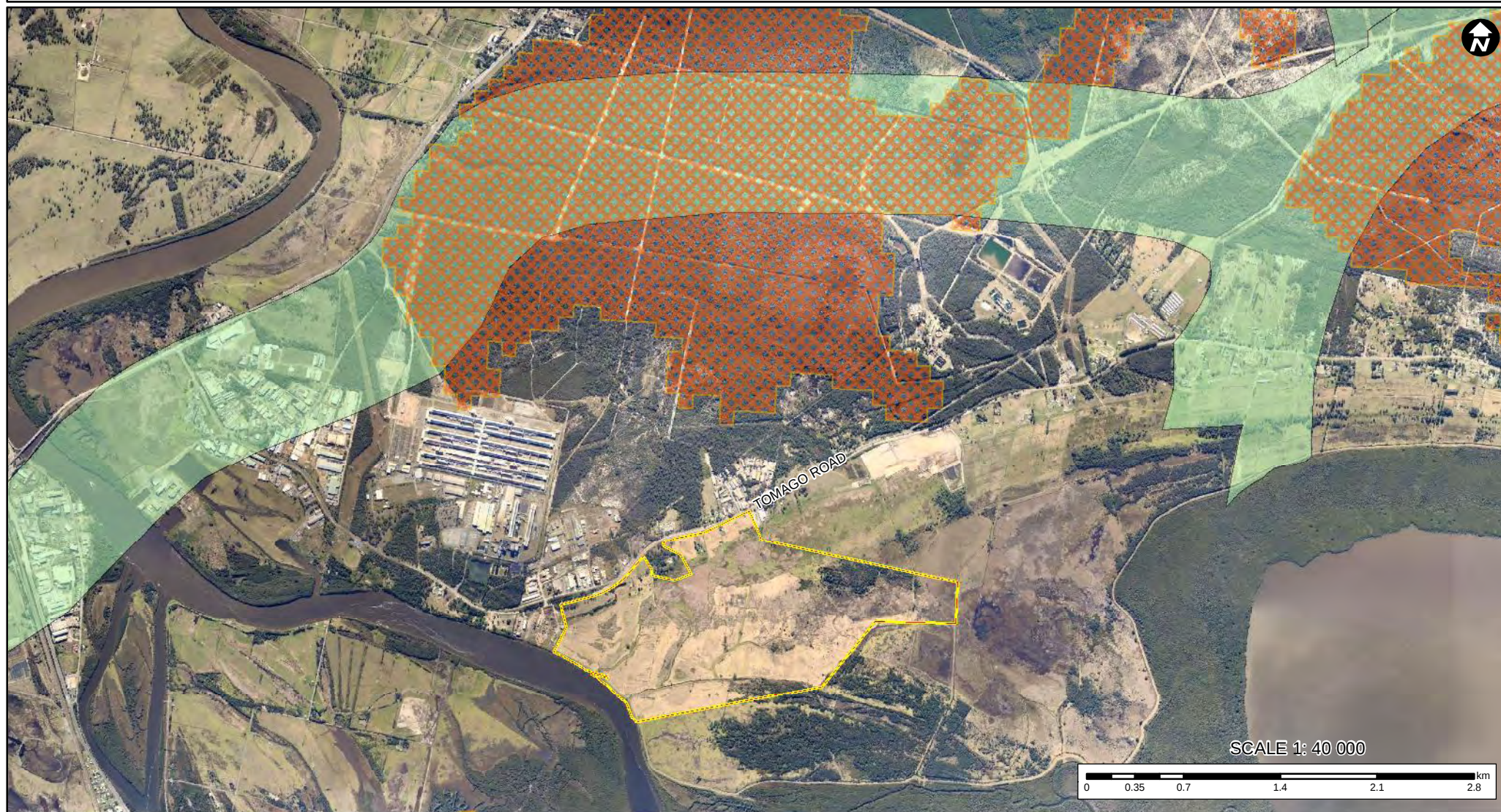
The LHRCP does not identify the study area as occurring within the Green Corridor. However, the corridor includes the Hunter Wetlands National Park to the south and east. Lot 1002 is proposed to be protected in perpetuity (as part of an offset for another local development) adding to the width of the existing mapped corridor.

1.9.11. Key habitats and corridors

Changes to the natural environment through land uses such as agriculture and urban development have reduced the amount of potential habitat available to wildlife. Remaining fragments of native vegetation are often small and isolated by open pastures or urban developments that act as significant barriers to wildlife movement. The requirement for wildlife to traverse a landscape for dispersing, foraging, recolonising or migrating is recognised, and the conservation of these movement avenues of vegetation cover is very important. Small habitat islands are considered less suitable for these lifecycle movements, and may lead to catastrophic vulnerabilities such as bushfire, disease outbreak, and reduced genetic diversity (Hanski 1999).

Important regional habitats and corridors have been identified in the Port Stephens Council area by OEH as part of a statewide Key Habitat and Corridor mapping project (Scotts 2003). These areas emphasise the habitat value of existing isolated habitats. The study area lies near a north-south corridor (Richardson Road) which also runs in an east-west direction to the north of the proposal (**Figure 5**). This corridor links the Tomago sand beds / Tilligerry area with the Hunter Wetlands National Park as identified in Scotts (2003).

Figure 5 - Key Habitat and Fauna Corridors



Legend / Notes

- Study Area
- Fauna Key Habitats
- Fauna Corridor



Project Ref:	350-694
Plot Date:	06/12/2010 1123
Revision:	JRN 001

Map Projection:
NSW Lamberts Conformal Conic

Data Sources:
OpenStreetMap - 2010
ecobiological - 2010
DECCW - 2010
LPI - 2006



2. Methods

2.1. Review of databases and literature

A list of threatened flora and fauna reported from the local area was obtained from the Department of Environment, Climate Change and Water database, the Atlas of NSW Wildlife.

In addition to a search of the Atlas of NSW Wildlife, a review of past ecological reports carried out in the general area (ecobiological 2007), the Director General's requirements, **ecobiological** consultant records, and a variety of other databases (PlantNET, Australian Museum OzCam and Birddata) were consulted for any additional threatened species records.

A field survey was then conducted using the compiled list of threatened species as a guide to species potentially likely to occur in the study area. The survey was not, however, limited to the species compiled from database extracts and past consultant records. Searches were carried out for any species listed on Schedules 1 and 2 of the TSC Act that were considered likely to occur in the type of habitat present in the study area. The likelihood of any 'key threatening processes' occurring in the study area was also assessed.

2.2. Weather conditions and survey activities

The study area was surveyed on numerous occasions between October 2009 and November 2011. A full list of survey activities and weather conditions during the survey period is provided in **Table 1**. Temperatures and total rainfall information for the fauna survey period are provided in **Table 2** (climate data was obtained from the Williamtown airport weather station or on-site using a handheld Kestrel weather station).



Table 1: Schedule of activities and weather conditions during the survey period.

Survey Method	Date/s	Weather Conditions	Survey Effort
Flora investigation			
Vegetation Community Mapping	28/10/2009	Cool, cloudy, 10.4 mm rain	7 person hours
Floristic searches and random meanders	27/10/2009, 30/10/2009	Humid, patchy showers, light wind Warm, clear skies, no wind	10.75 person hours
20 x 20m quadrat surveys	26/10/2009 (Q1-15), 27/10/2009 (Q16-17) 24/06/2010 (Q18-20)	Mild, clear skies, low winds Humid, patchy showers, light wind Warm, clear skies and low winds	21.5 person hours
Targeted threatened flora survey (meanders)	22/11/2010 29/11/2011	Warm, clear skies and moderate winds Warm, partly cloudy, light winds	12 person hours (6 hrs on each date)
Fauna and fauna habitat investigation			
Fauna trapping / habitat search for signs/scats	24 - 28/5/10	Cool nights, mild humid days, calm to light breeze, partly cloudy to overcast	40 person hrs
Habitat hollow survey	7/12/2010	Warm afternoon, light breeze, partly cloudy, no rain	30 mins (conducted in Swamp Mahogany Forest) Average hollow density in Swamp Oak Forest was collected during flora quadrat surveys
Koala SAT test	7/12/2010	Warm afternoon, light breeze, partly cloudy, no rain	30 mins
Spotlighting	6/6/10, 7/6/10, 8/6/10, 10/6/10, 1/12/2010, 2/12/2010, 3/12/2010, 4/12/2010	Cool to mild evenings, no rain, calm to light breeze, partly cloudy to overcast	9.5 person hrs
Anabat recording	22/10/09, 6/6/10, 8/6/10, 10/6/10, 2/12/10	Cool to mild evenings, no rain, calm to light breeze, partly cloudy to overcast	18.5 recording hours
Nocturnal call playback (owls and bitterns)	2/6/10, 6/6/10, 7/6/10, 8/6/10, 10/6/10, 7/12/2010	Cool to mild evenings, no rain, calm to light breeze, partly cloudy to overcast	30 mins per survey event
Bird survey	10/6/10, 11/6/10	Cool to mild mornings, partly cloudy, light breeze	4 x 2 ha 30 min plots repeated; 2 x 30 min meandering = 5 person hrs
Diurnal herpetofauna search	25/5/10, 26/5/10	Mild humid days, no rain, partly cloudy to overcast, calm	4 person hrs
Nocturnal herpetofauna search	2/6/10, 10/6/10	Mild humid evenings, no rain, partly cloudy to overcast, calm to light breeze	3.5 person hrs
Targeted threatened/migratory bird surveys	6/12/2010, 7/12/2010	Warm, humid mornings, clear to partly cloudy, no rain, light breeze	5 x 2 ha 30 min plots repeated; 2 x 1 hour meandering = 7 person hrs; 2 x 0.5 hr river transect repeated
Targeted Australasian Bittern surveys	20-21/9/2011	Mild, clear to partly cloudy evenings, slight breeze.	2.5 person hours



Survey Method	Date/s	Weather Conditions	Survey Effort
Targeted threatened amphibian surveys	1-4/12/2010	Mild humid evenings, some rain and light breezes	12 person hrs over 4 nights
Targeted Grass Owl surveys (Regional)	2/8/2011 – 23/8/2011	Mild evenings, scattered light rain on some evenings, light breezes	75 person hours
Synchronized Grass Owl survey (Regional)	12/9/2011 – 15/9/2011	Mild, clear evenings, slight breezes	7.5 person hours

Table 2: Minimum and maximum daily temperatures and total rainfall for the fauna survey period.

Date	Temperature (°C)		Rainfall (mm)
	Minimum	Maximum	
22/10/2009	11.2	22.1	0
24/5/10	8.2	20.8	0
25/5/10	12.4	19.3	8.6
26/5/10	12.1	19.4	2.6
27/5/10	14.3	21.1	24.0
28/5/10	10.1	20.9	0
2/6/10	8.7	19.8	0
6/6/10	9.2	18.0	0.2
7/6/10	8.2	17.2	7.4
8/6/10	9.0	17.9	4.2
10/6/10	9.6	16.6	0
11/6/10	3.8	15.8	0
1/12/2010	18.9	23.4	14.0
2/12/2010	18.0	27.5	19.6
3/12/2010	20.3	29.7	1.6
4/12/2010	19.7	27.0	0.2
6/12/2010	18.8	27.1	0
7/12/2010	17.7	27.4	0
2/08/2011	6.3	23.9	0
4/08/2011	5.2	24.7	0
8/08/2011	7.1	17.9	2.2
10/08/2011	6.7	17.3	0
11/08/2011	2.1	18.3	0
15/08/2011	7.5	18.7	5.4
16/08/2011	6.5	18.6	0
17/08/2011	4.8	17.4	0
18/08/2011	10.1	17.8	7.6
22/08/2011	12.4	18.8	8.4
23/08/2011	10.4	19.4	0.8
12/09/2011	9.0	17.8	2.6
14/09/2011	10.2	25.2	0
15/09/2011	12.7	21.5	0
20/09/2011	14.5	30.5	0
21/09/2011	8.2	20.9	0

Source: Williamtown RAAF (station 061078), BOM 2011.



2.3. Flora

2.3.1. Floristic diversity

Systematic flora surveys were conducted across the study area (**Figure 6**) and involved the following techniques:

Floristic Quadrats

A total of 20 standard 0.04 ha (20 m x 20 m) floristic quadrats were surveyed for the presence of flora species. Each quadrat was carefully examined to identify all plant species present (**Appendix 1**). Cover abundance of flora species within each quadrat was recorded using the modified Braun-Blanquet cover-abundance scale (Poore, 1955).

Targeted Threatened Flora Meanders

Random meanders included walks between floristic quadrats and time spent mapping vegetation community ecotones. Meandering routes were also used to undertake targeted surveys for threatened flora species identified as occurring in the region. Targeted surveys for a number of threatened flora species within the proposed Northbank Enterprise Hub site were undertaken by **ecobiological** on 22 November 2010 and 29 November 2011. The surveys were performed in spring to coincide with the flowering time of all target species. The surveys consisted of a random meander within the subject site during a 6 hour period in November 2010 and 2011 (**Figure 6**). Survey efforts were largely concentrated within the Freshwater Wetland EEC, Swamp Oak Forest EEC and Swamp Sclerophyll Forest EEC as these communities provide suitable habitat for the targeted threatened species; the Exotic Grassland areas do not represent suitable habitat for any of these threatened flora species.

Additionally, within the Freshwater Wetland EEC survey efforts were focussed in areas with the most suitable habitat for target species. Some areas within the Freshwater Wetland EEC were considered unsuitable habitat for target species or were inaccessible due to impenetrable patches of *Typha* and *Phragmites*.

Floristic Identification and Nomenclature

Floristic identification and nomenclature was based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNet (<http://plantnet.rbgsyd.nsw.gov.au>). If a plant was unable to be identified



using these references, a sample was sent to the National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW.

2.3.2. Flora survey limitations

Due to the considerable size of the study area, flora survey effort was stratified to cover representative areas of each vegetation community, meaning that the number of flora species detected is likely to underestimate the true diversity within the site. Random meanders have been undertaken within all vegetation communities in the study area. Searches for threatened flora targeted areas of highest potential habitat value e.g. threatened ecological communities, drainage lines and wetland areas. The total flora survey effort compared to the OEH (2004) guidelines is provided in **Appendix 3** and is mapped in **Figure 6**.

2.3.3. Vegetation community mapping

The identification of vegetation communities was based on dominant species present in the over-storey, mid-storey, shrub and ground layers as recorded in 0.04 ha (20 m x 20 m) floristic quadrats. The species composition of each vegetation community was compared to the vegetation descriptions in the Hunter, Central and Lower North Coast Vegetation Classification and Mapping Project (Somerville, 2009), in order to arrive at an accepted community identity.). In addition, each vegetation community was divided into vegetation formations and classes based on the classification system described by Keith (2004). An equivalent Biometric vegetation type was also assigned to all natural vegetation communities from the DECC Biometric Type Database.

The boundaries of each of the identified vegetation community within the study area were mapped using a combination of rapid data points (RDP), ecotone walking and aerial photography interpretation (API). RDPs involved taking waypoints over the subject site using a hand held Global Positioning System (GPS) and recording dominant species in each structural layer. Ecotone walking involved mapping the boundary of each vegetation community using a hand held GPS and using the recorded tracks. The RDPs and ecotone tracks were then overlaid on an aerial photograph and were used to define vegetation community boundaries.

2.3.4. Vegetation community significance

Vegetation communities within the study area received an assessment of their significance according to a number of floristic, structural and conservation criteria. These criteria are outlined in **Table 3**.

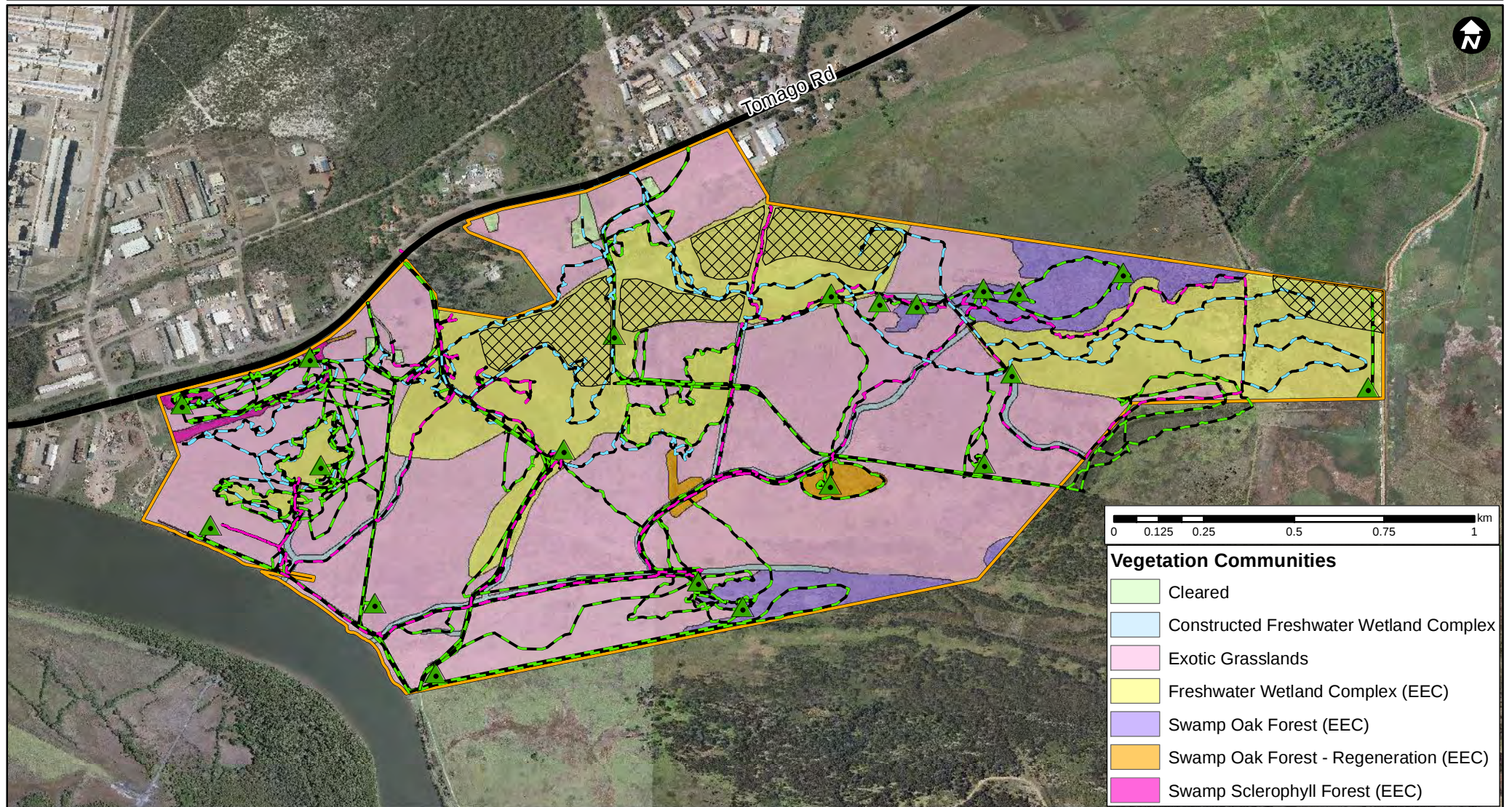


Table 3: Attributes and weighting of the scoring system for vegetation community significance assessment.

Significance Assessment:						
1	Is the vegetation community currently regarded as a TEC or a derivative of a TEC?				Yes	High
					No	Refer to Q2
2	Does the vegetation community support known threatened flora species populations?				Yes	High
					No	Refer to biometric benchmark scoring systems below
Biometric Benchmark Scoring System						
Attribute		Weighting				Score
Native plant species richness		10	High = 2	Moderate = 1	Low = 0	20
% foliage cover - over-storey		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - mid-storey		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - ground cover - shrubs		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - ground cover (grasses)		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - ground cover (shrubs)		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - ground cover (other)		5	High = 2	Moderate = 1	Low = 0	10
% foliage cover - exotics		5	High = 2	Moderate = 1	Low = 0	10
Total Score						Max 90
Vegetation communities shall be considered as follows:						
High if within the scoring system it attains a score of >70						
Medium if within the scoring system it attains a score of 20 - 70						
Low if within the scoring system it attains a score of <20						

NB: Species richness and foliage cover estimates were derived from the biometric benchmark scoring system (DECC, 2009b). For native plant species richness, a value greater than or equal to the benchmark data was given a high weighting, values between 50% and 100%, a moderate weighting and values below 50%, a low weighting. Native foliage cover received a high weighting for values within benchmark data, a moderate weighting for values 25% above or below benchmark data and a low weighting for values over 25% above or below benchmark data. Foliage cover of exotic species received a high weighting when less than or equal to 5%, a moderate weighting when between 5% and 33%, and a low weighting for values greater than 33%.

Figure 6 - Flora survey effort over vegetation mapping



Legend

- Study Area
- Low Quality Habitat/Inaccessible Typha/Phragmites
- Flora Survey Quadrat
- Threatened Flora Searches (Nov 2010)
- Vegetation Transect Meandering (2009)
- Threatened Flora Searches (Nov 2011)

ecobiological

Map Projection:
GDA94
NSW Lamberts Conformal Conic

Data Sources:
OpenStreetMap - 2010
ecobiological - 2010
DECCW - 2010
LPI - 2006

Project Ref: 350-694
Plot Date: 09/12/2010 1101
Revision: Joyce 002



2.4. Fauna

2.4.1. Fauna survey techniques

The assessment of vertebrate fauna was undertaken across the study area and the following fauna groups were surveyed based on the Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004; DECCW 2009a) and the Lower Hunter Central Coast Regional Environmental Management Strategy: Flora and Fauna Guidelines (Murray *et al.* 2002a, 2002b).

The study area was stratified based on broad fauna habitat types. The methods used to survey for fauna are outlined below. Aquatic fauna survey work was not undertaken as part of this assessment. Refer to Coast Ecology's report (2012) for the Aquatic Impact Assessment.

The locations of fauna trapping and other fauna survey techniques are shown in **Figure 7**. The total fauna survey effort compared to the OEH (2004 & 2009) guidelines is provided in **Appendix 3**.

2.4.2. Fauna survey limitations

Due to the considerable size of the study area, fauna survey effort was stratified to cover representative areas of each vegetation community, meaning that the number of fauna species detected is likely to underestimate the true diversity within the site. Not all of the trapping effort undertaken meets the OEH guidelines with respect to arboreal trapping and reptile pitfall trapping (DEC 2004). This is due to the study area being almost entirely cleared and supporting very little mature canopy vegetation or hollow-bearing trees suitable for arboreal fauna. Habitat for threatened reptile species is also lacking, however, several common species were detected during herpetofauna searches and other survey activities.

With regard to trapping and some fauna surveys being conducted predominantly in May and June 2010, **ecobiological** considers that these surveys were adequate for detecting the majority of threatened and common species with potential to occur on the site. Additional nocturnal surveys (targeting threatened owls, insectivorous bats, Australasian Bittern, mammals and amphibians) and targeted diurnal threatened / migratory bird surveys were conducted in December 2010, followed by targeted Eastern Grass Owl surveys in August and September 2011 and additional Australasian Bittern surveys in September 2011 to cover seasonality issues for remaining threatened species with potential habitat on site.



Opportunistic records of common species were recorded during these targeted threatened species searches and added to the overall species list.

Arboreal Mammals

Arboreal trapping was conducted along Transect 1 within the Swamp Oak Rushland Forest Community. Five Elliott B traps and five hair tubes were placed along the transect in trees at heights of 3 m or above. Traps were baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps and hair tubes were sprayed with a honey and water mixture to encourage a foraging animal to descend the trunk to the trap site.

Traps were checked daily for arboreal species and wafers from the hair tubes were collected after a four night period and checked for the presence of hair samples. Hair identification methods followed those of Brunner *et al.* (2002). If any hair samples were suspected to be from a threatened species, the sample was sent to Barbara Triggs, an expert in the field of hair identification for verification.

Spotlighting was undertaken on foot between dusk and dawn for a total of 9.5 person hours over 8 nights to identify the presence of any mammal species.

Small and Large Terrestrial Mammals

For small and medium sized terrestrial mammals, 75 Elliott A and 75 Elliott B traps, 18 cage traps and 30 hair tubes were placed on the ground along three transects at approximately 20 m intervals. Traps were baited with a mixture of rolled oats, honey, peanut butter and treacle. The traps were set in position for four consecutive nights and checked each morning.

As previously stated, spotlighting was undertaken on foot between dusk and dawn for a total of 9.5 person hours over 4 nights to identify the presence of any mammal species.

Bats

Anabat bat-call recorders (Titley Scientific, Ballina) were used to record the calls of any Microchiropteran bats feeding in the area. The units were set up after dusk and recording occurred for a total of 18.5 hours over 4 nights at 10 locations. Bat calls were analysed by Kristy Peters and David Paull of **ecobiological**.



One harp trap was positioned in bat ‘flyways’ along each transect and set in position for four consecutive nights and checked each morning.

Harp traps are useful for capture of slower flying bat species that commonly fly below the canopy. Some of these species have weak echolocation calls or have calls which are readily confused with other bat species, limiting the accuracy of echolocation call analysis.

Spotlighting searches of blossoming trees were undertaken to identify any Megachiropteran bat species. This was conducted during the spotlighting effort described above for mammals.

Birds

Quadrat-based surveys were conducted in June 2010 at four locations. The four 2 ha quadrats were surveyed for 30 minutes each on one morning and then repeated the following day. Two meandering transects were also undertaken (one through the exotic grasslands and one through the Swamp Oak community along the southern boundary of the study area).

An additional 5 quadrats were surveyed for 30 minutes on one morning in December 2010 and then repeated the following day, focusing on surveying the three main habitat types found within the study area (i.e. Freshwater Wetland Complex, Exotic Grassland and Swamp Oak Forest). NB: One of these quadrats was the same as in June 2010, therefore, 8 locations. A meandering transect was also undertaken on both days whilst walking between the 5 survey quadrats

Birds were identified either visually, with the aid of binoculars, or by call interpretation. Surveys were conducted in the morning or late afternoon, when bird activity is maximised (Bibby *et al.* 2000). Opportunistic surveys were also conducted while driving throughout the study area and during other fauna survey activities. These sightings were listed separately to actual survey results (**Appendix 2**).

Targeted Migratory Bird Surveys

Targeted surveys for threatened and/or migratory bird species were conducted in December 2010. A 200 m transect was walked along the Hunter River (see **Figure 7**) to look for migratory shorebird species potentially using the rocky banks of the Hunter River for roosting. Refer to section 3.2.1 for a



description of the available habitat along the Hunter River for migratory shorebirds.

Targeted Nocturnal Bird Surveys

Targeted nocturnal bird surveys were conducted on 6 nights at a total of 6 locations. On dusk or within an hour of nightfall, the calls of threatened nocturnal bird species (Powerful Owl, Barking Owl, Masked Owl, Eastern Grass Owl, Australasian Bittern and Black Bittern) were broadcast over a megaphone in an attempt to encourage a response. This process involved playing a pre-recorded call for a period of a few minutes, followed by listening and watching for a response from fauna for a few minutes, and repeating. Searches for the Red-backed Button-quail were undertaken on or just after dusk during walking and driving spotlight transects conducted across the study area.

Targeted Australasian Bittern Surveys

The Australasian Bittern was targeted again in September 2011. Over two nights, the calls of the Australasian Bittern were broadcast in potential habitat for this species. The process involved broadcasting the calls for five minutes followed by 10 minutes of listening, followed by another five minutes of broadcasting and another five minutes of listening at several locations throughout the study area (**Figure 7**).

Amphibians

Standardised survey techniques for amphibian species were employed throughout the survey period and included diurnal habitat searches, nocturnal spotlight surveys, call playback and dip netting for tadpoles.

Spot surveys of the local frog assemblage were carried out at 5 sites over eight days for a total of 17.5 person hours. Road surveys of calling frogs were also undertaken throughout the study area.

The Green and Golden Bell Frog (*Litoria aurea*) was subject to targeted surveys due to potentially suitable habitat for this species occurring across the study area. Targeted survey methods used follow that outlined in the NSW Threatened Amphibian Survey Guidelines (DECC 2009a) and the Commonwealth's guidelines for threatened frogs (DEWHA 2010). A habitat assessment to assess the suitability of habitat for this species in the study area was carried out. During diurnal surveys, dip netting and visual searches were



carried out to locate any tadpoles present in any water bodies. Nocturnal surveys, including spotlight searches and call playbacks were undertaken for this species. Spotlight searches were carried out by walking lengths of suitable habitat and using head torches to search for frogs by eye shine or by physical sightings over four consecutive nights (1 – 4/12/2010). Nights selected for this survey effort were mild (18-20° C), cloudless and following heavy rainfall during the previous week.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were keyed out using diagnostic features including mouthparts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle height and direction, vent length and direction, and tadpole behaviour according to Anstis (2002).

Reptiles

No trapping was undertaken for reptiles as a habitat assessment revealed that the study area did not support suitable habitat for any threatened reptile species. Meandering surveys were carried out over four days for a total of 7.5 person hours. During survey periods on the study area suitable reptile habitat was inspected to detect the presence of any reptile species by way of occupancy, scats or other detectable traces. Suitable habitat included roadsides, under rocks and in crevices (however, there was very limited rocky habitat on site), any fallen hollow logs and limbs, burrows and suitable rubbish items such as sheets of tin. Opportunistic sightings of any reptile species were also noted during nocturnal amphibian surveys, spotlighting and other meandering transects.

2.4.3. Fauna habitat value assessment

An assessment of fauna habitat values was made at 6 locations across the study area. Habitat attributes were assessed using a representative analysis, utilising 20m x 50m plot surveys within each vegetation community type. The analysis required a quantitative approach, reporting on a range of attributes. The attributes and associated weighting of the subjective scoring system are listed in **Table 4**.



Table 4: Attributes and weighting of the scoring system for fauna habitat value.

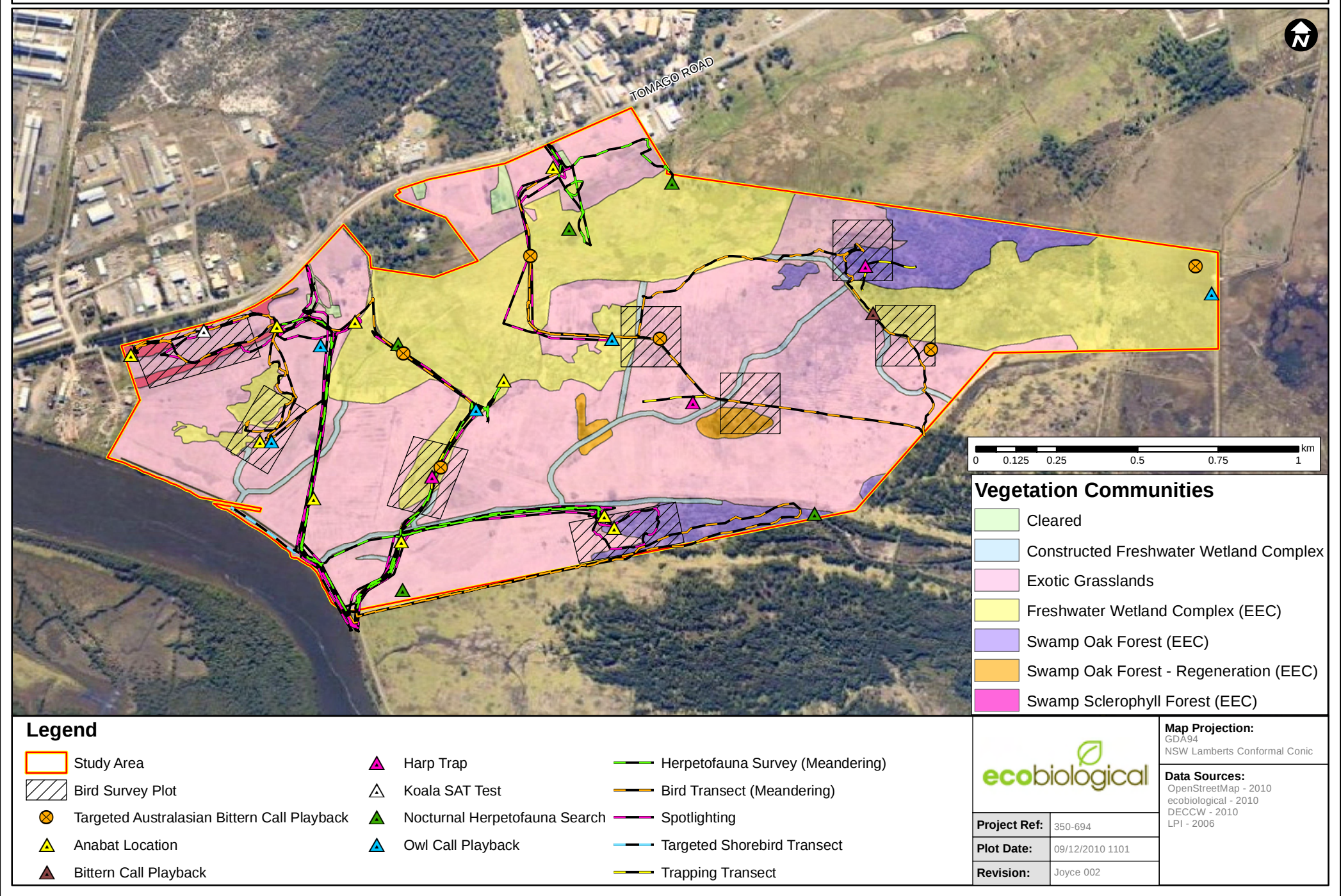
Attribute	Weighting				Score
Abundance of Hollows	10	High = 2	Moderate = 1	Low = 0	
Abundance of dead trees/stags	10	High = 2	Moderate = 1	Low = 0	
Caves/mines/tunnels	5	Yes = 2	-	No = 0	
Presence Wet areas/water bodies	10	Yes = 2	-	No = 0	
Abundance of rocks/escarpments	5	High = 2	Moderate = 1	Low = 0	
Abundance of fallen timber or logs	5	High = 2	Moderate = 1	Low = 0	
Abundance of nectar resources	5	High = 2	Moderate = 1	Low = 0	
Abundance of fruit resources	5	High = 2	Moderate = 1	Low = 0	
Community part of wildlife corridor	10	Regional =	Local = 1	None = 0	
Community in key habitat area	10	Yes = 2	-	No = 0	
Faunal refugia values	5	High = 2	Moderate = 1	Low = 0	
Dense shrub or ground cover	5	High = 2	Moderate = 1	Low = 0	
Faunal species diversity	5	High = 2	Moderate = 1	Low = 0	
Structural complexity of habitat	5	High = 2	Moderate = 1	Low = 0	
Total Score					

Each vegetation community is attributed a fauna habitat significance ranking using a 3-tiered approach (high, medium or low) as follows:

- High, if within the subjective scoring system it attains a score of >120;
- Medium, if within the subjective scoring system it attains a score of 61–120;
- Low, if within the subjective scoring system it attains a score of <60.

Results of the habitat values for the study area were then mapped and shown over an aerial image. For the Green and Golden Bell Frog, a systematic assessment was made of the wetland habitat scored against habitat attributes required by this species.

Figure 7 - Fauna survey effort over vegetation mapping





2.5. Regional Grass Owl survey

In August and September 2011 a regional survey was undertaken to determine the population status of the Eastern Grass Owl in the Newcastle region. The methods of this survey are outlined in the following sections.

2.5.1. Database search targeting the Eastern Grass Owl

A database search was conducted prior to field surveys to locate recorded sightings of the Grass Owl within the region (**Table 5**). This list enabled us to target suitable areas of habitat for this species. The list was compiled from the following databases:

- 75 km radius search of OEH's Atlas of NSW Wildlife: (www.wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp);
- 75 km radius search of SEWPAC's Protected Matters: (www.environment.gov.au/erin/ert/epbc/index.html).

Table 5: Grass Owl records within the Newcastle Region.

Location	Last date recorded	Number	Detection type	Latitude	Longitude
Seaham	30/12/1983	1	Road Kill	-32.6889	151.7093
1km south of Bulahdelah	31/10/1998	1	Dead	-32.4219	152.1991
Tomago Road, Tomago	15/02/2010	Unknown	Observed	-32.8338	151.7279
Tomago Road, Tomago	7/06/2010	Unknown	Observed, heard call	-32.8382	151.7347
Girvan	31/08/1993	1	Dead	-32.4776	152.0326
Allworth	31/12/1993	1	Observed	-32.5419	151.9563
Karuah	31/12/1993	1	Dead	-32.6556	151.9603
Anna Bay	30/09/1993	1	Dead	-32.7819	152.0817
Lakes Rd, Bombah Point	4/04/1997	1	Observed	-32.5072	152.275

2.5.2. Habitat determination and site selection

Sites were chosen throughout the Newcastle region by reviewing NPWS Atlas data records of the Grass Owl, by using **ecobiological's** previous survey data on the species, and by prior knowledge of the species habitat requirements (Hollands 2008, Higgins 1999, Clulow *et al.* 2011).



Suitable parcels of land that contained potential habitat were mapped and a qualified ecologist inspected each area in the field to confirm the suitability of each area.

In total, 40 sites were selected as being representative of suitable habitat for the Grass Owl within the Newcastle region.

2.5.3. Individual survey

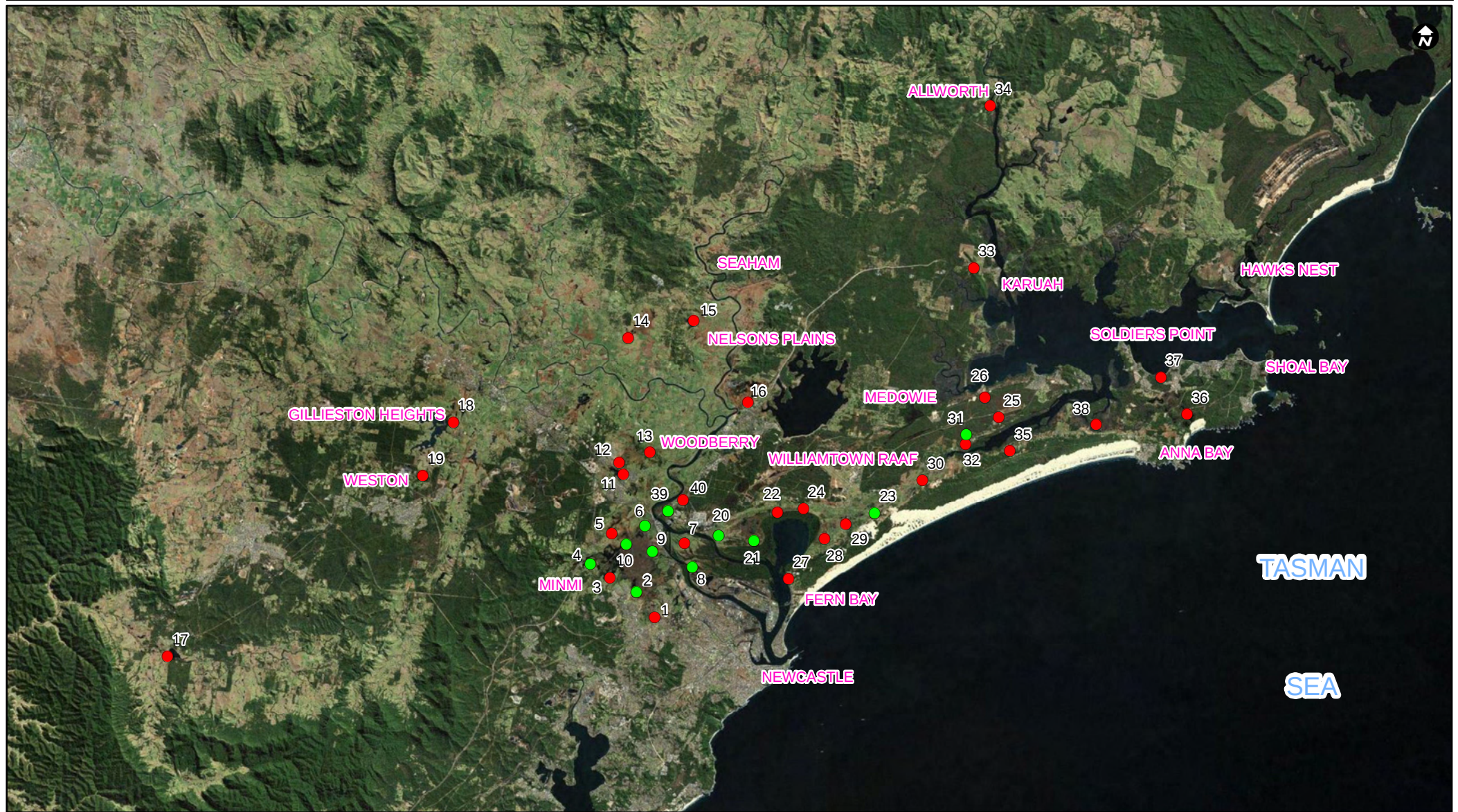
After dark, calls of the Grass Owl were broadcast using a megaphone in an attempt to encourage a call back response and/or a sighting of an owl. Calls were broadcast for an initial period of five minutes followed by a 10 minute waiting period. During this period an ecologist listened for responding calls and spot lit the immediate area for signs of present owls. A further five minutes of calls were once again broadcast, followed by a five minute listening period, overall totalling 25 minutes of survey time per site.

Each site was visited a total of five times or until a positive identification of a Grass Owl was made. All weather conditions and the direction of any owl call or individual were also noted. The sites surveyed in the region are shown in **Figure 8**.

2.5.4. Synchronised survey of confirmed sites

Sites where a Grass Owl was confirmed by either a call response or a sighting were surveyed again simultaneously in order to determine whether individual owls were being counted twice at sites in close proximity. This synchronised survey effort was repeated over three nights using the same method of owl call playback as used in the individual surveys. Sites 23 and 31 were excluded from the synchronised survey due to their isolation from other confirmed sightings. These two sites are located far enough apart from the others to represent separate records.

Figure 8 - Grass Owl Survey Locations



Legend / Notes

- Confirmed Grass Owl sightings
- Grass Owl survey locations

SCALE 1: 400 000



Project Ref:	411-870
Plot Date:	22/08/2012 09:05
Revision:	001 (G.Joyce)

Map Projection:

GDA 94
MGA Zone 56

Data Sources:

LPMA - 2011
OpenStreetMap - 2011
NearMap - 2011
ecobiological - 2011

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.



2.6. Port Stephens Comprehensive Koala Plan of Management

The Port Stephens Comprehensive Koala Plan of Management (CKPoM) applies to all development applications on land within the LGA of Port Stephens. It aims to ensure the long-term sustainability of any local Koala populations. The CKPoM Guidelines for Koala Habitat Assessment have been used to determine the impact that the proposed development will have on the subject property and surrounding potential koala habitat and/or populations. Compliance with the provisions of the CKPoM will constitute compliance with the provisions of SEPP 44. The Koala Habitat Assessment is undertaken in 4 major parts:

- 1) **Preliminary Assessment** – refer to the Koala Habitat Planning Map of the Port Stephens LGA to determine the mapped Koala Habitat and undertake an inspection of the subject site to determine whether the subject site contains individuals of preferred koala feed trees (**Table 6**) outside areas mapped as Preferred Koala Habitat.

Table 6: Preferred Koala tree species in Port Stephens LGA.

Scientific Name	Common Name
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus parramattensis</i>	Parramatta Red Gum

- 2) **Vegetation Mapping** – of the subject site and surrounding area using aerial photography and detailed ground-truthing. Floristic and structural characteristics of each vegetation community was determined using both transect and quadrat based survey methods.
- 3) **Koala Habitat Identification** – If the LGA-wide vegetation map produced by Port Stephens Council is inaccurate for the subject site, a revised Koala Habitat Planning Map in accordance with the vegetation communities definitions of the CKPoM must be produced. If it is identified that the subject site contains either Preferred or Supplementary Koala habitat, Habitat Buffers or Habitat linking areas then proceed to Step 4.
- 4) **Assessment of Proposal** - At this point a map needs to be produced showing information gathered in Steps 1, 2 and 3 and showing the proposed development. The appropriateness of the proposal is assessed using performance criteria from Appendix 4 of the CKPoM. If the applicant requests that council waive



provisions listed in Appendix 4, additional work is required. The additional work involves an assessment of koala habitat utilisation of the subject site using the Spot Assessment Technique (SAT). This method locates potential habitat and signs of the presence of the Koala (such as faecal pellets and claw marks) and determines the activity level and the significance of the Koala habitat. The activity level for the SAT is expressed as the percentage equivalent of the quotient derived by dividing the number of trees that had one or more Koala faecal pellets recorded beneath them, by the total number of trees sampled.

2.7. Groundwater and wetland policies

2.7.1. Groundwater dependent ecosystems

The NSW Government has published a rapid assessment methodology for identifying and attributing a value to Groundwater Dependent Ecosystems (DLWC 2002), based on the work conducted by the Nature Conservation Council of NSW. The methodology comprises eight steps as follows:

1. Identify geographical area. The area defined in this step can relate to an aquifer or parts thereof, or may be linked to the development of a planning instrument (i.e. the area might be delineated by an LGA or suburb boundary).
2. List GDEs present. Ecosystems known, or considered likely, to occur in the defined area is listed. These are tabulated according to location, type of GDE, and type of groundwater system. Any information gaps should also be recorded at this stage.
3. Assess the vulnerability of GDEs. Each ecosystem is to be assessed based on its vulnerability to quantity depletion (i.e. over extraction), quality impacts (i.e. contamination) and other threatening factors. The degree of dependence on groundwater is to be assessed, and the nature of that dependency is to be recorded (e.g. seasonal, permanent, and opportunistic).



4. Assess the value of the ecosystems. Factors such as the ecological values of biodiversity and species assemblages should be considered. The social and economic values of the groundwater system for water supply, as a recreational or tourism component, its cultural importance or its worth in maintaining local amenity are also to be considered. Priorities for action can then be decided.
5. List management tools to be used. Regulatory and non-regulatory tools should be identified that can be applied to the protection of the GDEs. These might include risk assessments, land use restrictions or applying special conditions to bore licences.
6. Prioritise management actions. Cost-benefit analyses should be undertaken to establish the most effective management tools and options to protect the GDEs identified in the area.
7. Implement management actions.
8. Review process and outcomes.

A Groundwater Dependent Ecosystem assessment has been completed in line with the above steps in section 4.9.

2.7.2. Wetlands

For wetlands in NSW, key elements of the Wetland Policy are given below:

- Wetlands are valued as significant parts of NSW landscapes - their conservation and management are most appropriately considered at the catchment scale;
- Appropriate water regimes and water quality needed to maintain or restore the ecological sustainability of wetlands will be provided through the implementation of water management plans;
- Wetlands of international, national, state and regional significance will be identified and conserved;
- Land use and management practices will maintain or rehabilitate wetland habitats, processes and cultural values;
- Degraded wetlands and their habitats will be rehabilitated and their ecological processes restored as far as is practicable;
- The potential impacts of climate change will be considered in long



term strategies for water resources and land use;

- Continued research into wetland ecology will be encouraged to better support water and land use planning and management;
- Natural wetlands should not be destroyed or degraded. When social or economic imperatives in the public interest result in a wetland being degraded or destroyed, the rehabilitation or construction of a compensatory wetland that supports similar biodiversity and ecological functions will be required;
- Purpose-built wetlands will not be constructed on the site of viable natural wetlands; and
- Cooperation and incentives among land managers, government authorities, catchment management authorities, non-government organisations and the general community is essential for effective wetland management, and will be encouraged.

An impact assessment in consideration of the above elements of the NSW Wetlands Policy has been undertaken in section 4.10.



3. Results and discussion

3.1. Threatened species database search

The records of threatened species, listed in the Atlas of NSW Wildlife, previously recorded within a five-kilometre radius of the study area are detailed in the following sections (accessed and updated in August 2012). In addition to a search of the Atlas of NSW Wildlife, a review of past ecological reports carried out in the general area, **ecobiological** consultant records, and a variety of other databases (PlantNET <http://plantnet.rbgsyd.nsw.gov.au>, Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Search Tool <http://www.environment.gov.au/erin/ert/epbc/index.html>, Ozcam www.ozcam.gov.au and Birddata <http://www.birddata.com.au>) were consulted for any additional threatened species records. Additional species listed in the Director General's Requirements for this project were also added.

Flora

Fourteen (14) threatened flora species were identified during the database search (**Table 7**). It should be noted that *Euphrasia arguta* was until recently presumed extinct. After the discovery of several sizeable populations in NSW, this species is now listed as critically endangered under the TSC Act.

Seven Threatened Ecological Communities which have the potential to occur in the study area and/or locality were also identified during the database search (**Table 7**).



Table 7: Threatened flora species and ecological communities recorded from preliminary database search and literature review.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	ROTAP code	Last Date Recorded	Source
Flora						
<i>Asperula asthenes</i>	Trailing Woodruff	V	V	3VC-	^	DGRs
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	2RCi	^	PlantNet
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	3VC-	^	DGRs
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	V	V	2VCi	1/4/2001	NPWS
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Parramatta Red Gum	V	V	2V	28/9/2010	NPWS
<i>Euphrasia arguta</i>		CE	-	3X	31/12/1886	NPWS
<i>Galium australe</i>	Tangled Bedstraw	E	-	-	^	DGRs
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	-	3/04/2008	NPWS
<i>Lindernia alsinoides</i>	Noah's False Chickweed	E	-	-	^	PlantNet
<i>Maundia triglochinos</i>	Small Water-ribbons	V	-	-	^	DGRs
<i>Persicaria elatior</i>	Tall Knot-weed	V	V	3V	^	PlantNet
<i>Rulingia prostrata</i>	Dwarf Kerrawang	E	-	2ECi	27/03/2006	NPWS
<i>Tetralix juncea</i>	Black-eyed Susan	V	V	3VCa	^	PlantNet
<i>Zannichellia palustris</i>		E1	-	3R	4/03/2008	NPWS
Ecological Community						
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	-		^	DGRs
Freshwater Wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	-		^	DGRs
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	CEEC		^	PMST
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		EEC	-		^	DGRs
River-flat Eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	-		^	DGRs
Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	-		^	DGRs
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC	-		^	DGRs

E = Endangered; V = Vulnerable; (NSW TSC Act 1995 & EPBC Act 1999); ^ Last date not available from database source; EEC = Endangered Ecological Community; CEEC = Critically Endangered Ecological Community; NPWS = NSW Wildlife Atlas; DGRs = Director General's Requirements; PMST = Protected Matters Search Tool (Federal); PlantNet = National Herbarium of NSW database.

'ROTAP Codes' are those provided in Rare or Threatened Australian Plants (Briggs & Leigh 1996). They are an aggregate code giving the Distribution Category (1, 2 or 3), the Conservation Status (X, E, V, R, or K, with or without C) and indication of the Size Class or Reserved Populations (a, i, t, -, or +). The key to the ROTAP codes is provided below:

- 1 - Known from one collection only.
- 2 - Geographic range in Australia less than 100 km.
- 3 - Geographic range in Australia greater than 100 km.
- X - Presumed extinct. Comparable to ANZECC and ESP categories.
- E - Endangered. Comparable to ANZECC and ESP categories.
- V - Vulnerable. Comparable to ANZECC and ESP categories.



- R – Rare.
- K – Poorly Known.
- C – Reserved. At least one population in National Park or other proclaimed reserve(s).
- a – 1000 plants or more are known to occur within a conservation reserve(s).
- i – Less than 1000 plants are known to occur within conservation reserve(s).
- – – Reserved population size is not adequately known.

Fauna

A total of 62 threatened fauna species (3 amphibian, 43 bird and 16 mammal species) and 32 migratory and/or marine bird species were identified in the preliminary database search (**Tables 8 and 9**). Obligate marine species (fishes, seals, sea-turtles, cetaceans and pelagic birds) are not considered in the preliminary assessment due to a lack of any suitable habitat in the study area.



Table 8: Threatened fauna species identified from preliminary database search and literature review.

Class/Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Last Date Recorded	Source
Amphibia					
<i>Crinia tinnula</i>	Wallum Froglet	V	-	7/10/2010	NPWS
<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V	26/03/2009	NPWS
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	V	V	^	PMST
Aves					
<i>Anseranas semipalmata</i>	Magpie Goose	V	-	10/01/2009	NPWS
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E	^	DGRs
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	20/07/2010	HBOC
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	-	^	DGRs
<i>Calidris alba</i>	Sanderling	V	-	^	DGRs
<i>Calidris ferruginea</i>	Curlew Sandpiper	V	-	19/1/2007	NPWS
<i>Calidris tenuirostris</i>	Great Knot	V	-	17/04/1999	NPWS
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	-	10/10/2008	NPWS
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	-	10/10/2008	NPWS
<i>Charadrius leschenaultii</i>	Greater Sand-plover	V	-	18/01/1992	NPWS
<i>Charadrius mongolus</i>	Lesser Sand-plover	V	-	13/02/1999	NPWS
<i>Circus assimilis</i>	Spotted Harrier	V	-	26/03/2009	NPWS
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	9/07/2008	NPWS
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	-	1/10/2003	NPWS
<i>Epthianura albifrons</i>	White-fronted Chat	V	-	15/05/2010	NPWS
<i>Esacus neglectus</i>	Beach Stone-curlew	CE	-	^	DGRs
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	9/07/2008	NPWS
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V	-	^	DGRs
<i>Haematopus longirostris</i>	Australian Pied Oystercatcher	E	-	13/02/1999	NPWS
<i>Hieraaetus morphnoides</i>	Little Eagle	V	-	10/10/2008	NPWS
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	-	30/11/1984	NPWS
<i>Ixobrychus flavicollis</i>	Black Bittern	V	-	7/02/1999	NPWS
<i>Lathamus discolor</i>	Swift Parrot	E	E	^	DGRs
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V	-	25/02/1990	NPWS
<i>Limosa limosa</i>	Black-tailed Godwit	V	-	13/03/2010	NPWS
<i>Lophoictinia isura</i>	Square-tailed Kite	V	-	6/07/1985	NPWS
<i>Neophema pulchella</i>	Turquoise Parrot	V	-	30/06/1991	NPWS
<i>Ninox connivens</i>	Barking Owl	V	-	^	DGRs
<i>Ninox strenua</i>	Powerful Owl	V	-	6/10/2010	NPWS
<i>Oxyura australis</i>	Blue-billed Duck	V	-	^	DGRs
<i>Pandion cristatus</i>	Eastern Osprey	V	-	25/02/2005	NPWS
<i>Petroica boodang</i>	Scarlet Robin	V	-	10/10/2008	NPWS
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	-	26/07/1996	NPWS
<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove	V	-	^	DGRs
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	-	10/10/2008	NPWS
<i>Rostratula australis</i>	Australian Painted Snipe	E	V	5/12/2004	NPWS
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	4/10/2007	NPWS



Table 8 cont: Threatened fauna species identified from preliminary database search and literature review.

Class/Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Last Date Recorded	Source
<i>Sternula albifrons</i>	Little Tern	E	-	6/02/1999	NPWS
<i>Stictonetta naevosa</i>	Freckled Duck	V	-	12/05/1985	NPWS
<i>Turnix maculosa</i>	Red-backed Button-quail	V	-	^	DGRs
<i>Tyto longimembris</i>	Eastern Grass Owl	V	-	7/06/2010	NPWS
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	18/10/2004	NPWS
<i>Xenus cinereus</i>	Terek Sandpiper	V	-	17/02/1999	NPWS
Mammalia					
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	^	DGRs
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	^	DGRs
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	6/10/2010	NPWS
<i>Miniopterus australis</i>	Little Bentwing-bat	V	-	10/06/2010	NPWS
<i>Miniopterus oceanensis</i>	Eastern Bentwing-bat	V	-	7/10/2010	NPWS
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	-	10/06/2010	NPWS
<i>Myotis macropus</i>	Southern Myotis	V	-	10/06/2010	NPWS
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	30/03/2010	NPWS
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	-	30/06/1992	NPWS
<i>Phascolarctos cinereus</i>	Koala	V	V	9/07/2008	NPWS
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo	V	V	^	PMST
<i>Pseudomys gracillicaudatus</i>	Eastern Chestnut Mouse	V	-	^	DGRs
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	-	V	^	PMST
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	10/06/2010	NPWS
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V	-	^	DGRs
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-	7/10/2010	NPWS

CE = Critically Endangered; E = Endangered; V = Vulnerable; (NSW TSC Act 1995 & EPBC Act 1999); ^ Last date not available from database source; NPWS = NSW Wildlife Atlas; DGRs = Director General's Requirements; PMST = Protected Matters Search Tool (Federal); HBOC = Hunter Bird Observers Club records.



Table 9: Migratory and/or marine species identified from preliminary database search and literature review.

Scientific Name	Common Name	EPBC Marine	JAMBA	CAMBA	RoKAMBA	Bonn
<i>Actitis hypoleucos</i>	Common Sandpiper	+	+	+	+	+
<i>Apus pacificus</i>	Fork-tailed Swift	+	+	+	+	
<i>Ardea alba</i>	Great Egret	+	+	+		
<i>Ardea ibis</i>	Cattle Egret	+	+	+		
<i>Arenaria interpres</i>	Ruddy Turnstone	+	+	+	+	+
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	+	+	+	+	+
<i>Calidris canutus</i>	Red Knot	+	+	+	+	+
<i>Calidris melanotos</i>	Pectoral Sandpiper	+	+		+	+
<i>Calidris ruficollis</i>	Red-necked Stint	+	+	+	+	+
<i>Charadrius bicinctus</i>	Double-banded Plover	+				+
<i>Charadrius ruficapillus</i>	Red-capped Plover	+				
<i>Galinago hardwickii</i>	Latham's Snipe	+	+	+	+	+
<i>Gallinago megala</i>	Swinhoe's Snipe	+	+	+	+	+
<i>Gallinago stenura</i>	Pin-tailed Snipe	+	+	+	+	+
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	+		+		
<i>Heteroscelus brevipes</i>	Grey-tailed Tattler	+	+	+	+	+
<i>Himantopus himantopus</i>	Black-winged Stilt	+				
<i>Hirundapus caudacutus</i>	White-throated Needletail	+	+	+	+	+
<i>Limosa lapponica</i>	Bar-tailed Godwit	+	+	+	+	+
<i>Merops ornatus</i>	Rainbow Bee-eater	+	+			
<i>Monarcha melanopsis</i>	Black-faced Monarch	+				+
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	+				+
<i>Numenius madagascariensis</i>	Eastern Curlew	+	+	+	+	+
<i>Numenius minutus</i>	Little Curlew	+	+	+	+	+
<i>Numenius phaeopus</i>	Whimbrel	+	+	+	+	+
<i>Philomachus pugnax</i>	Ruff	+	+	+	+	+
<i>Pluvialis fulva</i>	Pacific Golden Plover	+	+	+	+	+
<i>Pluvialis squatarola</i>	Grey Plover	+	+	+	+	+
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	+				
<i>Rhipidura rufifrons</i>	Rufous Fantail	+				+
<i>Tringa stagnatilis</i>	Marsh Sandpiper	+	+	+	+	+

JAMBA = Japan-Australia Migratory Bird Agreement; CAMBA = China-Australia Migratory Bird Agreement; RoKAMBA = Republic of Korea-Australia Migratory Bird Agreement; Bonn = Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention).



3.2. Assessment of likelihood of occurrence

An assessment as to whether each of the subject species/communities identified in section 3.1 are likely to occur on the study area was undertaken using the following primary sources:

- The Office of Environment & Heritage's threatened species website database
<http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx>;
- Van Dyke, S. and Strahan, R. (eds) (2008). *The Complete Book of Australian Mammals*. Reed New Holland Publishers, Australia.
- Cogger, H.A. (ed) (2000). *Reptiles and Amphibians of Australia*. Reed New Holland Publishers, Australia.
- *Handbook of Australian, New Zealand & Antarctic Birds*. Volumes 1 to 7. Oxford University Press Publishers, Melbourne.

Where any habitat used by these threatened species/ecological communities are likely to be directly or indirectly affected by the proposed development, these are deemed 'affected species' and an assessment of significance (seven-part test), and an EPBC Act assessment of significance where appropriate, was applied to each. **Table 10** summarises the likelihood of the subject matters occurring in the study area.

3.2.1. Migratory and marine species

Table 10 summarises the likelihood of the identified migratory and/or marine species occurring on the study area. The majority of the identified species do not have suitable habitat in the study area as discussed below but their habitat within nearby wetlands (SEPP 14 and Ramsar) may be indirectly impacted.

A search of various databases and relevant literature (Geering 1995; Straw 1999; Herbert 2007) revealed that there have been no recording of threatened migratory shorebirds on the study area. The majority of shorebirds feed on intertidal mudflats, the most extensive of which start on the eastern bank of the North Arm of the Hunter River at Fern Bay and extend into Fullerton Cove. Most of the remaining shoreline of the Hunter



River is mangrove-fringed with narrow margins of mud exposed at low tide. These areas are avoided by the majority of waders (Straw 1999). On the study area, potential habitat is restricted to rocky revetment along the Hunter River foreshore adjoining exotic grassland. The occasional mangrove clump is present along the 800 m of river frontage however; there is very limited foraging or roosting habitat for shorebirds.

Records of threatened migratory species such as the Great Knot, Terek Sandpiper, Black-tailed Godwit, Lesser Sand Plover and Australian Pied Oystercatcher are from nearby Kooragang Island, the Kooragang Dykes area and within Fullerton Cove. While the study area contains Freshwater Wetland Complex, this habitat is almost exclusively reedbeds dominated by *Typha orientalis* and *Phragmites australis*. There is no saltmarsh, permanent open water with muddy margins or sandy beach habitat within the study area.

Indirect impacts on SEPP 14 wetlands and the downstream Hunter Estuary Wetlands Ramsar site have been considered for these species and an assessment of impact undertaken in section 4.3.



Table 10: Likelihood of occurrence of subject matters in the study area.

Class/Scientific Name	Common Name	Likelihood of occurrence / suitability of habitat	Affected Matter (Yes / No)
Flora			
<i>Asperula asthenes</i>	Trailing Woodruff	Unlikely – some areas of suitable habitat present	Yes
<i>Callistemon linearifolius</i>	Netted Bottle Brush	Unlikely – unsuitable habitat	No
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	Unlikely – unsuitable habitat	No
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	Unlikely – unsuitable habitat	No
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Parramatta Red Gum	Unlikely – unsuitable habitat	No
<i>Euphrasia arguta</i>		Unlikely – unsuitable habitat	No
<i>Galium australe</i>	Tangled Bedstraw	Unlikely – unsuitable habitat	No
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	Unlikely – unsuitable habitat	No
<i>Lindernia alsinoides</i>	Noah's False Chickweed	Possible – some areas of suitable habitat present within Swamp Sclerophyll Forest	Yes
<i>Maundia triglochinoides</i>	Small Water-ribbons	Likely – suitable habitat	Yes
<i>Persicaria elatior</i>	Tall Knot-weed	Possible – some areas of suitable habitat present	Yes
<i>Rulingia prostrata</i>	Dwarf Kerrawang	Unlikely – unsuitable habitat	No
<i>Tetradlea juncea</i>	Black-eyed Susan	Unlikely – unsuitable habitat	No
<i>Zannichellia palustris</i>		Possible – some areas of suitable habitat present	Yes
Ecological Community			
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions		May have occurred historically in the study area, however, long-term water management for grazing and agriculture has altered the hydrology of the site from a more saline state to freshwater	No
Freshwater Wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		Present in the study area	Yes
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions		Unlikely – unsuitable habitat	No
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		Unlikely – unsuitable habitat	No
River-flat Eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		Unlikely – unsuitable habitat	No
Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		Present in the study area	Yes
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions		Present in the study area	Yes
Amphibia			
<i>Crinia tinnula</i>	Wallum Froglet	Possible – records from the immediate locality, including the adjoining MP07-0086 site	Yes
<i>Litoria aurea</i>	Green and Golden Bell Frog	Possible – records from the immediate locality	Yes
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	Unlikely – unsuitable habitat	No



Table 10 cont: Likelihood of occurrence of subject matters in the study area.

Class/Scientific Name	Common Name	Likelihood of occurrence / suitability of habitat	Affected Matter (Yes / No)
Aves			
<i>Anseranas semipalmata</i>	Magpie Goose	Possible – potential habitat, especially in times of prolonged wet weather.	Yes
<i>Anthochaera phrygia</i>	Regent Honeyeater	Unlikely – unsuitable habitat	No
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Some potentially suitable freshwater wetland roosting habitat occurs in southeast corner of site, however, there is little to no permanent open water foraging habitat present	Yes
<i>Burhinus grallarius</i>	Bush Stone-curlew	Unlikely – unsuitable habitat	No
<i>Calidris alba</i>	Sanderling	Unlikely – unsuitable habitat	No
<i>Calidris ferruginea</i>	Curlew Sandpiper	Unlikely – unsuitable habitat	No
<i>Calidris tenuirostris</i>	Great Knot	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Unlikely – unsuitable habitat	No
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Unlikely – unsuitable habitat	No
<i>Charadrius leschenaultii</i>	Greater Sand-plover	Unlikely – unsuitable habitat	No
<i>Charadrius mongolus</i>	Lesser Sand-plover	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Circus assimilis</i>	Spotted Harrier	Possible – potential habitat and foraging grounds occur within the site and surrounds	Yes
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Unlikely – unsuitable habitat	No
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Possible – itinerant visitor to the region during periods of prolonged wet weather when low lying areas become flooded	Yes
<i>Epthianura albifrons</i>	White-fronted Chat	Possible – this species has been recorded in freshwater wetland and coastal saltmarsh habitat on Kooragang and Ash Island and from Hexham Swamp	Yes
<i>Esacus neglectus</i>	Beach Stone-curlew	Unlikely – unsuitable habitat	No
<i>Glossopsitta pusilla</i>	Little Lorikeet	Unlikely – unsuitable habitat	No
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	Unlikely – unsuitable habitat	No
<i>Haematopus longirostris</i>	Australian Pied Oystercatcher	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Hieraaetus morphnoides</i>	Little Eagle	Unlikely – unsuitable habitat	No
<i>Irediparra gallinacea</i>	Comb-crested Jacana	Unlikely – unsuitable habitat	No



Table 10 cont: Likelihood of occurrence of subject matters in the study area.

Class/Scientific Name	Common Name	Likelihood of occurrence / suitability of habitat	Affected Matter (Yes / No)
Aves cont.			
<i>Ixobrychus flavicollis</i>	Black Bittern	Some potentially suitable freshwater wetland habitat occurs in southeast corner of site, however, there is no permanent open water present	Yes
<i>Lathamus discolor</i>	Swift Parrot	Unlikely – unsuitable habitat	No
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	Unlikely – unsuitable habitat	No
<i>Limosa limosa</i>	Black-tailed Godwit	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Lophoictinia isura</i>	Square-tailed Kite	Unlikely – unsuitable habitat	No
<i>Neophema pulchella</i>	Turquoise Parrot	Unlikely – unsuitable habitat. One record from study area in 1991 is considered unusual and possibly inaccurate.	No
<i>Ninox connivens</i>	Barking Owl	Unlikely – unsuitable habitat	No
<i>Ninox strenua</i>	Powerful Owl	Unlikely – unsuitable habitat	No
<i>Oxyura australis</i>	Blue-billed Duck	Unlikely – unsuitable habitat	No
<i>Pandion cristatus</i>	Eastern Osprey	Possible – may be observed flying over the study area, however, there are no permanent open water bodies present within the study area for foraging	Yes
<i>Petroica boodang</i>	Scarlet Robin	Unlikely – unsuitable habitat	No
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	Unlikely – unsuitable habitat	No
<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove	Unlikely – unsuitable habitat	No
<i>Chthonicola sagittata</i>	Speckled Warbler	Unlikely – unsuitable habitat	No
<i>Rostratula australis</i>	Australian Painted Snipe	Possible – Freshwater wetland habitat present is largely restricted to constructed drainage lines dominated by Phragmites. There are no areas of shallow water or mudflats present and the existing grass cover is dominated by exotic species, particularly Kikuyu to 50cm in height. However due to records in the area this species may use the site for opportunistic foraging.	Yes
<i>Stagonopleura guttata</i>	Diamond Firetail	Unlikely – unsuitable habitat	No
<i>Sterna albifrons</i>	Little Tern	Unlikely – unsuitable habitat	No
<i>Stictonetta naevosa</i>	Freckled Duck	Unlikely – unsuitable habitat	No
<i>Turnix maculosa</i>	Red-backed Button-quail	Possible – a record from Kooragang Island was accepted by the NSW Rarities Committee.	Yes
<i>Tyto longimembris</i>	Eastern Grass Owl	Recorded on site and in several locations within the locality and region	Yes
<i>Tyto novaehollandiae</i>	Masked Owl	Unlikely – unsuitable habitat	No



Table 10 cont: Likelihood of occurrence of subject matters in the study area.

Class/Scientific Name	Common Name	Likelihood of occurrence / suitability of habitat	Affected Matter (Yes / No)
Aves cont.			
<i>Xenus cinereus</i>	Terek Sandpiper	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
Mammalia			
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Unlikely – unsuitable habitat	No
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Unlikely – unsuitable habitat	No
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Recorded in study area	Yes
<i>Miniopterus australis</i>	Little Bentwing-bat	Recorded in study area	Yes
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Recorded in study area	Yes
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	Recorded in study area	Yes
<i>Myotis macropus</i>	Southern Myotis	Recorded in study area	Yes
<i>Petaurus norfolcensis</i>	Squirrel Glider	Unlikely – unsuitable habitat	No
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Unlikely – unsuitable habitat	No
<i>Phascolarctos cinereus</i>	Koala	The small amount of habitat present is sparse and does not represent core Koala habitat. The likelihood of a Koala utilising such a fragmented and disturbed patch is low. No evidence of presence was found during the SAT test.	Yes – removal of mapped Preferred Koala Habitat
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo	Unlikely – unsuitable habitat	No
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse	Unlikely – unsuitable habitat	No
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	Unlikely – unsuitable habitat	No
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Recorded in study area	Yes
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	Recorded in study area	Yes
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	Recorded in study area	Yes
Migratory and/or marine species			
<i>Actitis hypoleucos</i>	Common Sandpiper	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Apus pacificus</i>	Fork-tailed Swift	Possible – may be observed aerially foraging over the study area	Yes
<i>Ardea alba</i>	Great Egret	Unlikely – unsuitable habitat on study area	No
<i>Ardea ibis</i>	Cattle Egret	Present in the study area	Yes
<i>Arenaria interpres</i>	Ruddy Turnstone	Unlikely – unsuitable habitat	No



Table 10 cont: Likelihood of occurrence of subject matters in the study area.

Class/Scientific Name	Common Name	Likelihood of occurrence / suitability of habitat	Affected Matter (Yes / No)
Migratory and/or marine species cont.			
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Unlikely – unsuitable habitat	No
<i>Calidris canutus</i>	Red Knot	Unlikely – unsuitable habitat	No
<i>Calidris melanotos</i>	Pectoral Sandpiper	Unlikely – unsuitable habitat	No
<i>Calidris ruficollis</i>	Red-necked Stint	Unlikely – unsuitable habitat	No
<i>Charadrius bicinctus</i>	Double-banded Plover	Unlikely – unsuitable habitat	No
<i>Charadrius ruficapillus</i>	Red-capped Plover	Unlikely – unsuitable habitat	No
<i>Galinago hardwickii</i>	Latham's Snipe	Possible – some small patches of open water fringed by grasses and reeds in the northeast of the study area may provide marginal foraging habitat	Yes
<i>Gallinago megala</i>	Swinhoe's Snipe	Unlikely – rarely recorded from NSW	No
<i>Gallinago stenura</i>	Pin-tailed Snipe	Unlikely – rarely recorded from NSW	No
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Was observed flying over the Hunter River adjoining the study area, however, there are no permanent open water bodies present within the study area for foraging	Yes
<i>Heteroscelus brevipes</i>	Grey-tailed Tattler	Unlikely – unsuitable habitat	No
<i>Himantopus himantopus</i>	Black-winged Stilt	Unlikely – unsuitable habitat	No
<i>Hirundapus caudacutus</i>	White-throated Needletail	Possible – may be observed aerially foraging over the study area	Yes
<i>Limosa lapponica</i>	Bar-tailed Godwit	Unlikely – unsuitable habitat	No
<i>Merops ornatus</i>	Rainbow Bee-eater	Possible – some small areas of foraging habitat	Yes
<i>Monarcha melanopsis</i>	Black-faced Monarch	Unlikely – unsuitable habitat	No
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	Unlikely – unsuitable habitat	No
<i>Numenius madagascariensis</i>	Eastern Curlew	Unlikely – unsuitable habitat	No
<i>Numenius minutus</i>	Little Curlew	Unlikely – unsuitable habitat	No
<i>Numenius phaeopus</i>	Whimbrel	Unlikely – unsuitable habitat	No
<i>Philomachus pugnax</i>	Ruff	Unlikely – unsuitable habitat	No
<i>Pluvialis fulva</i>	Pacific Golden Plover	Marginal habitat represented by 1 – 2 m of muddy margins of Hunter River at low tide. The river frontage has been highly modified, with the deposition of large rocks as retaining and revetment and extensive clearing of mangroves.	Yes - indirectly
<i>Pluvialis squatarola</i>	Grey Plover	Unlikely – unsuitable habitat	No
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	Unlikely – unsuitable habitat	No
<i>Rhiphidura rufifrons</i>	Rufous Fantail	Unlikely – habitat remaining is fragmented and lacks structure	No
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Unlikely – unsuitable habitat	No



3.3. Flora

The floristic surveys conducted within the study area identified a total of 111 species, subspecies and varieties (**Appendix 1**). None of these species are listed as threatened under the TSC Act or EPBC Act, or rare under the ROTAP scheme. Given that the survey effort coincided with the flowering time of the target threatened species and weather conditions (high rainfall) at the time were conducive for flowering, it is unlikely that populations of these species occur within the study area.

Of the species recorded, 51 are considered exotic. Ten declared noxious weeds were recorded on the study area, including Crofton Weed (*Ageratina adenophora*), Lacy Ragweed (*Ambrosia tenuifolia*), Groundsel Bush (*Baccharis halimifolia*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Fireweed (*Senecio madagascariensis*), Castor Oil Plant (*Ricinus communis*), Camphor Laurel (*Cinnamomum camphora*), Pampas Grass (*Cortaderia selloana*), Blackberry (*Rubus fruticosus*) and Lantana (*Lantana camara*).

3.3.1. Vegetation community types

Field surveys revealed that the study area supported three natural vegetation communities, one regenerating natural vegetation community, one artificial wetland community and one highly disturbed grassland community dominated by exotic species (**Figure 9**). These include:

- Swamp Mahogany - Paperbark Swamp Forest;
- Swamp Oak Rushland Forest;
- Freshwater Wetland Complex;
- Swamp Oak Rushland Forest – Regeneration;
- Constructed Freshwater Wetland Complex;
- Exotic Grasslands.

The area of each vegetation community mapped is provided in **Table 11**. Approximately 28.7 ha of vegetation will be retained or rehabilitated within the study area (15.9 ha of which is proposed as on-site offsets). As part of proposed site rehabilitation, the remaining 12.8 ha of retained exotic grasslands will be rehabilitated to create an Overflow Wetland Rehabilitation Area (approximately 11 ha) and extend the areas of retained Swamp Oak Forest and Freshwater Wetland Complex (remaining 1.8 ha).

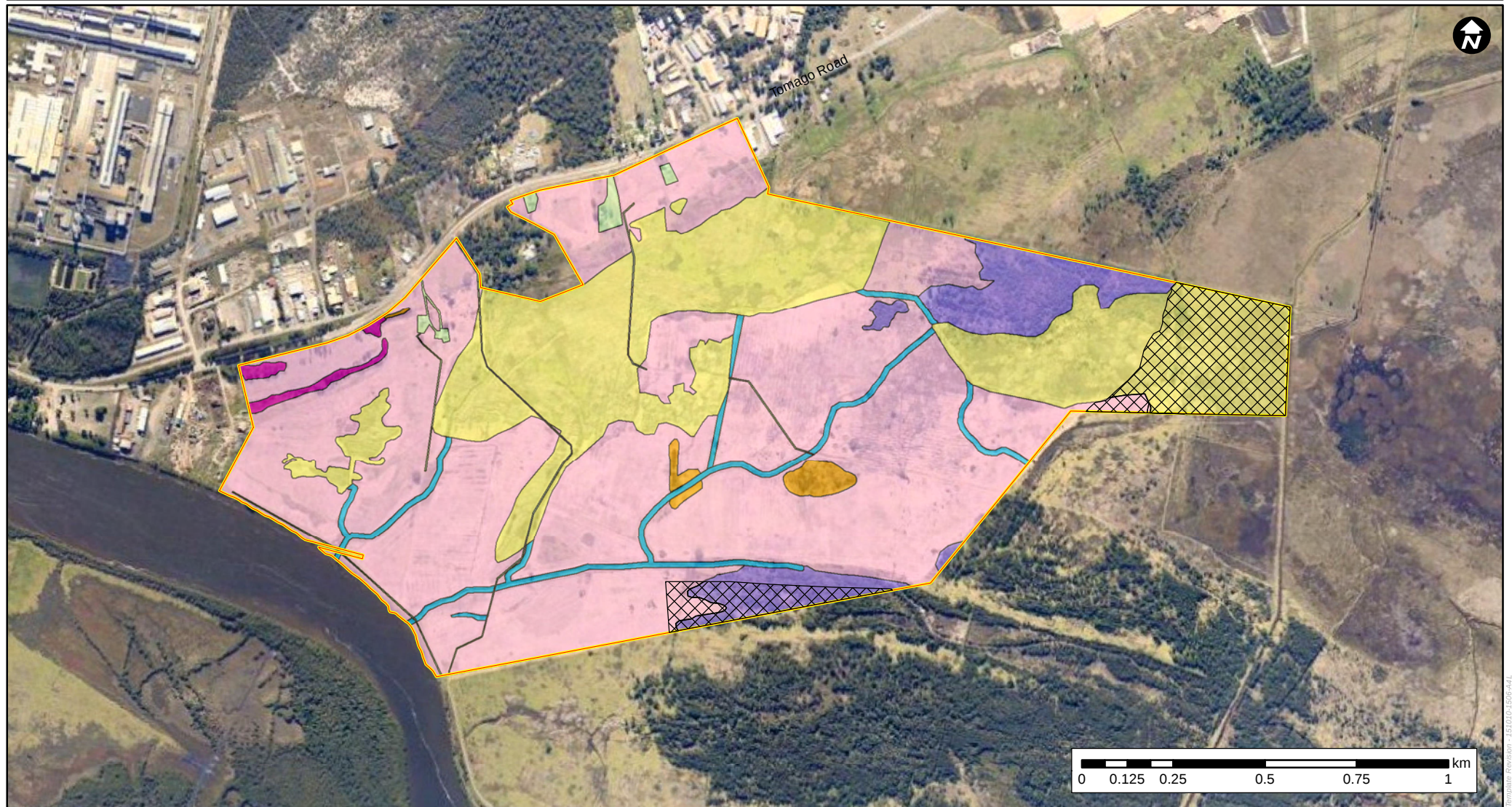


Table 11: Area (ha) of vegetation communities mapped on study area.

Vegetation Community	Area (ha)	Retained / rehabilitated (ha)
Cleared	2.89	
Exotic Grasslands	141.66	12.8 (to be rehabilitated to create native vegetation communities)
Freshwater Wetland Complex	70.59	12.5
Constructed Freshwater Wetland Complex	6.07	
Swamp Oak Forest	14.82	3.4
Swamp Oak Forest - Regeneration	2.20	
Swamp Sclerophyll Forest	1.47	
Total	239.7	28.7

Of the communities identified on the study area, three are listed as Threatened Ecological Communities (TEC). The Swamp Mahogany - Paperbark Swamp Forest forms part of the endangered *Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*. The Swamp Oak Rushland Forest and Swamp Oak Rushland Forest - Regeneration both form part of the endangered *Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions*. The Freshwater Wetland Complex constitutes part of the endangered *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*.

Figure 9 - Vegetation communities



Legend / Notes

Study Area

Vegetation Communities

Cleared

Constructed Freshwater Wetland Complex

Exotic Grasslands

Freshwater Wetland Complex (EEC)

Swamp Oak Forest (EEC)

Swamp Oak Forest - Regeneration (EEC)

Swamp Sclerophyll Forest (EEC)

Retained Vegetation



Project Ref: 350-694

Plot Date: 06/12/2010 1123

Revision: JRN 001

Map Projection:

NSW Lamberts Conformal Conic

Data Sources:

OpenStreetMap - 2010
ecobiological - 2010
DECCW - 2010
LPI - 2006



Swamp Mahogany – Paperbark Swamp Forest



Plate 1: Photograph of typical Swamp Mahogany – Paperbark Swamp Forest on the study area.

Corresponding Hunter, Central and Lower North Coast Vegetation Classification & Mapping Project Map Unit:

MU187 Broad-leaved Paperbark/Saw Sedge swamp forest of coastal lowlands.

Vegetation Formation:

Forested wetlands.

Vegetation Class:

Coastal swamp forests.

Equivalent Vegetation Type:

Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (DECC Biometric Type Database 2009).

**Structure:**

Open forest with an overstorey to 20m high (**Plate 1**). Scattered shrubs with a dense ground layer made up of a variety of sedges, grasses and ferns.

General description:

Several fragmented stands of Swamp Mahogany – Paperbark Swamp Forest are located at the eastern edge of the property. The canopy of this community is dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*Eucalyptus robusta*), along with Forest Red Gum (*Eucalyptus tereticornis*). The mid-storey comprises of scattered occurrences of Cheese Tree (*Glochidion ferdinandi* var. *ferdinandi*). The shrub stratum is characterised by Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*) and Prickly Tea-tree (*Leptospermum juniperinum*). The ground layer typically includes Tall Saw-sedge (*Gahnia clarkei*), *Eleocharis acuta*, Jointed Twig-rush (*Baumea articulata*), Harsh Ground Fern (*Hypolepis muelleri*), *Persicaria strigosa*, Blue Flax-lily (*Dianella caerulea* var. *assera*) and Matgrass (*Hemarthria uncinata*). The highly fragmented nature of this community on the study area, large edge effects and previous disturbance has led to the invasion of exotic species. Common exotic species include *Isolepis prolifera*, Kikuyu (*Pennisetum clandestinum*) and Paspalum (*Paspalum dilatatum*).

Conservation Status:

The Swamp Mahogany – Paperbark Swamp Forest on the study area forms part of the endangered *swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* TEC.



Swamp Oak Rushland Forest



Plate 2: Photograph of typical Swamp Oak Rushland Forest on the study area.

Corresponding Hunter, Central and Lower North Coast Vegetation Classification & Mapping Project Map Unit:

MU190 Swamp Oak/*Juncus kraussii*/*Baumea juncea* swamp forest on coastal lowlands.

Vegetation Formation:

Forested wetlands.

Vegetation Class:

Coastal floodplain wetlands.

Equivalent Vegetation Type:

Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner (DECC Biometric Type Database 2009).

**Structure:**

Open forest with an overstorey to 10-15m high (**Plate 2**). Sparse shrub layer with a dense ground layer made up of a variety sedges, grasses and herbs.

General description:

Stands of Swamp Oak Rushland Forest were identified on the north-east and south-east areas of the property. The canopy of this community is dominated by Swamp Oak (*Casuarina glauca*). The shrub stratum is generally sparse, with occurrences of Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*) and Swamp Paperbark (*Melaleuca ericifolia*). The ground layer is by dominated *Bolboschoenus caldwellii*, along with Water Couch (*Paspalum distichum*), Lesser Joy Weed (*Alternanthera denticulata*), Slender Knotweed (*Persicaria decipiens*), *Persicaria strigosa*, *Eleocharis acuta* and Sea Rush (*Juncus kraussii* subsp. *australiensis*). Common exotic species include Dock (*Rumex crispus*), Kikuyu (*Pennisetum clandestinum*) and Paspalum (*Paspalum dilatatum*).

Conservation Status:

The Swamp Oak Rushland Forest on the study area forms part of the endangered *swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions* TEC.



Swamp Oak Rushland Forest - Regeneration



Plate 3: Photograph of Swamp Oak Rushland Forest - Regeneration on the study area.

Corresponding Hunter, Central and Lower North Coast Vegetation Classification & Mapping Project Map Unit:

MU190 Swamp Oak/*Juncus kraussii*/*Baumea juncea* swamp forest on coastal lowlands.

Vegetation Formation:

Forested wetlands.

Vegetation Class:

Coastal floodplain wetlands.

Equivalent Vegetation Type:

Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner (DECC Biometric Type Database 2009).

**Structure:**

Low open forest to 8m high (**Plate 3**).

General description:

Several small areas of Swamp Oak Rushland Forest - Regeneration are located on the study. This vegetation community is dominated by young Swamp Oak (*Casuarina glauca*) trees, along with areas dominated by the low shrubs Swamp Paperbark (*Melaleuca ericifolia*) and Flax-leaved Paperbark (*Melaleuca linariifolia*.) The ground layer contains a dense cover of exotic species, including Kikuyu (*Pennisetum clandestinum*), Purpletop (*Verbena bonariensis*) and Paspalum (*Paspalum dilatatum*). Several native ground layer species also occur in low abundance, these include *Bolboschoenus caldwellii*, *Juncus usitatus*, *Lachnagrostis filiformis* and Couch (*Cynodon dactylon*).

Conservation Status:

The Swamp Oak Rushland Forest – Regeneration on the study area forms part of the endangered *swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions* TEC. Although this community is heavily dominated by weeds in the understorey, this community can still be considered as constituting part of the TEC, given the presence of key indicative species in the overstorey and a low abundance of native species in the understorey.