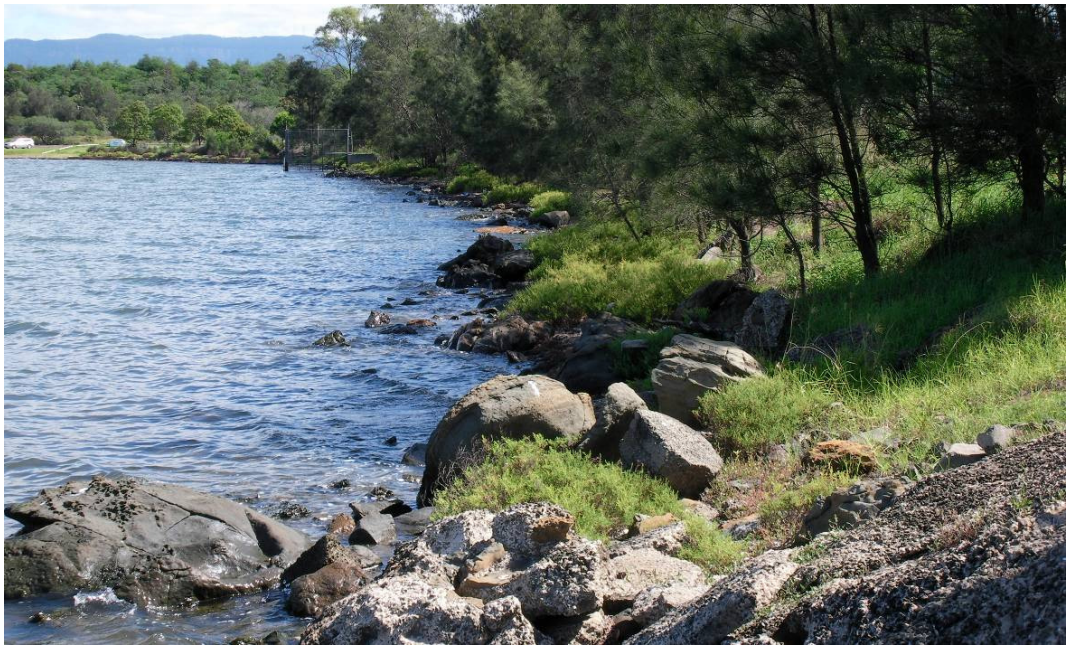
Tallawarra Lands Part 3A Concept Plan Application

Ecological Assessment

Prepared for
TRUenergy

4 March 2011



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Abbreviations

ABBREVIATION	DESCRIPTION
AS	Acacia Scrub
ASMF	Alluvial Swamp Mahogany Forest
AW	Artificial Wetland
BMP	Bushfire Management Plan
CAMBA	China - Australia Migratory Bird Agreement
CAP	Catchment Action Plan
CEMP	Preparation of Construction Environmental Management Plan
CGRGF	Coastal Grassy Red Gum Forest
CMP	Preparation of a Conservation Management Plan
CS	Coastal Saltmarsh
CSOF	Coastal Swamp Oak Forest
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEWHA	Department of Environment, Heritage and the Arts
DGRs	Director-General's Requirements
DoP	Department of Planning
E	Endangered
EAW	Estuarine Alluvial Woodland
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP	Endangered Population
EP	Exotic Pasture
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
FW	Freshwater Wetlands
GGBF	Green and Golden Bell Frog
GIS	Geographic Information Systems
GPS	Global Positioning System
ILGW	Illawarra Lowland Grassy Woodland

ABBREVIATION	DESCRIPTION
ISR	Illawarra Subtropical Rainforest
JAMBA	Japan - Australia Migratory Bird Agreement
KTP	Key Threatening Process
LDSR	Lowland Dry – Subtropica Rainforest
LEP	Local Environmental Plan
LEP	Local Environmental Plan
LES	Local Environmental Study
LGA	Local Government Area
LWMF	Lowland-Woollybutt Melaleuca Forest
M	Migratory
MBRGFF	Moist Box Red Gum Foothills Forest
NES	National Environmental Significance
NOW	NSW Office of Water
NW Act	*Noxious Weeds Act 1993*
OEMP	Preparation of Operations Environmental Management Plan
PCG	Project Control Group
PSOF	Planted Swamp Oak Forest
PWE	Planted Native, Weeds and Exotics
RCMS	Riparian Corridor Management Study
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SEPP	State Environmental Planning Policy
SM	Saltmarsh
SOF	Swamp Oak Forest
SOFF	Swamp Oak Floodplain Forest
SRCAP	Southern Rivers Catchment Action Plan
SRCMA	Southern Rivers Catchment Management Authority
SSF	Swamp Sclerophyll Forest
SWMP	Preparation of Soil and Water Management Plan
TSC Act	Threatened Species Conservation Act 1995
V	Vulnerable
VMP	Vegetation Management Plan
W&E	Weeds and Exotics
WMP	Preparation of Weed Management Plan

Executive Summary

Eco Logical Australia Pty Ltd (ELA) was commissioned by TRUenergy to undertake an ecological assessment of the proposed Tallawarra Concept Plan for the Tallawarra Lands in Yallah, NSW (Figure 1). The proposal includes mixed development incorporating residential, industrial and tourism and is to be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The study area has undergone extensive past disturbance particularly in the south and east where a number former ash settling ponds used by the former coal fired Tallawarra Power Station now remain. Extensive vegetation clearance has also previously occurred across much of the remainder of the site, mostly for grazing purposes, resulting in large areas of exotic grassland. The most intact vegetation occurs in the south eastern corner of the site with smaller areas in the north, adjoining a large stand of vegetation in Mount Brown Reserve, as well as along the south western boundary.

Despite this history of disturbance, the site retains ecological values in the form of remnant native vegetation, habitat for a number of threatened fauna species, potential and actual habitat for a number of threatened flora species, riparian and wetland features, and a regional corridor linkage.

A number of vegetation types are present throughout the study area including natural remnants, Endangered Ecological Communities (EECs) and areas that have been planted as part of past revegetation works.

Six EECs are present within the study area and these include:

- Swamp Sclerophyll Forest on Coastal Floodplains on the NSW North Coast, Sydney Basin and South East Corner Bioregions (SSF) - poor to very good condition
- Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion (ILGW) - poor to moderate condition
- Swamp Oak Floodplain Forest on the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF) – very poor to poor quality
- Coastal Saltmarsh of the Sydney Basin Bioregion (CS) - moderate condition
- Freshwater Wetlands on Coastal Floodplains (Freshwater Wetlands) (FW) – very poor condition
- Illawarra Subtropical Rainforest in Sydney Basin Bioregion (ISR) – poor condition

The proposal will result in the clearance of 51.63 ha of vegetation of which 4.37 ha are EECs. The EEC clearance is comprised of a number of very small areas of differing communities ranging from 0.17 ha to 2.54 ha in size. The remaining 117.23 ha of EEC vegetation (96.41 %) will be preserved much of which will be incorporated into the proposed environmental reserves across the study area. In addition to the retention of EEC vegetation is the retention of a number of artificial wetlands (18.00 ha) that provide habitat for various species. The retention of EEC and non-EEC vegetation also provides for the retention of potential and actual habitat for threatened flora species along with threatened fauna habitat.

Retention of EEC vegetation (and threatened species habitat) will be provided for in the concept plan by:

- Dedication of a number of environmental reserves including:
    - Duck Creek corridor;
    - A large wetlands reserve in the south east;
    - A reserve on the western boundary of the site near Yallah Creek;
    - Foreshore reserve between the power station and Duck Creek;
- Retention of vegetation in other areas of the site including:
    - Mount Brown;
    - Around a number of artificial wetlands;
    - In areas of open space.

Based on the amount of EEC clearance of 4.37 ha, the protection of 117.23 ha of EEC vegetation would represent a 27:1 protection ratio.

Natural and artificial wetlands are present across the study area including two that are protected under NSW State Environmental Planning Policy 14 – Coastal Wetlands (SEPP 14). The two SEPP 14 wetlands occur in the south eastern portion of the site and are retained in the concept plan. As per the gazetted boundaries these areas support Estuarine Alluvial Wetland, Swamp Oak Floodplain Forest and Saltmarsh with limited weed invasion. The SEPP 14 Wetlands will be conserved with a 50 m buffer provided around each wetland.

The numerous wetlands throughout the study area provide potential habitat for a variety of species including birds, reptiles, mammals and amphibians. The largest wetland in the south west of the site provides the greatest habitat value as it contains a variety of habitat features including sedges and rushes, mudflats, open water and small areas of saltmarsh. This area is particularly valuable for a large number of threatened and migratory species including 12 threatened birds and eighteen migratory birds that have been recorded on site.

In addition to the potential habitat, a number of threatened fauna species listed on the TSC Act and/or EPBC Act have been observed at the site. The threatened species recorded at the site however have been restricted to more mobile species such as bats and birds. No threatened amphibians, reptiles or mammals (excluding bats) have been recorded. No Green and Golden Bell Frogs where observed at the site despite extensive targeted surveying.

Potential habitat is present for eleven threatened flora species. Only one species, *Chorizema parviflorum* listed as an Endangered Population in Wollongong LGA, has been found on the site during target threatened flora searches, with this species being found in a proposed environmental reserve along the western boundary of the site.

The site was rezoned by Wollongong LEP 2009, informed by ecological values undertaken as part of the LES for Tallawarra Lands in 2006. The zones of the LEP 2009 afford E2 – environmental conservation and E3 – environmental management zones for the ecological values of the site that warrant retention and protection. These include a large area (95.98 ha) in the south east of the site, an

area of ILGW (approximately 14 ha) in the west of the site adjacent to Duck Creek and a disturbed area (20.37 ha) that will be rehabilitation in the east just south of the current power station. These areas will be protected and managed under the current master plan.

The proposal will result in EEC and wetland clearance and retention across the study area as outlined in Table 1 below.

Table 1: Proposed EEC and wetland clearance and retention

Vegetation type	Total within study area (ha)	Total clearance (ha)	Total retained (ha)	% of vegetation type cleared within the study area	% of vegetation type retained within the study area
Lowland Dry - Subtropical Rainforest (ISR)	8.43	0.38	8.05	4.51	**95.49**
Coastal Grassy Red Gum Forest (ILGW)	2.64	0.54	2.10	20.45	**79.55**
Moist Box – Red Gum Foothills Forest (ILGW)	7.2	0.2	7	2.78	**97.22**
Lowland Woollybutt – Melaleuca Forest (ILGW)	19.79	2.54	17.25	12.83	**87.17**
Alluvial Swamp Mahogany Forest (SSF)	17.34	0	17.34	0.00	**100.00**
Coastal Swamp Oak Forest (SOFF)	32.12	0.54	31.58	1.68	**98.32**
Saltmarsh (CS)	7.61	0.17	7.44	2.23	**97.77**
Estuarine Alluvial Wetland (SSF)	2.24	0	2.24	0.00	**100.00**
Artificial Wetland	21.89	3.96	17.93	18.09	**81.91**
Floodplain Wetland (FW)	24.23	0	24.23	0.00	**100.00**
Total	**143.49**	**8.33**	**135.16**	**5.81**	**94.19**

The proposal is considered to meet the 'maintain and improve' test under Part 3A of the EP&A Act as it:

- Will conserve all key habitat areas across the site through zoning for environmental protection;
- Will conserve the largest and most consolidated stand of vegetation in the south-east of the site;
- Will conserve the largest and most valuable artificial wetlands which provide habitat for threatened and migratory birds in the south east of the site and mitigation measures will be implemented to prevent indirect impacts;
- Implement a Vegetation Management Plan that will reduce the weed invasion in remnant vegetation across the study area and include substantial revegetation of Duck Creek and other riparian zones;

- Improve connectivity of the Duck Creek and regional corridors and will not fragment any current corridors;
- Result in approximately 187.63 ha of vegetation being protected across the study area which includes a number of EECs and two SEPP 14 wetlands; and
- Is unlikely to have a significant impact on any EPBC listed species.

Provided the recommended mitigation measures are implemented and the environmental conservation areas are managed, it is unlikely that the proposal would result in a significant impact on any Matters of National Environmental Significance (NES) listed under *the Environment Protection and Biodiversity Conservation Act 1999*. Nevertheless, given the large number of threatened and migratory species that have been recorded at the site, an EPBC Referral will be submitted to DEWHA as a precautionary approach.

1 Introduction

Eco Logical Australia Pty Ltd (ELA) was commissioned by TRUenergy to undertake an ecological assessment of the proposed Tallawarra Concept Plan for the Tallawarra Lands in Yallah, NSW (Figure 1). The proposal includes mixed development incorporating residential, industrial and tourism and is to be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This report addresses the ecological components of the Environmental Assessment for the Tallawarra Lands Part 3A Concept Plan Application. This report responds to the requirements of the Director General of the NSW Department of Planning under Part 3A of the NSW EP& A Act for this project (MP 09_0131) concerning ecological issues, which are as follows.

a) The EA shall address impacts on flora and fauna including threatened species, populations and EECs and their habitats and steps taken to mitigate any identified impacts to protect the environment. Such assessment must identify the likelihood of the presence and impact on EPBC Act 1999 listed threatened species and listed migratory species.

b) A field survey of the site should be conducted and documented in accordance with the gazetted draft *Guideline for Threatened Species Assessment*. The survey is to be accompanied by the following:

- An assessment and evaluation of the likely impacts on threatened species and their habitat
- Description of actions that will be taken to avoid or mitigate impacts or compensate for unavoidable impacts of the project on threatened species and their habitat

c) The EA shall outline the measures for conservation/management of the existing DEC Regional Habitat Corridor values and/or connective importance of any vegetation on the subject land and shall address any measures to protect and manage the riparian corridor and adjacent aquatic habitat.

d) An Environmental Management Strategy is to be undertaken to address potential impacts on aquatic and terrestrial flora and fauna and their habitats in accordance with DECC's Threatened Biodiversity and Assessment Guidelines for Developments and Activities. It shall also address river and wetland protection, water quality, protecting and rehabilitating estuaries, protection of marine ecosystems, and provide measures for their conservation, where relevant.

e) The EA shall address potential impact of the proposal on the wetlands, including modification to wetlands hydrologic regime/groundwater recharge. Assess water quality and loss/degradation of habitat needs and provide safeguard measures to protect and minimise impacts on wetlands.

f) The Ea shall provide details on the presence and distribution of Groundwater Dependent Ecosystems (GDEs) in the vicinity of the site and identify any potential impacts on GDEs as a result of the proposal.

g) The EA shall investigate and map EECs and justify / detail proposed vegetated corridors and riparian buffers, and any other form of proposed methods of conservation within the property.

1.1 STUDY AREA

The study area is located on the Tallawarra Lands in Yallah, east of Dapto, within the Wollongong Local Government Area (LGA), NSW. Lake Illawarra marks the eastern boundary of the study area, with the Princess Highway to the west, residential development and Mount Brown Reserve to the north and the suburb of Haywards Bay to the south (Figure 2). The Tallawarra Gas-fired Power Station, owned by TRUenergy, is present in the east of the study area although it is excluded from the concept plan. A public recreation area owned by Lake Illawarra Authority is also present on the foreshore of Lake Illawarra between the power station and the northern boundary of the site. Yallah Bay Road runs through the centre of the site.

Large portions of the study area have undergone past disturbance particularly in the south and east where a number former ash settling ponds used by the former coal fired Tallawarra Power Station now remain. Extensive vegetation clearance has also occurred across much of the remainder of the site, mostly for grazing purposes, resulting in large areas of exotic grassland. The most intact vegetation occurs in the south eastern corner of the site with smaller areas in the north, adjoining a large stand of vegetation in Mount Brown Reserve, as well as along the south western boundary.

The study area is defined by the following:

- Lot 1 in DP 109795
- Lot 109 in DP 1050302 (main lot)
- Lot 1 in DP 551658
- Lots 21 & 22 in DP 774118
- Lot 20 in DP 633211
- Lot 102 in DP 716727
- Lot 3 in DP 109795
- Lot 15 in DP 105255
- Lot 151 in DP 628980
- Lot 1 in DP 543285
- Lots 10 & 11 in DP 552933
- Lots 1 & 2 in DP 792664
- Lots 7 & 8 in DP 1049520

1.1.1 Regional Context

The site has important contextual issues, such as the West Dapto release area, the Yallah-Marshall Mount environmental precinct (also referred to as the Yallah - Calderwood corridor or the DEC Regional Habitat Corridor) and its proximity to Lake Illawarra. The Yallah-Calderwood corridor covers most of Tallawarra Lands and has been included by the Department of Planning (2006) in the Draft Illawarra Regional Strategy.

Figure 1: Site location

Figure 2: Study site

1.1.2 Geology, Topography & Soils

Tallawarra Lands rise from the foreshore of Lake Illawarra to about 120 m adjacent to Mount Brown Reserve in the north. The area is underlain by Bundgong Sandstone (Morse McVey & Associates in Pacific Power 1997). The northern part of the site is characterised by gradients of 35% on the side of Mount Brown to 7% at the foothills. The southern part of the site is low lying and generally flat (JBA Urban Planning Consultants 2005).

Morse McVey & Associates (in Pacific Power 1997) found that a broad alluvium slope wash filled valley originates on the middle slopes of Mount Brown and trends in a south-easterly direction into an alluvial plain area covering the shores of Lake Illawarra. Thick alluvium and estuarine sediments lie beneath fill material on the lake shore adjacent to the power station. These sediments continue in the flat areas to the south of the power station, a large part of which is covered by ash deposits.

Soils across the site exhibit the following similarities (identified by Morse McVey & Associates in Pacific Power 1997):

- Yellow and brown, light to heavy clay subsoils
- Moderately well structured layers
- Approximately neutral pH soils on the hill slopes
- Highly acid layers on alluvial and swampy lowlands

The hillslope or upslope soils were found to have low to moderate erodibility. Swamp associations adjacent to Duck Creek have a high erodibility due to the predominance of fine sand and silt.

A number of soil landscape groups are present throughout the study area. These are listed in Table 2 below together with a description of the characteristics of each group.

Table 2: Soil landscapes present within the study area

Soil Landscape Group	Location within study area	Characteristics
Albion Park (ap)	South-	**Geology:** Berry Formation – mid-grey to dark grey siltstone, mudstone, and fine sandstone with localised outcrops of Bundgong Sandstone on the mid to upper slopes. Localised outcrops of Bumbo Latite occasionally occur on crests. Short steep upper slopes grading into long gently inclined footslopes (relief 60 - 100 m). Extensively cleared with remnant stands of tall open-forest. **Soils:** Moderately deep (50 – 100 cm) • Brown Podzolic Soils on crests • Yellow Podzolic Soils on midslopes • Soloths on footslopes and drainage lines

Soil Landscape Group	Location within study area	Characteristics
		sandy clay loam, light clay, heavy clay
Fairy Meadow (fa)	South west, centre, south east, east	**Geology:** Quaternary Sediments – quartz, sand, lithic fluvial sand, silt and clay. Alluvial plains, floodplains, valley flats and terraces below the Illawarra Escarpment (relief < 10 m). Almost completely cleared except for some isolated stands of low open forest and woodland. **Soils:** Moderately deep (50 – 100 cm) • Alluvial loams and siliceous sands on terraces • Prairie and Yellow Podzolic Soils on the drainage plains Light clay to sandy clay loam, heavy clay to medium clay
Gwynneville (gw)	North west	**Geology:** • Illawarra Coal Measures – resistant interbedded quartz-lithic sandstone, grey siltstone and claystone, carbonaceous claystone, clay and laminite. • Dapto Latite Member – melanocratic coarse-grained to porphyritic latite. Undulating to steep hills on the Coastal Plain (local relief 10 – 70 m). In residual areas the original tall open-forest and open-forest have been extensively cleared. **Soils:** Shallow(50 – 100 cm) • Brown Podzolic and Xanthozems on the upper slopes • Lithosols on simple slopes • Shallow Brown Earths on midslopes and lower slopes Sandy clay loam, light to heavy clay.
Shellharbour (sh)	North	**Geology:** Budgong Sandstone – red brown and grey volcanic sandstones on the Coastal Plain. Located on low rolling hills (20 – 50 m relief) with long sideslopes and broad drainage patterns. Extensively cleared with stands of tall open-forest and closed-forest in

Soil Landscape Group	Location within study area	Characteristics
		sheltered locations. **Soils:** Deep (>150 cm) • Prairie soils on the crest and upper slopes • Brown Krasnozems on midslopes • Red Podzolic and Prairie Soils on lower slopes and drainage plains Sandy loam, sandy clay to light clay.
Disturbed Terrain (XX)	Central east, south west	Topography varies from level plains to undulating terrain. Has been disturbed by human activity to a depth of at least 100 cm. The original soils has been removed, greatly disturbed or buried. The original vegetation has been completely cleared.

Source: Hazelton (2002a)

1.1.3 Creeks, Lakes and Watercourses

Tallawarra Lands comprise approximately 2% of the Lake Illawarra catchment (Pacific Power 1997) and drain into the lake via Duck Creek, Wollingurry Creek, Barrons Gully and a number of unnamed waterways. Activities within the catchment affect hydrology and water quality, and the aquatic ecosystems which inhabit the waterways and lake. Lake Illawarra is a coastal lagoon with a surface area of about 35 km^2. The lake is characterised by extreme fluctuations in salinity that result from tidal exchange and fresh water inputs, and that are tolerated by a limited number of aquatic species. Lake Illawarra is strongly nitrogen limited and eutrophication is a key environmental problem associated with increases in urban, industrial and rural pollution in the catchment (Qu 2004). An assessment of the riparian features found on the site is detailed in ELA (2010a).

1.1.4 Climate

The climate of the Illawarra region is temperate and moderated by Lake Illawarra and the Pacific Ocean. Climatic data measured at the Port Kembla Signal Station (latitude -34.4772 S; longitude 150.9131 E; elevation 11 m) between 1950 and 2004 (www.bom.gov.au) indicate the region experiences warm to hot summers (mean 24.4ºC in February) and cool to mild winters (mean 9.8ºC in July). The average annual daily maximum and minimum temperatures are 20.9ºC and 14.4ºC, respectively. Mean rainfall is 1,277.4 mm pa with the wettest months being February, April and June, and the driest months being July and September (ELA 2008).

1.2 DESCRIPTION OF THE PROPOSAL

The proposal involves the establishment of a number of land uses throughout the study area (Figure 3). These include:

- Residential development in the north east of the site along the Lake Illawarra Foreshore;
- Residential development, a local centre and an employment zone in the central–western parts of the site, north of Duck Creek and Yallah Bay Road;
- An employment area and tourism facility in the central–eastern parts of the site;
- An employment precinct, primary school, retirement village and residential development in the south west of the site; and
- Significant dedication of various parts of the site for environmental and open space purposes:
    - Provision of a significant environmental corridor for Duck Creek;
    - A large environmental reserve in the south east incorporating two SEPP 14 wetlands;
    - Conservation of two artificial wetlands in the south west for incorporation into open space areas;
    - An environmental reserve on the upper slopes of Mount Brown;
    - An environmental reserve on the central western boundary;
    - Provision of riparian zones for affected waterways; and
    - Large areas of open space reserves.

The proposal also covers:

1. A Landscape Masterplan (Corkery Consulting, 2010);
2. Water Sensitive Urban Design (WBM BMT, 2010);
3. Riparian Management (ELA 2010a); and
4. Vegetation Management (ELA 2010b).

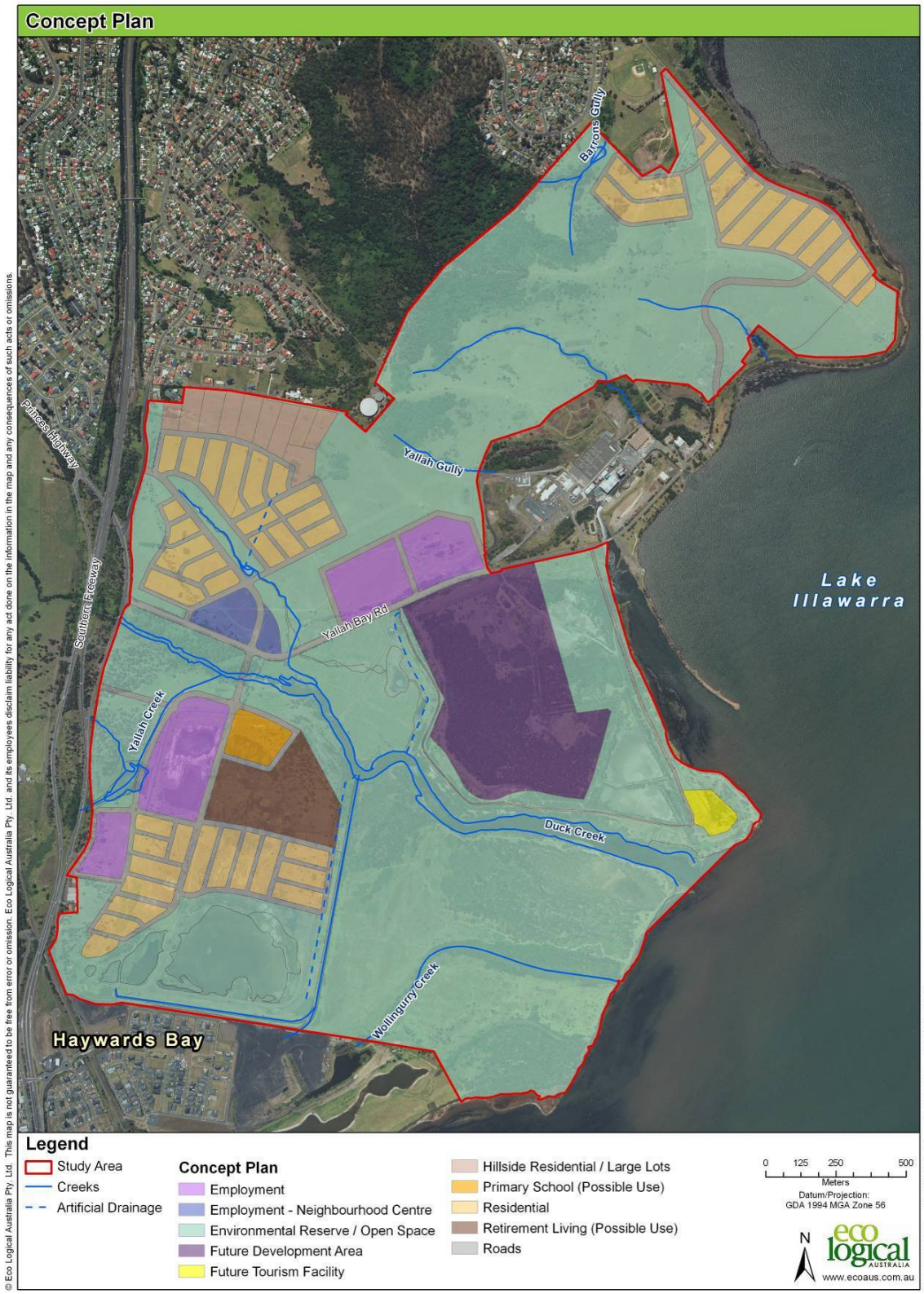

Figure 3: Tallawarra Lands Concept Plan

1.3 REPORT STRUCTURE

The report is structured in order of the following:

Introduction – provides context for the landscape in which the study area is located and provides a description of the proposal.

Planning and assessment framework – outlines the legislative framework under which the proposal is to be assessed include Commonwealth and NSW legislation and any requirements under State Environmental Planning Policies (SEPPs).

Ecological Site Assessment – outlines the survey methodology and results of the surveys.

Impact Evaluation – outlines the measures undertaken to avoid and mitigate impacts from the proposal and assesses the likely direct and indirect impacts from the proposal

Offset Strategy – presents the proposed offset options for those residual impacts that cannot be avoided or mitigated.

Conclusion / **Recommendations** – summarises the key findings of this assessment under state and Commonwealth legislation.

2 Planning & Assessment Framework

2.1 COMMONWEALTH LEGISLATION

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The primary objective of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to 'provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance.'

Environmental approvals under the EPBC Act are required for an 'action' that is likely to have a significant impact on:

- Matters of National Environmental Significance (known as 'NES matters') including:
  - World Heritage Areas;
  - National Heritage Places;
  - Ramsar wetlands of international importance;
  - Nationally listed threatened species and ecological communities;
  - Listed migratory species;
  - Nuclear actions;
- Commonwealth marine areas; and
  - Commonwealth heritage places.
    - Actions taken on Commonwealth land that are likely to have a significant impact on the environment;
    - Actions that are likely to have a significant impact on the environment of Commonwealth land, even if the action is taken outside Commonwealth land; and
    - Any action taken by a Commonwealth agency that is likely to have a significant impact on the environment.

An 'action' is considered to include a project, development, undertaking, activity or series of activities.

Of potential relevance to the site are matters of NES which include nationally listed threatened species and ecological communities and listed migratory species.

2.2 INTERNATIONAL AGREEMENTS

2.2.1 International Migratory Bird Agreement

Japan - Australia Migratory Bird Agreement / China - Australia Migratory Bird Agreement

The JAMBA and CAMBA agreements list terrestrial, water and shorebird species which migrate between Australia and the respective countries. In both cases the majority of listed species are shorebirds.

Both agreements require the parties to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

The JAMBA agreement also includes provisions for cooperation on the conservation of threatened birds.

Australian government and non-government representatives meet every two years with Japanese and Chinese counterparts to review progress in implementing the agreements and to explore new initiatives to conserve migratory birds (DEWHA 2010f).

Republic of Korea – Australia Migratory Bird Agreement

In April 2002, Australia and the Republic of Korea agreed to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA.

The ROKAMBA formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (DEWHA 2010f).

2.3 NEW SOUTH WALES LEGISLATION

2.3.1 Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for NSW. It provides a framework for land use control and assessment, determination and management of development. Part 3A of the Act facilitates major project and infrastructure delivery of development which is of significance to the State and encourages economic development, while strengthening environmental safeguards and community participation.

An assessment of the potential impacts of the proposal in accordance with the Part 3A requirements of maintaining or improving the biodiversity values and the Director General Requirements (DGRs) has been made. Key thresholds include:

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain and improve biodiversity values;
- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and
- Whether or not the proposal will adversely affect critical habitat.

2.3.2 Threatened Species Conservation Act 1995

The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the NSW EP&A Act and requires consideration of whether a major infrastructure or other project (Part 3A of the EP&A Act), a development (Part 4 of the EP&A Act) or an activity (Part 5 of the *EP&A Act*) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

2.3.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. The FM Act defines 'fish' as any marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history, exclude whales, mammals, reptiles, birds, amphibians or species specifically excluded. No threatened fish species, or endangered populations are known to occur within the study area.

In accordance with section 75U of the EP&A Act, applications for separate permits under section 201, 205 or 219 of the *Fisheries Management Act 1994* are not required as these matters are addressed and approved as part of the EP&A Part 3A process.

2.3.4 NSW Catchment Management Authorities Act 2003

Through a network of Catchment Management Authorities, this Act aims to devolve operational, investment and decision making natural resources functions to catchment levels, to provide for proper natural resource planning at a catchment level, to apply sound scientific knowledge and to involve communities in decision making regarding catchment management.

Under the Act, Catchment Management Authorities have been established and are required to prepare a Catchment Action Plan (CAP). The CAP aims to guide the CMA's investment in sustainable natural resource management and focuses on actions that the CMA can achieve within the scope of its role and capacity. The CAP contains targets for environmental improvement and is a plan for action that the CMA can directly undertake or directly influence. The CAP aims to ensure that future investment by the CMA is put towards key issues in the catchment and is based on the best available knowledge.

The project is located within the Illawarra region within the Southern Rivers Catchment and is, therefore, within land managed under the Southern Rivers Catchment Action Plan (SRCAP) (2010). The following targets in the SRCAP are relevant to this project:

Biodiversity catchment target 1: By 2016 there is an improvement in native vegetation condition and an increase in connectivity and extent.

The proposal will assist in achieving this target through the implementation of a VMP across the study area and the rehabilitating of Duck Creek which forms part of a regional corridor.

Biodiversity catchment target 2: By 2016 the regional status of priority threatened and regionally significant species, ecological communities and populations within the Southern Rivers catchment is maintained and improved.

The proposal will assist in achieving this target as large areas of EECs and habitat for threatened and migratory species will be conserved and protected.

2.3.5 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The Act sets up categorisation and control actions for the various noxious weeds, according to their potential to cause harm to our local environment.

The objectives of the *Noxious Weeds Act 1993* (NW Act) include:

- To identify noxious weeds in respect of which particular control measures need to be taken;
- To specify those control measures;
- To specify the duties of public and private landholders as to the control of those noxious weeds; and
- To provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Under this Act, noxious weeds have been identified for Local Government Areas and assigned Control Categories (eg. 1, 2, 3, 4 and 5). Part 3 provides that occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy.

2.4 STATE ENVIRONMENTAL PLANNING POLICIES

2.4.1 State Environmental Planning Policy 19 (Urban Bushland)

This NSW *State Environmental Planning Policy No. 19—Bushland in Urban Areas* aims to protect and preserve bushland within selected local government areas. The policy specifically applies to those areas of land zoned or reserved for public open space and which satisfy the definition of urban bushland in the policy. SEPP 19 requires the listed councils, when preparing draft local environmental plans, give priority to preserving bushland and to have regard to the general and specific aims of the policy.

The policy recognises the recreational, educational and scientific significance of such bushland and aims to protect the flora, fauna, significant geological features, landforms and archaeological relics in such areas. It encourages management to protect and enhance the quality of the bushland and facilitate public enjoyment, compatible with its conservation. The policy states that a person shall not disturb bushland zoned or reserved for public open space purposes without the consent of the council.

2.4.2 State Environmental Planning Policy 14 (Coastal Wetlands)

State Environmental Planning Policy 14 (Coastal Wetlands) aims to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State.

On land to which this policy applies, the following cannot be undertaken except with the consent of the council and the concurrence of the Director.

- Clearing;
- Construction of a levee;
- Draining; and
- Filling.

Under this SEPP a person must not carry out restoration works within a SEPP 14 wetland except with the consent of the council and the concurrence of the Director. An application for consent to carry out restoration works must be lodged with the council and a restoration plan prepared in accordance with the guidelines issued by the Department of Planning. Consent to implement any proposed revegetation works as part of the VMP would need to be obtained from Council prior to works being conducted.

2.4.3 State Environmental Planning Policy 44 (Koala Habitat)

State Environmental Planning Policy 44 (Koala Habitat) aims to encourage 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. SEPP 44 applies to both the Wollongong LGA. However, SEPP 44 does not apply to Part 3A projects as they are not a Development Application. An assessment under SEPP 44 is therefore not required.

Under SEPP 44, areas of potential koala habitat are categorised as either core koala habitat or potential koala habitat based on the following criteria:

Core koala habitat: an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

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

2.5 LOCAL GOVERNMENT PLANS

2.5.1 Wollongong LGA Bioregional Assessment Studies (NPWS)

Conservation Assessment of Wollongong Local Government Area – Bioregional Assessment Study Part III

The *Conservation Assessment of Wollongong Local Government Area – Bioregional Assessment Study Part III* assesses the conservation values of the Wollongong Local Government Area. It builds on the *Native Vegetation of the Illawarra Escarpment and Coastal Plain* (NPWS 2002a) and *Fauna of the Illawarra Escarpment, Coastal Plain and Plateau* (NPWS 2002b). A framework for broadly assessing the conservation values and conservation significance of vegetation and habitat throughout the LGA is provided.

2.6 OTHER PLANS AND POLICIES (LISTED FOR CONSIDERATION IN THE DGRS)

2.6.1 Estuary Management Plan of Lake Illawarra

An estuary process study of Lake Illawarra was undertaken and subsequently a strategic plan prepared. The Plan outlines how the estuary will be managed, gives recommended solutions to management problems and details a schedule of prioritised activities for the implementation of the recommendations (WBM Oceanics Australia 2006).

A number of estuarine management objectives were identified. Those relevant to the proposal include:

- **Water quality**
  - Reduce the impacts of stormwater and sewer overflows on Lake Illawarra from existing and future urban developments but achieving the recommended water quality criteria in these discharges.
- **Erosion and sedimentation**
  - Remediate areas within the Lake and its tributaries that are subject to foreshore and bank erosion and minimise susceptibility to future erosion.
  - Reduce sediment loads entering the Lake from both rural and urban catchments to pre-European levels.
- **Catchment Inputs (Catchment Management)**
  - Protect estuarine habitats from detrimental impacts resulting from any future urban development within the catchment.
  - Prevent future development from increasing runoff volumes and pollutant loads.
- **Ecology and the Fishery**
  - Protect and enhance existing areas of valuable terrestrial and aquatic habitat, and preserve communities and species of particular significance
  - Encourage recovery of threatened species that utilise Lake Illawarra for food and / or shelter.
  - Improve knowledge of the status of estuarine communities and monitor any changes to the ecology in the future.
- **Riparian Zones**
  - Develop, wherever possible, a contiguous riparian zone along streams entering the Lake and around the Lake foreshore. Wherever possible, this riparian zone should exist in conjunction with appropriate facilities for shared pathways and maintenance equipment.
- **Commercial opportunities**
  - Investigate opportunities for sustainable tourism ventures on foreshore areas around the Lake.

2.6.2 Riparian Corridor Management Study (2004)

The Riparian Corridor Management Study covers the Wollongong Local Government Area and Calderwood Valley, which spans both the Wollongong and the Shellharbour Local Government Areas.

Three categories of riparian environmental objectives were developed for the streams in the study area that reflect their relative environmental significance and these categories, in order of importance, are:

- Cat. 1. Environmental Corridor – provide biodiversity linkages ideally between one key destination to another, (the coast and the escarpment, or large nodes of vegetation).

- Cat. 2. Terrestrial and Aquatic Habitat – provides basic habitat and preserves the natural features of a watercourse (not necessarily linking key destinations).
- Cat. 3. Bank Stability and Water Quality – has limited (if any) habitat value but contributes to the overall basic health of a catchment

For each of the above categories, the recommended minimum width of the riparian zone varies in order to achieve the functioning identified by the objective being sought.

The methods applied in this study have been applied to the riparian areas throughout the study area and is documented in the Tallawarra Lands Riparian Assessment (ELA 2010a).

2.6.3 NSW Coastal Policy 1997

The NSW Coastal Policy 1997 sets the direction for coastal zone management, planning and conservation in NSW. The policy applies to land:

- three nautical miles seaward of the mainland and offshore islands;
- one kilometre landward of the open coast high water mark;
- a distance of one kilometre around:
    - all bays, estuaries, coastal lakes, lagoons and islands;
    - tidal waters of coastal rivers to the limit of mangroves, as defined by NSW Fisheries'(1985) maps or the tidal limit whichever is closer to the sea;
- with the line on the maps being taken to the nearest cadastral boundary and/or easily recognisable physical boundary, in consultation with local councils.

The policy applies to both urban and non urban areas along the NSW coast outside the Greater Metropolitan Region.

The NSW Coastal Policy is based on four principles of Ecologically Sustainable Development (ESD):

- Conservation of biological diversity and ecological integrity. This refers to the need to conserve the variety of all life forms, especially the variety of species, and to ensure that the productivity, stability and resilience of ecosystems are maintained.
- Inter-generational equity. This requires that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Social equity considerations, in terms of equal access opportunities to resources, are inherent in the concept of inter-generational equity.
- Improved valuation, pricing and incentive mechanisms. This requires environmental factors, such as the value of ecosystems, polluter pays principles etc, to be incorporated into the valuation of assets and services and considered in decision-making processes.
- The precautionary principle. Requires a risk adverse approach to decision making. Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty is not to be used as a reason for postponing measures to prevent environmental degradation.

Section 117 Direction under the EP&A Act has been issued to ensure local councils take account of the Coastal Policy in preparation of their Local Environmental Plan (LEPs). Councils are required to consider the Coastal Policy when determining development applications under Section 90 of the EP&A Act. The proposal will assist in implementing the objectives of the NSW Coastal Policy through the protection of the biodiversity and ecological integrity of the site.

3 Methodology

3.1 LITERATURE REVIEW

A review of all readily available literature and database records pertaining to the ecology of the study area and surrounding locality was undertaken to provide important background information. The information reviewed included:

- Department of Environment, Water, Heritage and the Arts (2010a) Online search – Protected Matters Search Tool for Matters of National Environmental Significance (Accessed May 2010);
- Department of Environment, Water, Heritage and the Arts (2010b) Online search for Weeds of National Significance (Accessed June 2010);
- Department of Primary Industries (2010) online search for noxious weeds in Wollongong LGA. (Accessed June 2010);
- *Assessment of Fauna and Flora – Lands Associated with the Tallawarra Power Station* (Burcher 1997);
- *Birds of the Tallawarra Site.* (Brandis 2010);
- *Tallawarra Lands Ecological Assessment. Local Environment Study* (ELA 2006);
- *Illawarra EcoEnergy Park Combined Cycle Generation Plant – An assessment of the Large Bentwing Bat and a survey of the microchiropteran bat fauna* (Greg Richards & Associates 1997a);
- *Illawarra EcoEnergy Park Combined Cycle Generation Plant – Report on roost location of the Southern Myotis population recorded in the EcoEnergy Park* (Greg Richards & Associates 1997b);
- *Native Vegetation of the Illawarra Escarpment and Coastal Plain. Bioregional Assessment Study Part I* (NPWS 2002a);
- *Native Vegetation of the Illawarra Escarpment and Coastal Plain. Bioregional Assessment Study Part II* (NPWS 2002a);
- *Conservation Assessment Identifying Areas of National, State and Bioregional Significance for Biodiversity within the Wollongong LGA. Bioregional Assessment Study Part III* (NPWS 2002b);
- *Conservation Assessment of Wollongong Local Government Area. Bioregional Assessment Study Part III* (NPWS 2003);
- *Flora and Fauna Survey and Assessment for Proposed Installation of a Gas Pipeline, Tallawarra, NSW* (URS 2006);
- *Wollongong Council, Shellharbour City Council, Kiama Municipal Council 2010. DRAFT Illawarra Biodiversity Strategy: Illawarra Regional Biodiversity Corridors*. Map 2.

3.1.1 Aerial Photograph Interpretation

Aerial photograph interpretation and contour information was used to broadly verify the previous vegetation mapping prior to the site inspection. Any predicted changes to the boundaries based on the aerial photographs were marked and verified during the field surveys.

Mapping prepared for the *Native Vegetation of the Illawarra Escarpment and Coastal Plain - Bioregional Assessment* and previous vegetation mapping of the site (ELA, 2006) was reviewed and verified during the site inspection.

3.2 FIELD SURVEY

The design of the site inspections was based on the requirements specified in the DGRs, an initial assessment of habitat and likelihood of species occurrence, the characteristics of the current concept plan and the amount of information for the site obtained through a number of previous survey exercises and studies. Given that the current concept plan is highly sympathetic to the environmental assets of the site and that a significant amount of target survey had already been undertaken for species relevant to the site, the surveys were primarily comprised of habitat assessments supplemented with survey for specific elements requested in the DGRs or considered essential to undertaking an appropriate assessment of impacts. Thus the survey was essentially completed in 2 parts, an overall habitat assessment and vegetation validation exercise, followed by target survey work for specific species and species groups.

A general site inspection was conducted by two ecologists over a four day period (19 April 2010, 22 – 23 April 2010 and 27 April 2010) with four ecologists attending on the 19 April 2010. The following tasks were undertaken throughout the surveys:

- verify the vegetation mapping previously undertaken across the study area and in particular the presence of Endangered Ecological Communities (EECs) listed under the TSC Act and EPBC Act;
- conduct targeted surveys for threatened flora species (for those species where April was a suitable survey season);
- assess and map fauna habitat values across the study area;
- assess and map the condition of the vegetation type present; and
- assess the likelihood of the study area to provide potential habitat for threatened and migratory species listed under the TSC Act and EPBC Act.

The target survey which was completed in addition to the general site inspection covered the remaining threatened flora species, frogs, particularly the Green and Golden Bell Frog, raptor nest / stag watching and supplementary micro bat survey. This additional survey was completed as follows:

- additional target flora survey undertaken on 28 September 2010, 11 October 2010 and 14-15 December 2010. In addition to the on-site survey, reference sites were checked for flowering species (or confirmed by others) wherever possible and relevant prior to conducting surveys;
- target Green and Golden Bell Frog survey over four separate survey periods in appropriate weather conditions (11-15 October 2010, 15-18 November 2010, 20-23 December 2010 and 24-25 January 2011 and 3-4 February 2011);

- additional anabat survey (11 October 2010, 18 November 10 and 21-22 December 2010) focusing on collecting recent anabat data from the site to supplement the volume of work already completed for the site; and
- stag / nest watching for raptors and microbats on 11 October 2010.

Further details pertaining to the survey methodology are included in the sections below. A summary of the previous studies utilised for information regarding the presence of threatened species across the site is included below in Table 3.

Table 3: ELA survey summary and previous studies utilised

Guild / Species	Surveys conducted by ELA	Previous studies relied upon
FLORA		
Threatened flora	Random meander / traverses	Burcher 1997 ▪ Walking transects Kevin Mills & Associates 1997 ▪ 1 day vegetation survey including flora searches in July.
FAUNA		
Birds	Opportunistic	Brandis 2010 ▪ Surveys undertaken since 1995 Mills & Associates 1997 ▪ Opportunistic Burcher 1997 ▪ Half-hour transects in each habitat type ▪ Call playback for Barking Owl and Masked Owl (20 minutes) URS 2006 (note: some of survey offsite) ▪ 30 min transects of 100 m (4 survey sites)
Bats	Anabat detection	Richards 1997a & b ▪ Anabat detection (over 3 night across 12 sites) ▪ Harp trapping at 3 sites Targeting Myotis macropus: ▪ Harp trapping ▪ Radio-tracking (1 night) Burcher 1997 ▪ Anabat detection (8 locations) ▪ Harp trap (1 trap over 2 nights near Ash Ponds 3) Turton 1996 ▪ Anabat (8 site for 3 nights) ▪ Harp trap (1 trap for 2 nights) Kevin Mills & Associates 1997 ▪ Anabat detection (4 locations over 1 night)

Guild / Species	Surveys conducted by ELA	Previous studies relied upon
Frogs	Initial habitat assessment and mapping with target intensive searches during the survey season	Australian Museum 1997 ▪ Spotlighting & call playback (5 sites for < 30 min each on 1 night) ▪ Habitat assessment (1/2 day) Burcher 1997 ▪ Spotlighting and listening ▪ Debris search during the day ▪ GGBF search (1 night after period of heavy rain)
Reptiles	Opportunistic / habitat assessment	Burcher 1997 ▪ 6 hours over 3 consecutive days
Mammals (excluding Bats)	Habitat Assessment	Burcher 1997 Trapping at 2 locations over 2 nights (54 trap nights) ▪ 15 small elliots, 1 medium elliot, one cage trap (Bangalay Forest and Paperbark Swamp) ▪ 10 small elliots, 1 medium elliot, one cage trap (herb swamp near wetland 381b) ▪ Two hair tubes (1 large, 1 small) at each trap line plus at the shore edge of wetland 381b and in ridge-top forest Spotlighting (2 hours for 4 nights)

3.2.1 Survey Conditions

Weather conditions during the survey period and the monthly averages for the months preceding the surveys have been included in Table 4 below. In general, conditions during the survey period were mild to warm, with no rainfall and very little wind.

Table 4: Summary of survey conditions

Date	Minimum temperature (°C)	Maximum temperature (°C)	Total rainfall (mm)
Monthly averages			
February 2010	20.4	25.8	137.4
March 2010	18.5	24.8	146.2
April 2010	16.0	22.9	12.6
September 2010	11.9	19.5	105.6
October 2010	14.1	20.3	94.8
November 2010	15.9	20.8	191.2
December 2010	17.1	23.9	125.4

Date	Minimum temperature (°C)	Maximum temperature (°C)	Total rainfall (mm)
January 2011	19.7	24.8	56.4
Survey dates - General			
19th April 2010	17.4	24.0	0
22nd April 2010	17.3	24.0	0
23rd April 2010	17.0	27.0	0
27th April 2010	12.3	19.0	0
Survey dates – GGBF Survey			
11th October 2010	14.0	22.0	6.0
12th October 2010	15.0	22.0	4.0
13th October 2010	14.0	23.0	1.0
14th October 2010	14.0	27.0	5.0
15th November 2010	20.0	22.0	1.0
16th November 2010	17.0	22.0	16.0
17th November 2010	15.0	21.0	0.4
18th November 2010	13.0	23.0	0.0
20th December 2010	13.0	22.0	3.0
21st December 2010	12.0	27.0	0.0
22nd December 2010	10.0	24.0	0.0
23rd December 2010	13.0	22.0	3.0
24th January 2011	18.0	32.0	2.0
25th January 2011	20.0	27.0	1.0
3rd February 2011	23.0	36.0	11.0
4th February 2011	21.0	31.0	0.8
Survey dates – Target Threatened Flora Survey			
28th September 2010	5.0	25.0	0.0
11th October 2010	14.0	22.0	6.0
14th December 2010	14.0	27.0	5.0

Date	Minimum temperature (°C)	Maximum temperature (°C)	Total rainfall (mm)
15th December 2010	16.0	25.0	0.0
Survey dates – Stag Watching			
11th October 2010	14.0	22.0	6.0
Survey dates – Additional Anabat Survey Nights			
11th October 2010	14.0	22.0	6.0
18th November 2010	13.0	23.0	0.0
21st December 2010	12.0	27.0	0.0
22nd December 2010	10.0	24.0	0.0

Source: Albion Park Weather Station (BOM 2010)

3.2.2 Vegetation Mapping

Ground-truthing of previous vegetation mapping was undertaken across the study area. Traverses were undertaken throughout each vegetation type to obtain a general species list and in particular to verify the presence of any EECs. The boundaries of vegetation communities were mapped onto an aerial photograph and marked using a GPS.

Any specimens unidentifiable in the field were retained and later identified. Any specimens that were thought to be threatened species or for which identification was problematic were sent to the Herbarium at the Royal Botanic Gardens, Sydney for verification.

ArcMap Version 9.3, a Geographic Information System (GIS), was used to map and interpret data in this report. Vegetation communities and records of threatened species were plotted onto geo-referenced aerial photographs. This program was then used to calculate areas of each vegetation community and other habitats across the site.

3.2.3 Vegetation Condition Assessment

A vegetation condition assessment was conducted by mapping the distribution and abundance of weeds across the site. Each area was assigned a weed density ranking to reflect the level of weed invasion. The assigned categories included:

- **very high:** ≥ 75 % exotic species
- **high:** ≥ 50 – 74 % exotic species
- **moderate:** ≥25 – 49 % exotic species
- **low:** ≥10 – 24 % exotic species
- **very low:** 0 – 9 % exotic species

3.2.4 Vegetation Recovery Potential Assessment

Using information collected in the field 'recovery potential' was determined across the site. Table 5 outlines the decision making rules used in this step. This assessment results in a ranking of High, Moderate, Low or Very Low recovery potential for each vegetation remnant.

Table 5: Recovery potential matrix

CURRENT CONDITION AND LAND USE	PAST LAND USE AND DISTURBANCE	SOIL CONDITION	VEGETATION	RECOVERY POTENTIAL
Cleared (no woodland canopy).	Recently cleared (<2 years)	Unmodified or largely natural. Uncultivated.	Native dominated	High
			Exotic dominated	Moderate
		Modified. Heavily cultivated and/or pasture improved. Imported material.	Either	Very Low
	Historically cleared (>2 years) and consistently managed as cleared.	Unmodified or largely natural. Uncultivated.	Native dominated	Moderate
			Exotic dominated	Low
		Modified. Heavily cultivated and/or pasture improved. Imported material.	Either	Very Low
Wooded/Native Canopy present or regenerating	No recent clearing of understorey	Unmodified or largely natural. Uncultivated.	Native understorey relatively intact or in advanced state of regeneration. Native dominated.	High
			Native understorey significantly structurally modified, absent or largely absent. Includes areas dominated by Lantana.	Moderate
			Exotic dominated	Very Low
		Moderately modified by long term grazing or mowing.	Native dominated	Moderate
		Modified. Heavily cultivated and/or pasture improved. Imported material.	Native understorey significantly structurally modified, absent or largely absent. Includes areas dominated by Lantana.	Very Low
			Native understorey present. Heavily weed invaded.	Very Low
	Understorey patchily intact	Disturbed	Native dominated	Moderate
			Exotic dominated	Very Low
	Recent clearing of understorey and or native understorey significantly structurally modified due to existing land use (eg. Mowing, grazing)	Unmodified or largely natural. Uncultivated.	Native dominated. If no vegetation present, assume native dominated.	High
			Exotic dominated	Moderate
		Modified. Heavily cultivated and/or pasture improved. Imported material.	Native dominated	Very Low
			Exotic dominated	Very Low

3.2.5 Threatened Flora Surveys

Random meanders were undertaken throughout areas of suitable habitat for threatened flora species known from, or with the potential to occur within the locality. A total of 68 person hours were spent searching for threatened flora across the study area (Figure 4). However, other traverses were undertaken throughout the study area and inventories recorded whilst traversing for other survey techniques, thus the total survey effort is somewhat more than the total formal person hours stated above.

Surveys were undertaken during a variety of seasons to account for different flowering and detection periods for different species. Reference sites were checked prior to surveying for those species that are difficult to detect (i.e. orchid species) and where this was not possible consultation with orchid experts or other surveyors of reference sites was undertaken to ensure surveys were conducted at the most appropriate time (ideally when species are detectable at a reference site). Table 6 below outlines the survey that has been completed for each species and those for which reference sites were checked prior to survey.

Table 6: Threatened flora species survey

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Survey / Flowering Period	Reference site checked
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	September to November	A known reference site for this species was checked on a number of occasions but no flowering individuals were recorded. Surveys were undertaken during the period in which the reference population normally flowers
Chorizema parviflorum	*Chorizema parviflorum* population in the Wollongong LGA	EP		August to January (seeds maturing from November)	A nearby reference population was checked and was flowering at the time of the surveys. The population recorded on site was also found to be in flower.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	November to February	Not possible
Cynanchum elegans	White-flowered Wax Plant	E	E	August to May, with a peak in November	Not necessary
Daphnandra sp. *C Illawarra*	Illawarra Socketwood	E	E	Flowers briefly in September and early October with fruits taking 10 to 12 months to	Not necessary

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Survey / Flowering Period	Reference site checked
				mature	
Haloragis exalata subsp. *exalata* var. *laevis*	Square Raspwort	V	V	November to January	Not necessary
Lespedeza juncea subsp. *juncea*	*Lespedeza juncea* subsp. *sericea* population in Wollongong LGA	EP		February to March	Known population nearby confirmed to be in flower at time of survey.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Flowering occurs over just 3-4 weeks in September and October	Not necessary
Pterostylis gibbosa	Illawarra Greenhood	E	E	Only visible above the ground between late summer and spring Flower stem in winter. Spring flowering	A nearby reference population was checked and was flowering at the time of the surveys.
Solanum celatum		E		Flowers August to October Produces fruit December to January	Not necessary
Thesium australe	Austral Toadflax, Toadflax	V	V	Spring	Not possible

Note:
E = Endangered, EP = Endangered Population, V = Vulnerable
TSC Act = *Threatened Species Conservation Act 1995*
EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

3.2.6 Fauna Habitat Mapping

The presence of important habitat features for fauna such as hollow-bearing trees, potential nesting or roosting sites, rocky outcrops, waterbodies and winter flowering eucalypts were recorded. The location of any important habitat features were marked using a Global Positioning System (GPS) so that they could be mapped and advised to the project design team to be avoided where required.

Hollow-bearing Tree Mapping

The location of hollow-bearing trees within the proposed development areas were recorded during the site inspection and marked with a GPS. Areas proposed for conservation were not targeted although where hollow-bearing trees were seen there position was marked with a GPS. It is anticipated that those trees marked represent the hollow-bearing trees present within the development area. In areas where the density of hollow-bearing trees was high (woodland in the north-east of the site) notes were made regarding the high hollow density (all trees were not marked with a GPS) and development in these areas has been avoided.

3.2.7 Anabat Surveys

An Ultrasonic Anabat Detection (Z-Caim) recorder was placed in suitable flyways along tracks, riparian areas and adjacent to wetlands for two nights (Figure 4). It was activated just before dusk for three nights (22nd April - 24th April 2010) and retrieved each morning. Recordings were analysed by Alicia Lyon (Eco Logical Australia).

Additional Anabat detection was undertaken on 11th October 2010, 18th November 2010 and 21-22 December 2010 to supplement previous survey effort by Eco Logical and others and to collect recordings from specific locations across the site. Recordings were analysed by Alicia Lyon (Eco Logical Australia) and Anna Lloyd.

3.2.8 Stag / Nest Watching

A large tree with numerous hollows is present within the proposed development area. This tree was observed during the initial general survey to support a large raptor nest. It was not possible to determine which species, if any, were using the tree during the autumn survey period and therefore targeted surveys were conducted in October to coincide with likely higher activity levels of target species.

The tree was observed from two angles by two eclogists for an hour before dusk and hour after dusk to identify if any hollows were being used by microbats as roost sites and to ascertain if the nest was currently being utilised. An anabat was also placed facing the tree to detect the species of bat, should any individuals exit any of the hollows.

3.2.9 Green and Golden Bell Frog Survey

The initial general site inspection (April) assessed the presence, type and characteristics of available Green and Golden Bell Frog habitat at the Tallawarra Lands site. Target survey for this species was subsequently undertaken to meet both Department of Environment and Climate Change (DECCW) and Department of Sustainability, Environment, Water, Populations and Communities (DSEWPC) survey guidelines for this species. This included:

Dip Netting

Two Ecologists used two D shaped dip nets with a catch of 50cm long. Edges of habitat in each 'pond' were surveyed for tadpoles in water along vegetation. Tadpoles that were captured were then identified and recorded.

Diurnal Searches

Active searches along the 'pond' edges were completed by two Ecologists for each pond. This included searching for the presence of any basking frogs in vegetation and frogs within streamside vegetation. Opportunistic calls were also identified and recorded.

Call Playback

A Call Playback procedure was conducted as per DECCW guidelines. Post sunset; previously recorded Green and Golden Bell Frog calls was projected through a loud hailer. Calls were played for 5 minutes followed by a listening period of 5 minutes with the procedure repeated 5 times for each pond. All frog calls were identified and recorded. For larger ponds including Ponds this procedure was repeated multiple times depending on access to corners of the site and size of the pond.

Nocturnal Search

Following the Call Playback procedure Two Ecologists performed active nocturnal searches among streamside and pond vegetation looking for the presence of frogs. When driving along the roads of the site any frogs crossing the road were also identified and recorded.

Survey Effort

The survey was completed over four separate survey sessions between October 2010 and February 2011 with approximately 4 weeks separation between each survey session. Surveys were conducted immediately following periods of rain with warm nights suitable for frog activity. In order to comply with DECCW and DEWHA survey guidelines, areas of potential habitat >0.3 ha were surveyed for at least 4 hours during each session and habitat areas <0.3 ha were surveyed for at least 1 hour during each survey session. Survey locations are indicated on Figure 13.

Survey Details

Trip 1

The trip 1 survey was performed by two Eco Logical Australia Ecologists Ross Wellington and Danielle Bennett from the 11th October until the 14th October 2010 over 4 days. Temperatures were warm during the field survey, with maximum temperatures ranging between 22°C and 27°C during the four days. Prior to the survey a total of 50.4mm of rainfall occurred between the 2nd and the 10th October. During the survey period a total of 16mm of rainfall was recorded which fell mostly during the evening.

Trip 2

The trip 2 survey was performed by ecologists Danielle Bennett, Deb Frazer and Michael Ward from the 15th November to the 18th November 2010 over 4 days (two ecologists on each day). Temperatures were cool to warm during the field survey, with maximum temperatures ranging between 21°C and 23°C during the four days. Prior to the survey a total of 59mm of rainfall was recorded between the 1st November 2011 and 14th November 2010. During the survey period a further 17.4mm of rainfall was recorded.

Trip 3

The trip 3 survey was performed by ecologists Danielle Bennett and Alastair Patton from the 20th December to the 23rd December 2010. Temperatures were warm during the field survey, with maximum temperatures ranging between 22°C and 27°C during the four days. Prior to the survey a total of 44mm of rainfall was recorded between the 6th December and 17th December 2010. A further 3mm of rainfall was recorded during the survey period.

Trip 4

The trip 4 survey was performed by ecologists Danielle Bennett and Alastair Patton over two separate periods ranging from the 24th January to the 25th January 2011 and 3rd February to the 4th of February 2011. Temperatures were warm to hot during the field survey, with maximum temperatures ranging between 27°C and 36°C during the four days. Prior to the survey a total of 46.2mm of rainfall was recorded between 8th January and 21st January 2011 with a further 3mm of rainfall recorded during the survey. In the second survey period (3rd to 4th February) a total of 11.8mm of rainfall was recorded during the survey period.

The weather conditions during and proceeding the surveys are summarised in section 3.2.1.

3.2.10 Opportunistic records

Opportunistic sightings of flora and fauna were recorded particularly for those species for which detailed targeted species were not undertaken as part of this assessment (eg, birds, reptiles).

3.3 LIMITATIONS

3.3.1 General

This assessment was not intended to provide an inventory of all species present across the study area but instead an overall assessment of the ecological values of the site with particular emphasis on threatened species, endangered ecological communities and key fauna habitat features. It is important to note that some species may not have been detected on the site during the inspection as they may be cryptic or seasonal. In this case the likelihood of their occurrence on site has been assessed based on the presence of potential habitat.

3.3.2 Vegetation Community Boundaries

Vegetation mapping of an area seeks to describe the distribution of the plant species in that area at that time by defining a number of vegetation units (assemblages or communities), which are relatively internally homogeneous. This generalised approach can over simplify the real situation as plants rarely occur in well-defined communities with distinct boundaries. Accordingly, vegetation units used for mapping should be viewed as indicative of their extent.

3.3.3 Mapping data limitations

Spatial co-ordinates for features, habitats or species, recorded in the field were captured using a Garmin GPSmap 76 (GPS) and transferred to ArcGIS Geographic Information System (GIS). The accuracy of GPS readings varies depending on the number of signals obtained by the GPS unit from satellites. Where possible GPS points were only taken when the accuracy was < 10 m. Sub 10 m accuracy was considered appropriate for this assessment.

3.4 IMPACT ASSESSMENT – TSC ACT LISTED SPECIES

The *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) for projects assessed under Part 3A of the EP&A Act were used to assess the likely impacts of the proposal on threatened

species listed under the TSC Act that are known or likely to occur within the study area. The assessment provides a means for assessing whether the proposal is likely to meet the provisions of the 'maintain and improve' test. Key thresholds include:

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain and improve biodiversity values;
- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and
- Whether or not the proposal will adversely affect critical habitat.

3.5 IMPACT ASSESSMENT – EPBC ACT LISTED SPECIES

The EPBC Act Administrative Guidelines on Significance sets out 'Significant Impact Criteria' that are to be used to assist in determining whether a proposed action is likely to have a significant impact on matters of national environmental significance (NES). Matters listed under the EPBC Act as being of national environmental significance include:

- Listed threatened species and ecological communities
- Listed migratory species
- Wetlands of International Importance
- The Commonwealth marine environment
- World heritage properties
- National heritage places
- Nuclear actions

Specific 'Significant Impact Criteria' are provided for each matter of NES except for threatened species and ecological communities in which case separate criteria are provided for species listed as endangered and vulnerable under the EPBC Act. These criteria were considered when assessing whether a Referral was likely to be required for the proposal.

Figure 4: Survey locations*

*Note: The survey meander track from the September 2010 flora survey is unavailable due to an equipment malfunction. The areas covered in this survey included LWMF along western boundary of the site (Yallah Creek area) and the Mount Brown area.

4 Results

4.1 LITERATURE REVIEW

Database searches indicated that a number of threatened species and endangered ecological communities had been recorded, or have the potential to occur, within the locality (DECCW 2010a, DEWHA 2010a). An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database searches and is included in Appendix C.

4.2 VEGETATION COMMUNITIES

A number of vegetation types are present throughout the study area including natural remnants, endangered ecological communities and areas that have been planted as part of past revegetation works. Vegetation communities identified across the study area, together with their conservation status under the TSC Act and condition are listed below in Table 7. None of the communities present within the study area are listed under the EPBC Act.

Much of the site has been cleared in the past and large areas are currently grazed. Many of the vegetation communities are in poor to moderate condition due to heavy invasion from species such as *Lantana camara, Sida rhombifolia* and exotic grasses. The most abundant and wide spread weed species are *Lantana camara*, *Delairea odorata* (Cape Ivy), *Araujia sericifera* (Moth Vine), *Lycium barbarum* (Chinese Boxthorn), *Rubus fruiticosus* agg. (Blackberry), *Solanum mauritianum* (Wild Tobacco), *Acacia saligna* (Golden Wattle), *Pennisetum clandestinum* (Kikuyu), *Chloris gayana* (Rhodes Grass) and *Paspalum dilatatum* (Paspalum). The most significant weed species observed on the Tallawarra lands is Lantana as this species is highly abundant and widespread across much of the site.

However, many of the vegetation communities have been identified as having a moderate capacity for resilience. Figure 9 shows the distribution of vegetation types across the study area with Figure 10 and Figure 11 illustrating their resilience and level of weed invasion (ELA 2010b).

Two wetlands listed under the NSW State Environmental Planning Policy 14 – Coastal Wetlands also occurs within the study area. As per the gazetted boundaries these wetlands have been mapped as supporting Coastal Saltmarsh, Swamp Oak Floodplain Forest and Estuarine Alluvial Reedland and are situated south of Duck Creek near the confluence with Lake Illawarra and on the south eastern boundary of the site.

Table 7: Vegetation communities present across the study area and their condition

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Alluvial Swamp Mahogany Forest	ASMF	Swamp Sclerophyll Forest on Coastal Floodplains on the NSW North Coast, Sydney Basin and South East Corner Bioregions	**Canopy:** *Eucalyptus tereticornis* *Eucalyptus amplifolia* *Angophora floribunda* **Mid layer:** *Lantana camara** *Melaleuca ericifolia* **Understorey:** *Pteridium esculentum* *Microlaena stipoides* *Eragrostis curvula** *Imperata cylindrica* **Open areas:** *Paspalum dilatatum** *Andropogon virginicus** *Setaria gracilis**	Poor. Heavily weed infested with Lantana, Whiskey Grass and Paspalum.

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Coastal Grassy Red Gum Forest	CGRGF	Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion	**Canopy:** *Eucalyptus tereticornis* **Mid layer:** *Lantana camara** *Melaleuca styphelioides* **Understorey:** *Carex longebrachiata* *Oplismenus imbecillis* *Dichondra repens* *Microlaena stipoides* **Climber:** *Pandorea pandorana*	Poor. Heavily weed infested with Lantana and African Olive (lower density). Mature trees present, many with hollows.
Coastal Swamp Oak Forest	CSOF	Swamp Oak Floodplain Forest on the NSW North Coast, Sydney Basin and South East Corner Bioregions	**Canopy:** *Casuarina glauca* **Mid layer:** *Lantana camara** **Groundlayer:** *Juncus kraussii* *Cynodon dactylon* *Pennisetum clandestinum** *Paspalum dilatatum** *Stenotaphrum secundatum** **Climber:** *Parsonsia straminea*	Varies in condition from poor quality to very poor quality. Some areas dominated by Lantana, others dominated by pasture grasses (i.e. Paspalum).

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Estuarine Alluvial Wetland	EAW	Swamp Sclerophyll Forest on Coastal Floodplains on the NSW North Coast, Sydney Basin and South East Corner Bioregions	*Selliera radicans* *Juncus kraussii* *Leptinella longipipes* *Suaeda australis* *Sporobolus virginicus* *Triglochin striata* *Samolus repens* *Schoenoplectus validus*	Very good condition with no weed species observed within the community.
Saltmarsh	SM	Coastal Saltmarsh of the Sydney Basin Bioregion	*Selliera radicans* *Juncus kraussii* *Sarcocornia quinqueflora* *Sporobolus virginicus* *Triglochin striata* *Samolus repens* *Tetragonia tetragonioides*	Moderate condition. Edges are dominated by pasture grasses, particularly Kikuyu.
Floodplain Wetland	FW	Freshwater Wetlands on Coastal Floodplains (Freshwater Wetlands)	*Lantana camara** *Pennisetum clandestinum** *Conyza bonariensis** *Paspalum dilatatum** *Sida rhombifolia** *Senecio madagascariensis** *Rubus ulmifolius**	Very poor condition. Dominated by pasture grasses with occasional areas of Blackberry.

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Lowland Dry – Subtropical Rainforest	LDSR	Illawarra Subtropical Rainforest in Sydney Basin Bioregion	**Canopy:** *Elaeodendron australe* *Streblus brunonianus* *Toona ciliata* *Acmena smithii* **Mid layer:** *Lantana camara** **Understorey:** *Carex longebrachiata* *Pseuderanthemum variabile* *Oplismenus imbecillis* *Commelina cyanea* *Adiantum formosum* **Climber:** *Pandorea pandorana* *Parsonsia straminea* *Araujia hortorum**	Poor condition with the understorey dominated by Lantana.

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Lowland Woollybutt – Melaleuca Forest	LWMF	Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion	**Canopy:** *Eucalyptus longifolia* *Eucalyptus botryoides* *Eucalyptus tereticornis* *Corymbia maculata* *Salix* sp.* (along creek) **Mid layer:** *Lantana camara** *Rubus fruiticosus** *Melaleuca decora* **Understorey:** *Sida rhombifolia** *Pennisetum clandestinum** *Microlaena stipoides* *Oplismenus sp.* *Paspalum dilatatum** *Dichondra repens* *Paspalidium distans* *Commelina cyanea*	Very poor and Moderate condition. Very poor areas dominated by either Lantana or Kikuyu in the ground layer. In moderate condition areas, many weed species present but in low abundance.
Moist Box – Red Gum Foothills Forest	MBRGFF	Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion	**Canopy:** *Eucalyptus tereticornis* *Eucalyptus bosistoana* **Mid layer:** *Olea europaea* subsp. *cusp** *Maclura cochinchinensis*	Poor condition. Understorey dominated by Lantana.

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Planted Swamp Oak and Weeds	PSOF	-	**Canopy:** *Casuarina glauca* **Mid layer:** *Lantana camara** **Understorey:** *Chloris gayana** *Verbena rigida** *Paspalum dilatatum** *Pennisetum clandestinum** **Climber:** *Araujia hortorum**	Poor condition. Practically a monoculture but with an understorey often dominated by Lantana or exotic grasses.
Artificial Wetland	AW	-	*Typha orientalis* *Juncus kraussii* *Phragmites australis* *Eleocharis sphacelata* *Schoenoplectus mucronatus* *Juncus usitatus*	Moderate to good condition. Mixture of native and exotic species around the fringes of some wetlands. Primarily grassy pasture on the banks of others.
Acacia Scrub	AS	-	*Acacia saligna** *Acacia mearnsii* *Lantana camara**	Very poor condition. Understorey dominated by Lantana.

Vegetation Community	Abbreviation	Corresponding EEC under the TSC Act	Characteristic species	Vegetation Condition
Planted Native, Weeds and Exotics	PWE	-	**Trees / Shrubs:** *Acacia mearnsii* *Banksia integrifolia* *Lantana camara** *Tecoma capensis** *Nerium oleander** **Understorey:** *Chloris gayana** *Conyza bonariensis** *Paspalum dilatatum** *Pennisetum clandestinum** *Senecio madagascariensis**	Very poor quality. Understorey dominated by Lantana and Golden Wreath Wattle.
Weeds and Exotics	W&E	-	*Lantana camara** *Acacia saligna** *Chloris gayana** *Andropogon virginicus** *Pennisetum clandestinum** *Verbena rigida** *Conyza bonariensis** Occasional *Casuarina glauca, Melaleuca styphelioides*	Lantana and Golden Wreath Wattle.
Exotic Pasture	EP	-	*Chloris gayana** *Paspalum dilatatum** *Pennisetum clandestinum** *Sida rhombifolia**	Extremely poor condition. Kikuyu, Paspalum and other pasture grasses.

* = exotic species

4.3 VERIFICATION OF DIFFICULT VEGETATION TYPES

Given the history of disturbance on the site a number of areas of vegetation are difficult to classify and it is often difficult to determine if some areas are natural remnants particularly in the central-east. These are discussed further in the following sections.

4.3.1 Coastal Saltmarsh

Coastal Saltmarsh is characterised by an assemblage of species, intermittent inundation and proximity to a brackish or estuarine waterbody within a specific geographic area (including the Illawarra). Sites can be heavily disturbed, but contain some characteristic features for them to classify as Coastal Saltmarsh. The community is somewhat dynamic and its extent is influenced by a number of factors (such as disturbance, wetting and drying). This community is frequently observed along the boundary of the site with Lake Illawarra, generally in a narrow strip (often only 1-2m wide) just above the intertidal area.

On Tallawarra Lands, saltmarsh species indicative of this community are also found in a number modified/man made features (being referred to as artificial wetlands) although the past disturbance at the site makes it is difficult to determine if these areas of saltmarsh are naturally occurring and therefore whether they warrant consideration as a listed EEC. The areas in question include the settling basins in the central east (AW 11 & 12) and in a depression of the former ash dam near the southern boundary (AW4) along with a few other small isolated locations.

4.3.1.1 Artificial Wetlands 11 & 12

AW 12 & 13 are used as settling basins for the power station with excess water deposited into these storage areas before evaporating or in situations where there is excess, discharged into Lake Illawarra. These storages were constructed although it is unknown whether prior to disturbance these areas were connected to the tidal zone of the Lake and whether the area comprised naturally occurring saltmarsh.

Currently the area supports saltmarsh species but it is hydrologically separated from the Lake by a mound of earth covered with terrestrial flora. This area undergoes periods of wetting and drying (see Figure 5) which influences the occurrence of saltmarsh. It is noted in the EIS for the construction of the power station wastewater treatment system, that the wetland was created with a clay lining to prevent seepage into the local ground water and to prevent contact with the ash deposits (Pacific Power 1998). Therefore, it is likely that some, if not all, of the salt currently being received in this area is not from natural sources such as groundwater or tidal influence but instead from the power station discharge or even seepage through ash deposits with potentially saline characteristics.

Historical photographs (Figure 5, Figure 6, Figure 7 and Figure 8) of the site were obtained to assist in determining if this area would have in the past supported saltmarsh. It appears from the photographs that this area has undergone extensive historical disturbance with cattle shown grazing an area of grassland in 1960 (Figure 5) that appears to be a raised alluvial deposit that would have been unlikely to support saltmarsh and a constructed wetland present in 1974. Based on the 1949 aerial photograph (Figure 7) it appears that the topography of this area is such that it is raised slightly above the land along the banks of Duck Creek and the Lake Illawarra foreshore which further indicates that this area is unlikely to have naturally supported saltmarsh. This aerial photograph also shows the extent of historical clearing across the site including within the area of interest.

Whilst it is not possible to definitively determine if saltmarsh was present in this area of the site pre 1949, it is evident that this area is highly disturbed and has been raised above the likely natural tidal

zone along at least the foreshore for an extensive period. However, it is possible that the water from the Lake and the species associated with saltmarsh (such as *Sarcocornia quinqueflora*) entered the area through flows from further upstream on Duck Creek. In the 1949 aerial photograph it appears that the suspected embankment decreases further west along Duck Creek such that flows may have occurred between the wetland area and Duck Creek.

Sarcocornia quinqueflora is generally water-dispersed and this species is present throughout these artificial wetland areas. It is plausible that the presence of this species is an artefact and may have been transported to the area through a variety of other means (eg. human activities, feet of birds). However, this also cannot be confirmed.

The quality of old aerial photographs makes landscape interpretation at this level very difficult. Although the available historical information suggests that this area is unlikely to have been saltmarsh historically, it cannot be determined with absolute certainty that this area did not receive flows in the past and hence result in the establishment of the saltmarsh nor whether there is any way the area may be currently receiving saline water from natural sources. Therefore in accordance with the precautionary principle, this area has been mapped as Coastal Saltmarsh (EEC).

Regardless, the saltmarsh in this area will be conserved under the current master plan and protected from indirect impacts. Therefore the presence of saltmarsh does not have significant impacts for the current concept plan. However, should future use of this area be proposed it is recommended that further investigation be undertaken with regards to the source of the saltmarsh and hence whether it is naturally occurring.

4.3.1.2 Artificial Wetland 4

The saltmarsh found at AW 4 is also found in a highly modified and disturbed setting. The area is located at the southern boundary of a large ash dam and coal wash depository area that extends north to near Duck Creek. The area is bunded on all sides although there is a hydrological connection through a created drainage network from AW4 to AW3, and then a created drainage channel along the southern boundary of the site which turns to the north and follows the outside of the bund to Duck Creek. The area of AW4 is the lowest area within this large bunded area and receives periodic inundations which are thought to be primarily from rainfall events over a limited catchment area (i.e. primarily from within the bunded area).

Whilst there are some similarities in species present in AW4 with relation to the suite of species listed in the final determination for this community, the saltmarsh is found growing on coal wash deposits and is not thought to be tidally connected to the lake such that it would receive salt water influence from this source. The water that is periodically found in AW4 would likely have saline elements (sufficient for the surrival of at least some saltmarsh species) however it is not known whether this is provided from groundwater sources or through seepage through the coal wash deposits which may have saline characteristics.

Further, the history of disturbance is not well known at this time (outside that discussed above) and knowledge of the former character of this area is limited to what can be gleaned from historical aerial photos (Figure 7). Figure 7 shows the landscape being utilised for former rural activities and shows the exent of variation to what is found at the site today (in terms of landform, riparian alignments and vegetation extent). The area where AW4 is located shows a predominately cleared landscape in a floodplain environment with a nearby riparian area, which may have had floodplain or saline wetland environments suitable for the occurrence of saltmarsh. This cannot be definitively detemermined however, and the use of this location as a coal wash depository area has highly modified the landscape both in terms of sediments, hydrological character and vegetation clearance.

In summary, as with AW11 & 12 (and along with a number of smaller patches with similar characteristics and disturbance history) it cannot be definitively determined whether the saltmarsh in AW4 is a natural remnant, or is now found in this location due to other sources and influences. As such, the saltmarsh in this area has been conservatively classified as Coastal Saltmarsh (EEC) on a precautionary basis.

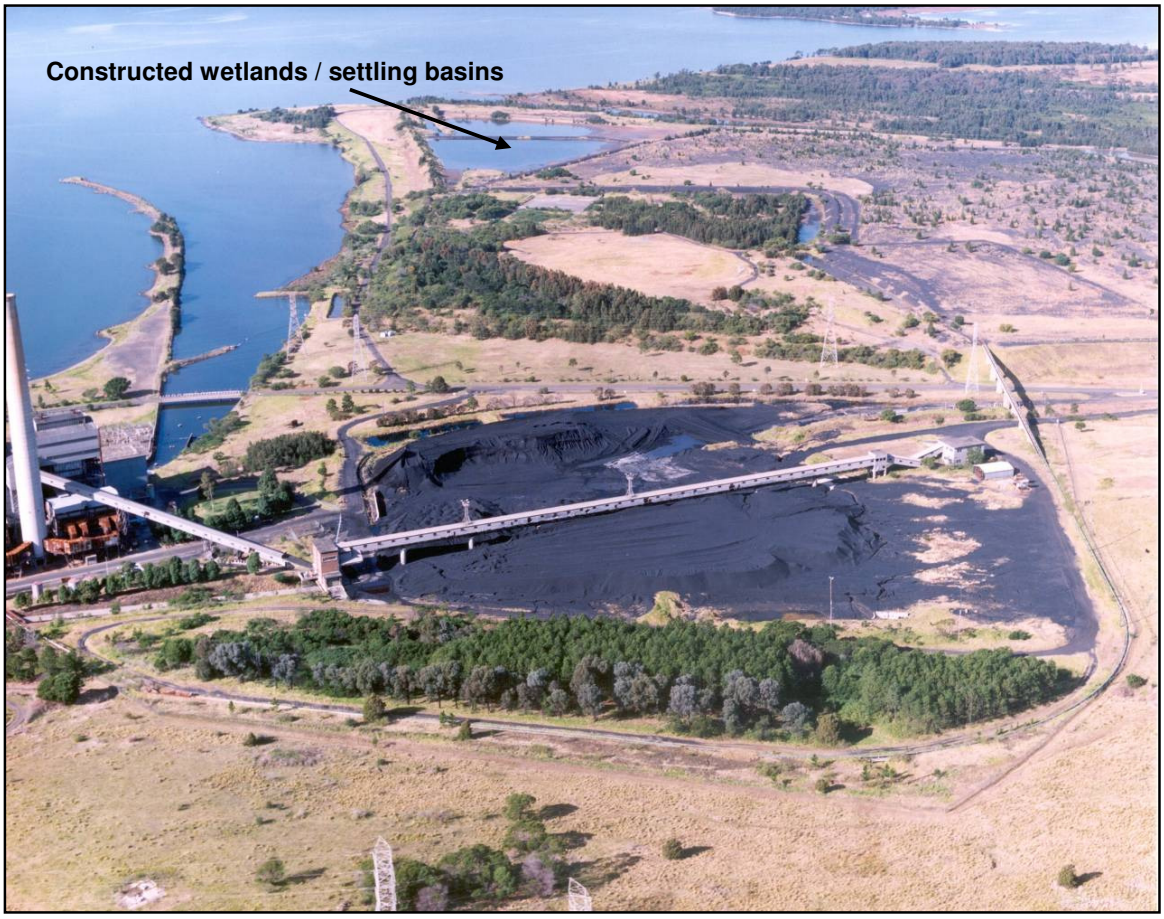

Figure 5: Constructed wetlands when filled with discharged water (Source: TRUenergy)

Figure 6: Tallawarra Power Station 1960 (Source: National Archives of Australia)

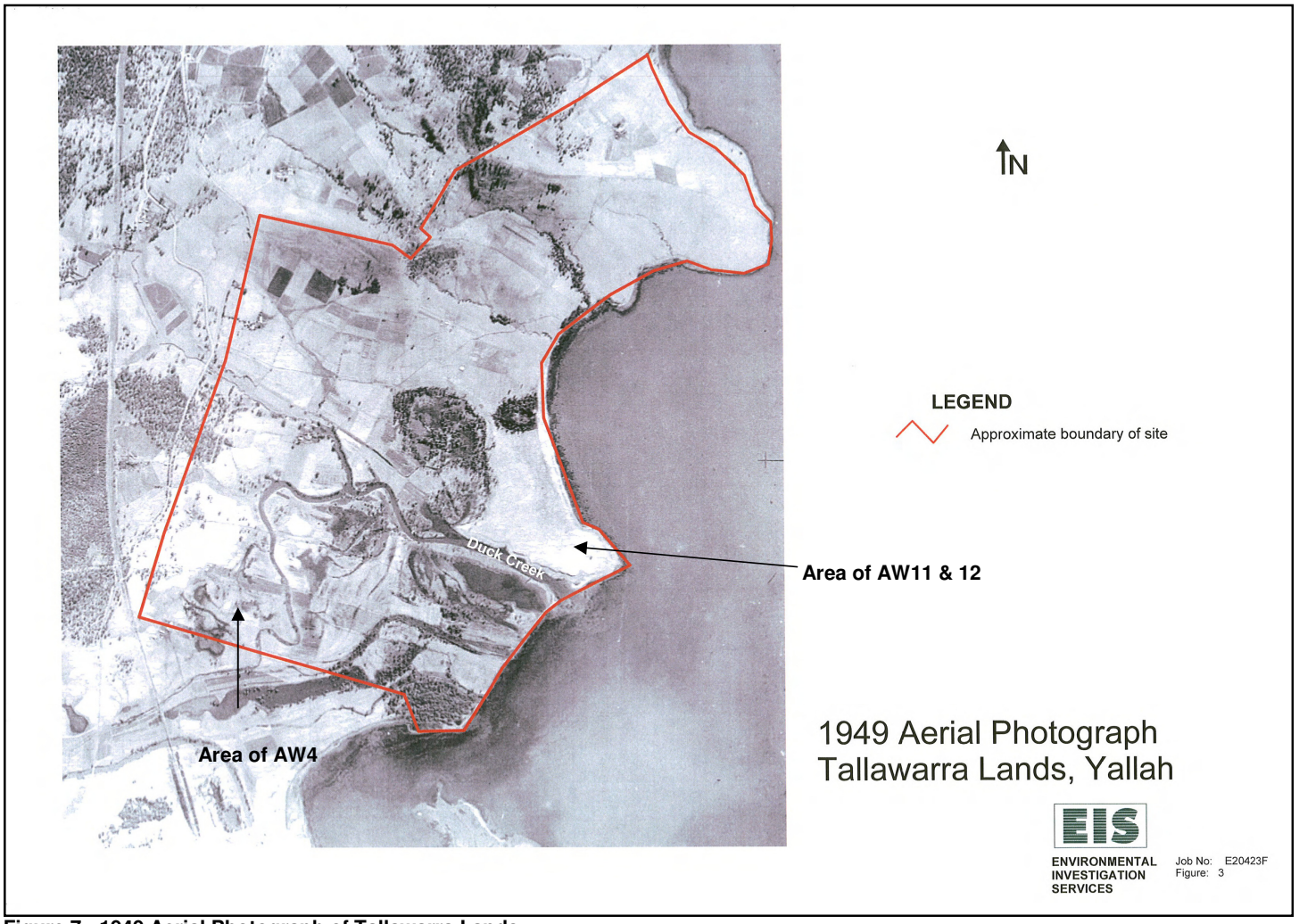

Figure 7: 1949 Aerial Photograph of Tallawarra Lands

Figure 8: 1974 aerial photograph of Tallawarra Lands, Yallah (provided by TRUenergy)

4.3.2 Swamp Oak Forest

The area of Swamp Oak Forest in the central east of the site has also undergone extensive disturbance and in the past has been used as an ash and asbestos disposal area for the Tallawarra Power Station. Consequently the substrate across much this area is not natural and for the most part, consists of ash wash. Figure 7 is a historic aerial photograph showing the high level of disturbance across this area.

The majority of the Swamp Oak Forest in this area is heavily invaded by exotic species and Lantana (*Lantana camara*) is the dominant understorey species. Previous mapping undertaken in 2006 (ELA, 2006) mapped the proposed impact area as primarily "Weeds and Exotics". Significant vegetation growth has occurred since this time and larger areas previously mapped as Weeds and Exotics now support a dense canopy of Swamp Oak (*Casuarina glauca*). Given this area was previously used as an ash dam for the Power Station and therefore has undergone extensive soil modification, vegetation clearing and other disturbances, this area is not considered to comprise the Swamp Oak Floodplain Forest (SOFF) EEC (as listed on the TSC Act 1995) and has been mapped as Planted Swamp Oak and

Exotics. Further, apart from *Casuarina glauca* the vegetation in this area contains very few of the characteristic species for this community.

Soil investigations as part of an Environmental Impact Statement (EIS) (Pacific Power, 1998) undertaken for the site, when it was formerly Illawarra EcoEnergy Park, did not assign a soil type to this area presumably indicating that the substrate was no longer natural. Further, the DECCW/NPWS vegetation mapping (NPWS 2002) for the study area has mapped this area as "Weeds and Exotics". *Lantana camara* and other exotic species are abundant in the understorey and therefore this mapping reflects the type and condition of the vegetation in this area. Consequently and for the following additional reasons the large stand of *Casuarina glauca* in the east of the study area has been mapped as *Planted Swamp Oak and Exotics* by this study and as such is not considered to be characteristic of the SOFF EEC:

- The soils have been extensively modified and therefore it is unlikely that the suite of species that would normally occur in stands of SOFF would recolonise this area;
- The *Casuarina glauca* present in this area has been mostly planted as part of rehabilitation works;
- Historical aerial photography shows that the site was cleared of all vegetation in 1974 and 1984 and was being used as an Ash Dam; and
- The understorey is almost entirely comprised of exotic species and is not characteristic of SOFF.

4.4 GROUNDWATER DEPENDANT ECOSYSTEMS

Groundwater Dependant Ecosystems (GDE) include ecosystems that use groundwater as part of survival, and can potentially include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps. The groundwater dependence of ecosystems will range from complete reliance to those that partially rely on groundwater, such as during droughts. The degree and nature of dependency will influence the extent to which ecosystems are affected by changes to the groundwater system, both in quality and quantity (Australian Government 2010).

The natural wetlands at the site would be considered GDEs. This would include the two SEPP 14 wetlands in the south east of the site. It is unlikely that the artificial wetlands in the south west of the site are groundwater dependant as clay linings may have been laid when these wetlands were constructed to prevent contaminants leaching into the groundwater. It is unlikely that the small dams (labelled artificial wetlands) present across pasture areas would be groundwater dependant.

It is also likely that the moist vegetation types present in the south east of the site (LWMF, SOFF, SM, ASMF and FW) are also dependant on groundwater to some degree. The degree to which these communities are influenced by groundwater is unknown. However, it is unlikely that significant changes to groundwater in this area would occur as a consequence of the proposal. Impacts on groundwater have been assessed in a separate report prepared by Coffey (2010a). Eco Logical Australia (2010c) details the likely presence and potential impacts to GDEs in more detail that this report.

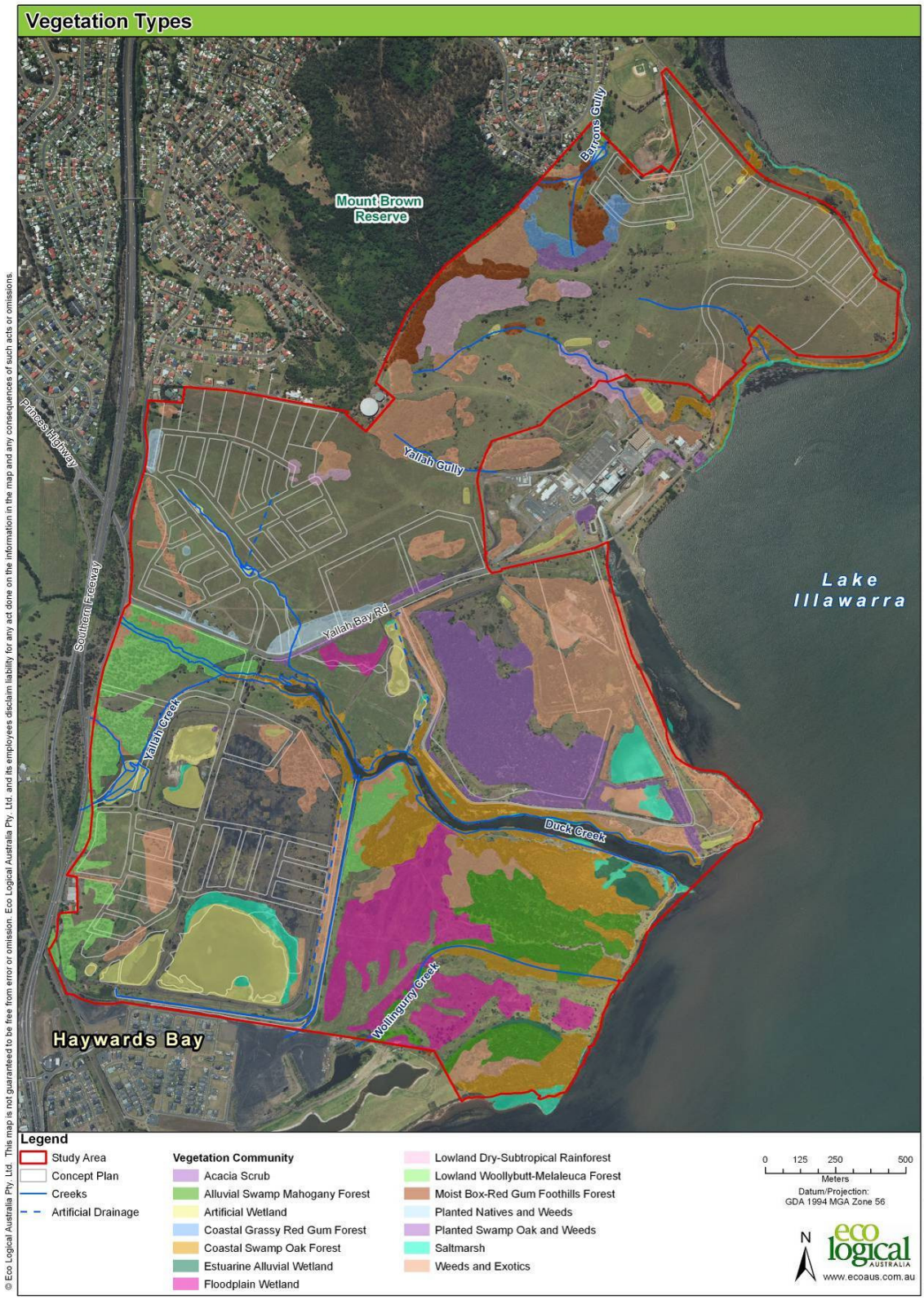

Figure 9: Vegetation types

Figure 10: Resilience

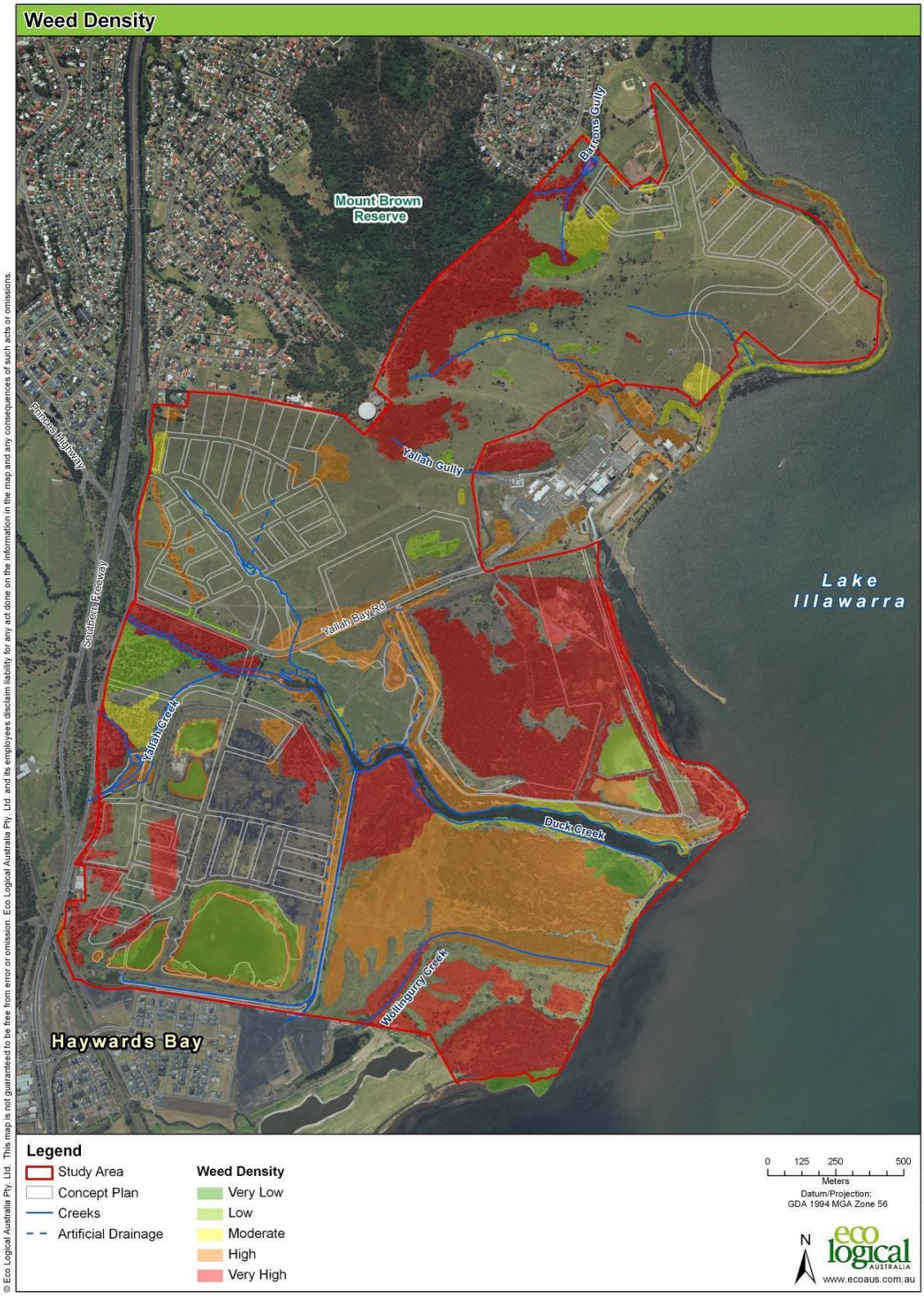

Figure 11: Weed density