Vineyard Precinct

Biodiversity and Riparian Corridors Assessment

Prepared for
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Abbreviations

Abbreviation	Description
AHCVV	Additional High Conservation Value Vegetation
AW	Alluvial Woodland
CAMBA	China – Australia Migratory Bird Agreement
CEEC	*Critically* Endangered Ecological Community
CPW	Cumberland Plain Woodland
CRCIF	Cooks River Castlereagh Ironbark Forest
DoE	Department of the Environment
DPE	NSW Department of Planning and Environment
EECs	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
ENV	Existing Native Vegetation
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
Growth Centers SEPP	*State Environmental Planning Policy (Sydney Growth Centers) 2006*
HCC	Hawkesbury City Council
ILP	Indicative Layout Plan
JAMBA	Japan – Australia Migratory Bird Agreement
LGA	Local Government Area
RFEF	River-Flat Eucalypt Forest
NES	National Environmental Significance
NOW	NSW Office of Water
NPWS	NSW National Parks and Wildlife Service
OEH	Office of Environment and Heritage
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SGTF	Shale/Gravel Transition Forest
TSC Act	*Threatened Species Conservation Act 1995*
WM Act	*Water Management Act 2000*

Executive summary

Eco Logical Australia was engaged by NSW Department of Planning and Environment (DPE) to assess the biodiversity and riparian values of the Vineyard Precinct as a component of the broader precinct planning/rezoning process that is being coordinated by DPE. The purpose of this assessment was to identify the key biodiversity and riparian features of the precinct and to provide recommendations on how those values with the highest conservation significance could be appropriately considered in the development of an Indicative Layout Plan (ILP), rezoning and ultimately, future urban development within the precinct. A key consideration in this process was the identification and validation of Existing Native Vegetation (ENV) on both certified and non-certified lands to ensure that the ENV retention target defined under the draft Growth Centre Conservation Plan (2007) was achieved. Achieving this target is a critical element of the Growth Centres being able to realise the broader 2000 ha ENV retention target that underpins the Biodiversity Certification and Strategic Assessment Approval that has been conferred on the Growth Centres under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), respectively.

The Vineyard Precinct is approximately 588 ha in size and contains four vegetation communities; Cumberland Plain Woodland, River-Flat Eucalypt Forest, Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest. There legal status is identified below;

Table 1: Vegetation communities and legal status

COMMUNITY	TSC STATUS	EPBC STATUS
Cumberland Plain Woodland	Critically endangered	Critically endangered
Shale Gravel Transition Forest	Endangered	Critically endangered
Cooks River Castlereagh Ironbark Forest	Endangered	Critically endangered
River-Flat Eucalypt Forest	Endangered	NA

A total of 170.2 ha of these vegetation communities were identified within the precinct. Of the validated vegetation 93.0 ha was confirmed as ENV, of which 42.2 ha was within certified lands, while 50.8 ha was within non-certified lands. Under the Draft Growth Centres Conservation Plan the precinct has an ENV retention target of 62.1 ha. Given that only 50.8 ha of ENV has been confirmed within the non-certified lands of the precinct, the balance of 11.3 ha may have to be retained within land that is currently certified and appropriately protected under the ILP and ultimately the gazetted Vineyard Precinct Plan.

The precinct also includes a very small area (0.1 ha), which is non-certified land in accordance with Condition 12 of the Biodiversity Certification Order. As a result, ENV cannot be cleared on land to which this condition applies unless it is in accordance with a plan of management or unless it has been agreed to by the OEH.

Within the precinct there are numerous watercourses that have been grouped into 5 watercourse systems. The systems are generally highly degraded and serve as tributaries or sections of Killarney

Chain of Ponds which flows in a northerly direction through the length of the precinct, or to Eastern Creek which is located to the west. Top of bank mapping was completed to identify appropriate riparian buffer requirements that will need to be considered during the development of the ILP, particularly for those reaches or systems that have been assigned moderate or high conservation significance. Stream F, in the east of the site has been removed as it was found to not qualify as a stream.

1 Introduction

1.1 Description of Project

Eco Logical Australia Pty Ltd (ELA) was engaged by the NSW Department of Planning and Environment to undertake an assessment of the ecological, riparian and bushfire issues so as to inform the Vineyard Precinct Planning Process within the North West Priority Growth Area (NWPGA). The aim of this assessment is to identify key ecological and riparian features and constraints of the site as well as to provide recommendations with respect to terrestrial and aquatic ecosystem management. The bushfire assessment has been completed in a separate report.

The aim of this integrated assessment is to identify key constraints, assess the impacts and provide input for the three stages of the Vineyard rezoning process:

- Stage 1 – flora and fauna field habitat assessments, riparian location and habitat survey, provision of a consolidated constraints analysis and provision of recommendations for incorporation into the Indicative Layout Plan (ILP);
- Stage 2 – assessment of the ILP, updated reporting, agency consultation and project team liaison;
- Stage 3 – input to finalisation of the ILP and associated reporting for public exhibition.

This report fulfils Stage 1 of the integrated assessment of biodiversity and riparian issues relevant to the Vineyard Precinct.

Specific objectives of this project are to:

- Undertake a strategic biodiversity assessment including a flora and fauna study, analysis of ecological values particularly in regards to identifying areas of high, moderate and low ecological value;
- Ensure the statutory requirements for the protection, restoration and enhancement of threatened species, populations, ecological communities and their habitats will be met, and that precinct rezoning processes are consistent with the terms of the biodiversity certification granted to the Growth Centres SEPP and the Commonwealth Strategic Assessment;
- Provide recommendations for achieving innovative management frameworks for ecological and riparian issues which enable long term conservation and management while facilitating the safe urban development outcomes for the precinct.

This report demonstrates the objectives are achieved through;

- Methodology that includes a literature review of previous work, detailed terrestrial aquatic and geomorphic field assessment;
- Integrated assessment of the current and future ecological and riparian issues;
- Consideration of statutory requirements, including; Growth Centres Commission Development Code, *Threatened Species Conservation Act 1995* (TSC Act), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and approved Strategic Assessment, Growth Centres SEPP Biodiversity Certification Order, *Water Management Act 2000* (WM Act), *Fisheries Management Act 1994* (FM Act).

1.2 Study Area

The Vineyard Precinct is approximately 588 ha and is located within the northwest corner of the NWPGA. The precinct lies entirely within the Hawkesbury City Council (HCC) Local Government Area (LGA) and is bounded by Commercial Road and Menin Road to the north, Boundary Road to the east, and Windsor Road and Bandon Road to the south. Stage 1 of the Precinct is expected to accommodate up to 2,400 dwellings for approximately 7,400 future residents.

The Precinct is currently zoned RU1 Primary Production, Ru4 Primary Production Small Lots and SP2 Infrastructure under Hawkesbury Local Environmental Plan (2012) (HLEP) and comprises small rural holdings that are made up primarily of low density/rural residential development and farming lands including poultry, market garden, horticulture and mushroom production. There are also some fodder production and animal husbandry enterprises in the north-western corner of the site. As a result, much of the precinct has been cleared; however, relatively large patches of remnant vegetation exist in the south-western and south-eastern corners of the precinct. There is also reasonably contiguous woody vegetation within the riparian corridor of Killarney Chain of Ponds, which flows though the eastern part of the site. Elsewhere, remnant vegetation is scattered throughout the precinct, much of which is considered to be less than 50 years of age and has been significantly disturbed by historic land use practices.

The main watercourse within the precinct is Killarney Chain of Ponds, which flows in a north-westerly direction throughout the entire length of the precinct and is located to the north of Windsor Road. Eastern Creek is also located beyond the western boundary of the precinct, to which those parts of the site that are west of the Blacktown-Richmond Railway line. Throughout the precinct the watercourses have been frequently dammed in order to support either domestic or agricultural water uses, or modified with the installation of box culverts and piped sections. Elsewhere, drainage lines have been modified to divert drainage away from yards, houses and other structures (e.g. sheds, garages etc.). In general, watercourses within the majority of the precinct have been heavily impacted by exotic species with little or no remaining native vegetation, or only small patches of well separated native vegetation remaining, perhaps with the exception of Killarney Chain of Ponds. In addition, several of the watercourses depicted on the 1: 25 000 NSW Topographic Series Maps did not meet the definition of a watercourse as they had no defined banks or beds.

A small area in the south-eastern corner of the precinct is also affected by Condition 12 of the Biocertification Order. This condition identifies non-certified land and requires that validated ENV cannot be cleared unless it is in accordance with a plan of management or has been agreed to by the OEH.

The Vineyard Precinct study area is shown in **Figure 1**.

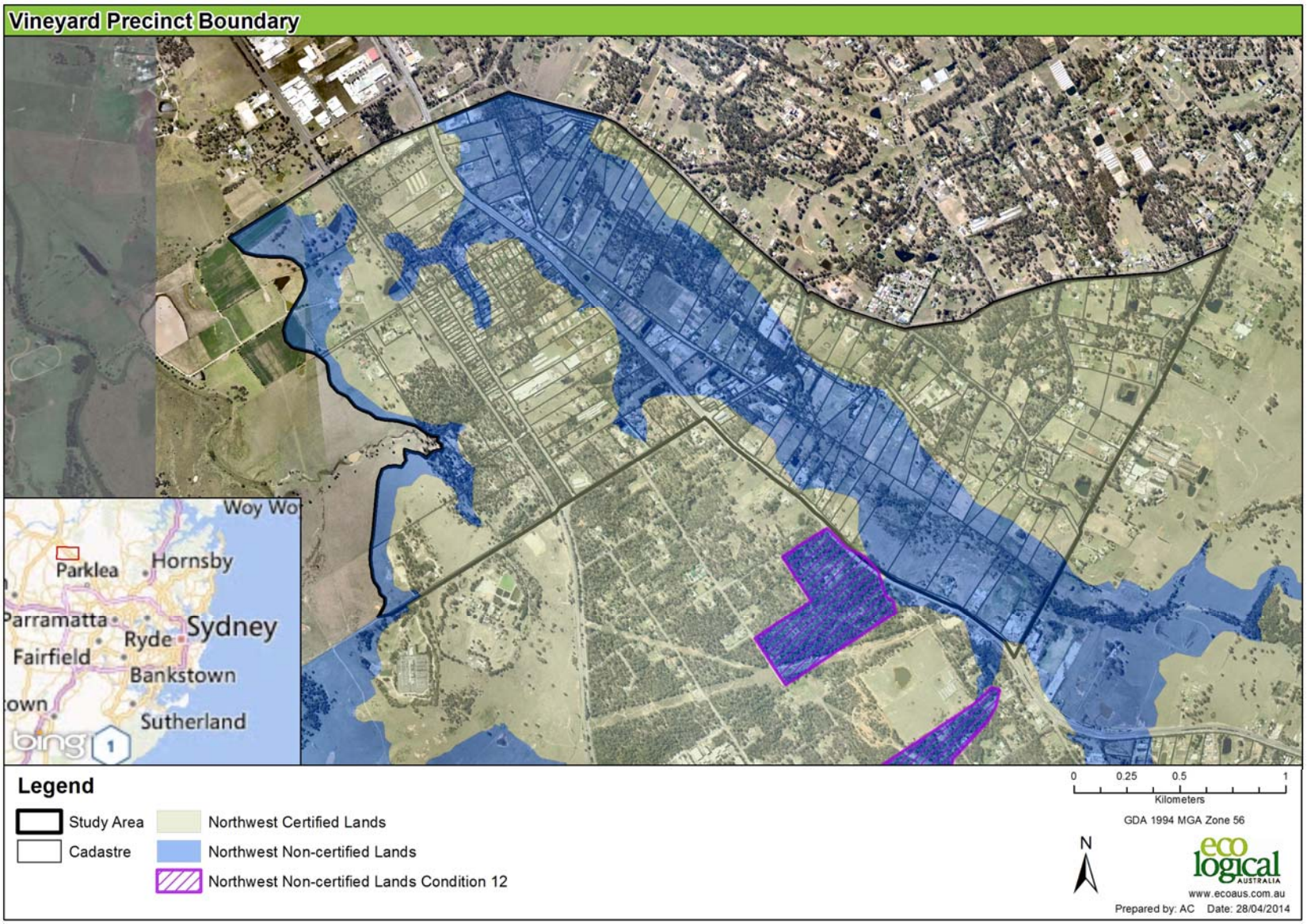

Figure 1: Vineyard Precinct

2 Statutory Framework

A substantial array of legislation, policies and guidelines apply to the assessment, planning and management of biodiversity values within the Vineyard Precinct. This information was reviewed and will be used to identify priority constraints and opportunities within the study area (Refer to **Appendix A**). Legislation and policies reviewed include:

2.1 International

- Japan – Australia Migratory Bird Agreement (JAMBA)
- China – Australia Migratory Bird Agreement (CAMBA)
- Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA)

2.2 Commonwealth

- Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)
- National Biodiversity Strategy (Draft 2011)

2.3 State

- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Threatened Species Conservation Act 1995 (TSC Act)
- Biodiversity Certification Order (2007) (BCO)
- National Parks and Wildlife Act 1974 (NPW Act)
- Fisheries Management Act 1994 (FM Act)
- Native Vegetation Act 2003 (NV Act)
- Noxious Weeds Act 1993 (NW Act)
- Protection of the Environment Operations Act 1997 (POEO Act)
- State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP)
- State Environmental Planning Policy No.19 – Bushland In Urban Areas
- Growth Centres Development Code 2006
- (Draft) Growth Centres Conservation Plan 2007
- Sydney Regional Environment Plan No 20 – Hawkesbury Nepean River (No 2 1997)
- Local Government Act (1993)
- NSW (Draft) Biodiversity Strategy 2010 – 2015

2.4 Local

- Hawkesbury Local Environmental Plan 2012

3 Biodiversity Conservation Assessment

3.1 Biodiversity certification

The Sydney Region Growth Centres State Environmental Planning Policy (referred to as the 'Growth Centres SEPP') has been 'biodiversity-certified' by order of the Minister for the Environment under s.126G of the *TSC Act*. The mechanism for achieving this is outlined in the (*Draft) Growth Centres Conservation Plan* (Eco Logical Australia, 2007) and the conditions for biodiversity-certification are documented in the Ministers order for consent[1]

Biodiversity certification negates the requirement for impact assessment on threatened species under s.5A of the *Environmental Planning and Assessment Act, 1979* thus turning off the requirements for assessments of significance (i.e. seven part tests) or species impact statements on all certified land within the northwest and southwest Growth Centres.

The (*Draft) Growth Centres Conservation Plan* (2007) assessed native vegetation across the entire Growth Centres area and identified areas of Existing Native Vegetation (ENV). **Figure 2** below shows the area of mapped ENV for the Vineyard as well as the delineation of Certified and Non-Certified land in the Precinct.

By definition (TSC Act 1995, Biodiversity Certification Order) ENV means areas of indigenous trees (including mature and saplings) that:

a) had 10 % or greater over-storey canopy cover present,

b) were equal to or greater than 0.5 ha in area, and

c) were identified as "vegetation" on maps 4 and 5 of the (Draft) Growth Centres Conservation Plan, at the time the biodiversity certification order took effect, subject to condition 13.

Condition 13 of the biodiversity-certification details the ground-truthing requirements for ENV; namely, if new information becomes available after the biodiversity certification order took effect that demonstrates that the vegetation within an areas does not otherwise meet the definition of existing native vegetation, then for the purposes of conditions 7-8 and 11-12 only the area of *validated* ENV need be considered. The field validation of vegetation across the site has updated the extent of ENV within the precinct.

This has resulted in changes to the boundaries of mapped ENV and the mapping of new areas of Additional High Conservation Value Vegetation (AHCVV), that is, vegetation which meets criteria a) and b) above but was not mapped in the original conservation plan.

The area of certified and non-certified land and the originally mapped ENV is shown in **Figure 2**. The Precinct contains 340 ha of certified land and 247 ha of non-certified land including 0.1 ha that is subject to the requirements of condition 12 of the Certification Order.

[1] http://www.environment.nsw.gov.au/resources/nature/biocertordwsgcentres.pdf

Condition 12 identifies non-certified land where validated ENV must not be cleared unless it is in accordance with a plan of management or unless the clearance has been agreed to by OEH (referred to in the order as the former Department of Environment and Climate Change, DECC). The land to which this condition applies comprises a very small area in the southern portion of the precinct. As a result, ENV cannot be cleared within this part of the precinct unless it is in accordance with the requirements of Conditions 12. The area within the precinct to which this condition applies is shown in **Figure 2.**

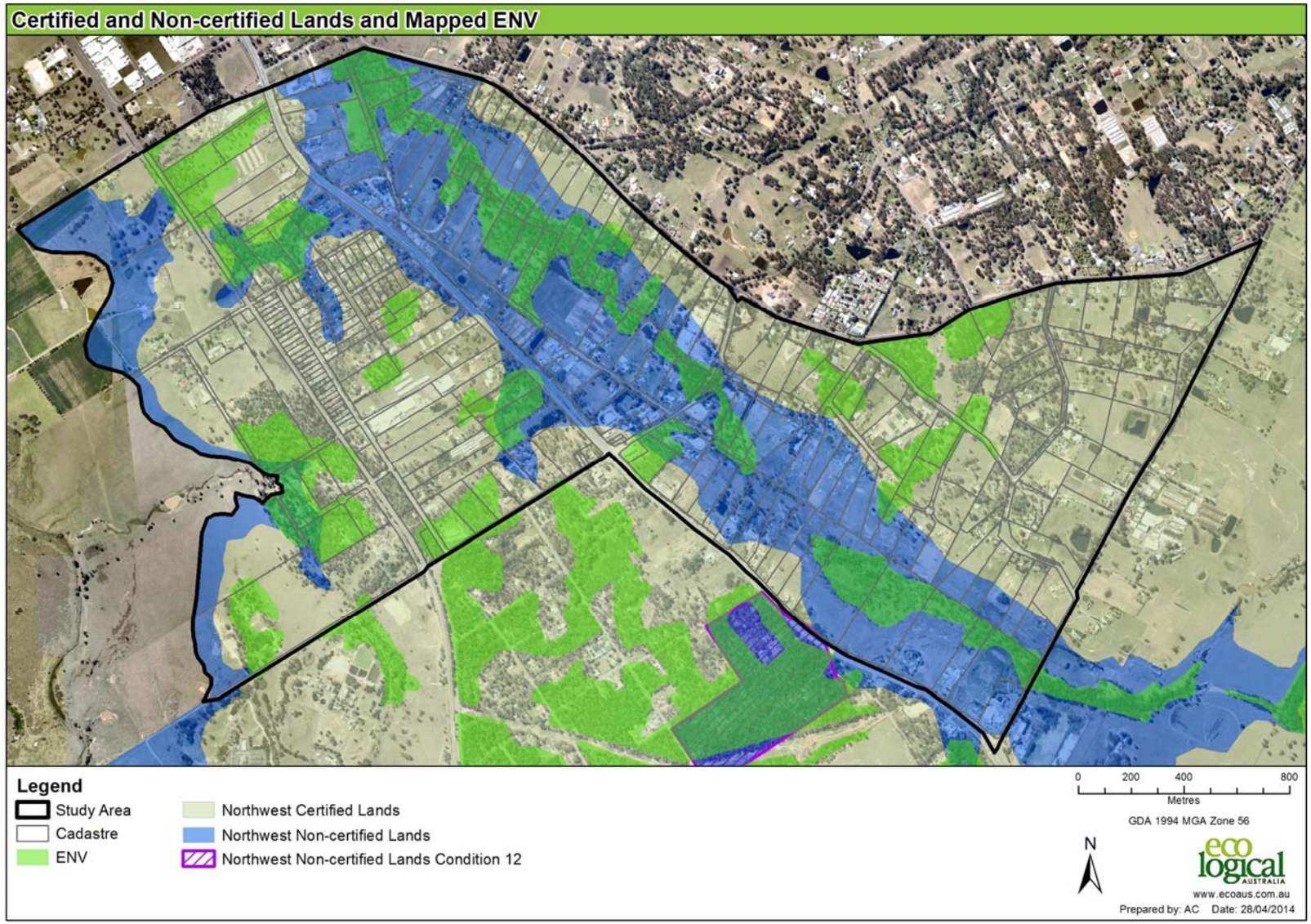

Figure 2: Certified and Non-certified Land and Conservation Plan (mapped) ENV

3.2 EPBC Act Strategic Assessment

The approval of both stages of the strategic assessment under the Commonwealth EPBC Act occurred on the 28th February, 2012. This approval essentially means that the Commonwealth is satisfied that the conservation and development outcomes that will be achieved through development of the Growth Centres Precincts will satisfy their requirements for environmental protection under the EPBC Act. So that, provided development activity proceeds in accordance with the Growth Centres requirements (such as the Biodiversity Certification Order, the Growth Centres SEPP and DCPs, Growth Centres Development Code etc) then there is ***no requirement*** to assess the impact of development activities on matters of National Environmental Significance (NES) and hence ***no requirement*** for referral of activities to the Department of the Environment (DoE) (formerly Commonwealth Department of Sustainability, Environment, Water, Population and Communities). The requirement for assessment and approval of threatened species and endangered ecological communities (EECs) under the EPBC Act has now been "turned off" by the approval of the Strategic Assessment.

3.3 Methods

3.3.1 Literature Review

A desktop literature review was undertaken by ELA to determine the location and extent of previous field surveys identify the known constraints within the study area and evaluate the presence and likelihood of threatened species, populations and ecological communities listed under both the TSC Act and EPBC Act that could potentially occur within the precinct. The following documentation and data was reviewed;

- Topographic maps, digital elevation models and aerial photography of the study area
- Database searches of NSW OEH Wildlife Atlas and EPBC online Protected Matters
- '(Draft) Growth Centres Conservation Plan' prepared by Eco Logical Australia (2007) for NSW Growth Centres Commission
- Western Sydney Vegetation Mapping (NPWS 2002a) and Western Sydney Condition and Conservation Significance Mapping (NPWS 2002b)
- Box Hill Precinct Planning Study, Post Exhibition Biodiversity Assessment (ELA 2012).
- Box Hill Precinct Planning Study, Post Exhibition Riparian Assessment (ELA 2012)
- Alex Avenue and Riverstone Precinct Planning, Part 2 of 3: Riparian Assessment (GHD 2008)
- Alex Avenue and Riverstone Precincts - Integrated Natural Environment Management, Part 1 of 3: Ecological Assessment (GHD 2008)
- Riverstone Precinct Green and Golden Bell Frog Survey, Growth Centres Biocertification (ELA 2009)
- Conservation Assessment, Riverstone West Precinct (Travers Environmental 2008)

3.3.2 Field Survey

A rapid assessment of the vegetation within the precinct was undertaken to confirm the extent, type and condition of vegetation communities present. This included classification of native vegetation communities in accordance with the NSW OEH profiles using diagnostic species and where possible to EPBC Act level where relevant.

Property access within the precinct was reasonably limited and therefore assessments including the ground truthing of ENV were determined using a combination of aerial photography interpretation, actual inspection where access was possible, visual inspection from adjoining properties (where access

was permitted), roadways and public reserves. Of the 294 properties within the precinct unconditional access was permitted to 68 (23%) and conditional access to 11 (4%). Access was denied to a further 6 (2%). For the remaining properties where owners had not provided any indication with regard to access, access was assumed to be unavailable. No properties were visited or accessed other than those that had provided written (to DPE) and verbal confirmation to (ELA) prior to the site inspection period.

Given the landscape context of the assessment detailed survey was not undertaken for threatened flora and fauna species; instead habitat assessments were undertaken using random meanders based on the access restrictions described above.

Detailed field survey methodology can be found in **Appendix B.**

3.4 Vegetation Communities and condition

The study area is dominated by a combination of cleared pastureland and scattered remnant vegetation that often occurs in discrete patches. In general, native vegetation is concentrated in two bands that are located approximately parallel to the boundary of the precinct, one of which is primarily remnant vegetation associated with Killarney Chain of Ponds.

The northern and south-western areas of the site are dominated by Cumberland Plain Woodland, with a large area of River-Flat Eucalypt Forest running northwest-southeast through the centre of the site along Killarney Chain of Ponds. A small area of Cooks River Castlereagh Ironbark Forest is located in the north western area of the precinct, and to the south of this, Shale Gravel Transition Forest. The characteristics of these four native vegetation communities, their conservation significance and ecological condition are summarised in **Table 2** and presented in **Figure 3** and **Figure 4**.

3.4.1 Cumberland Plain Woodland

The Cumberland Plain Woodland (CPW) Critically Endangered Ecological Community is listed under both the TSC and EPBC Acts. Under the TSC Act there are two sub-communities of CPW, being Shale Plains Woodland and Shale Hills Woodland. The species compositions of both sub-communities are generally identical on sites with some level of disturbance, and it is their position in landscape that predominantly determines whether an area is classified as Shale *Plains* or Shale *Hills* Woodland.

Under the EPBC Act, Shale Gravel Transition Forest is also considered to be a component of CPW. Within this report, in reference to the NSW TSC Act these two communities will be separated and when referencing the EPBC Act these communities will be combined and referred to as CPW. For the purpose of description, these communities will be described together within this section.

CPW is the most widely distributed community on the Cumberland Plain, predominantly occurring on soils derived from Wianamatta Shale. CPW present within the study area consists of a mixture of good, moderate and poor condition vegetation due to the varying levels of disturbance to the site. The majority of CPW across the site is in good condition, with some areas of vegetation in moderate and poor condition scattered across the northern, eastern, and central areas of the precinct. There are also a number of patches of CPW that meet EPBC criteria within the study area, located in the northeast and southwest areas of the precinct.

It was generally noted that within the precinct, the canopy is dominated by Grey Box (*Eucalyptus moluccana*), Forest Red Gum (*Eucalyptus tereticornis*), and Narrow-leaved Ironbark (*Eucalyptus crebra*), and Silky Oak (*Grevillea robusta*) were also observed in some patches of vegetation.

The shrub layer over large parts of the study area has been or is currently subject to grazing or other forms of agricultural activity, and or large lot/rural residential land uses. Species present included Native Blackthorn (*Bursaria spinosa*), Climbing Saltbush (*Einadia nutans*) and exotic species such as African Olive (*Olea europaea*).

Groundcover vegetation is typically dominated by a mixture of native and exotic grasses and herbs. Native groundcover species include Weeping Grass (*Microlaena stipoides*) and *Glycine tabacina*. Exotic groundcovers include Spear Thistle (*Cirsium vulgare*), Paddy's Lucerne (*Sida rhombifolia*) and Kikuyu (*Pennisetum clandestinum*).

In 2009 both the Commonwealth and State Governments 'up-listed' CPW to the status of a ***Critically*** Endangered Ecological Community (CEEC) under the EPBC and TSC Acts respectively. The criterion that must be met for vegetation to be captured by the new CEEC listings has changed under both Acts.

Under the EPBC Act, changes to both the vegetation characteristics and the assigning of condition classes were introduced. Smaller scale changes to vegetation characteristics, such as the inclusion of derived native grassland in areas of CPW, have been made under the TSC Act. Consequently, vegetation mapping completed to illustrate areas of CPW that meet the TSC Act criteria and areas that meet the EPBC Act criteria have been included separately (refer to **Figure 3** and **Figure 4**). With regard to the TSC Act criteria, derived native grasslands were not identified within the precinct.

Within the precinct there is a total of 98.2 ha of field validated CPW under the NSW definition and 86.9 ha under the Commonwealth/EPBC definition (**Table 2**). A further 10.0 ha of SGTF is located onsite which meets the NSW definition but not the Commonwealth/EPBC definition of CPW.

3.4.2 River-Flat Eucalypt Forest

The River-Flat Eucalypt Forest (RFEF) within the study area is part of the endangered ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (River-Flat Eucalypt Forest), which is listed on Schedule 1 of the TSC Act. RFEF is not listed under the EPBC Act.

A large band of RFEF runs northwest to southeast generally through the centre of the site along Killarney Chain of Ponds Creek. Another small remnant patch of RFEF is found in the centre of the site, just southwest of the main creekline (**Figure 3**).

The most common canopy species found within RFEF in the precinct is Swamp Oak (*Casuarina glauca*) and Cabbage gum (*Eucalyptus amplifolia*). The shrub layer is quite variable with Native Blackthorn (*Bursaria spinosa*) and African Olive (*Olea europaea*) occurring infrequently.

Groundcover vegetation is typically dominated by a mixture of native and exotic grasses and herbs. Native groundcover species dominated by Weeping Grass (*Microlaena stipoides*) and Couch Grass (*Cynodon dactylon*). Exotic groundcovers include Panic Veldtgrass (*Ehrharta erecta*) and Paddy's Lucerne (*Sida rhombifolia*).

Within the precinct there is a total of 40.4 ha of field validated RFEF (**Table 2**).

3.4.3 Cooks River/Castlereagh Ironbark Forest

Cooks River/Castlereagh Ironbark Forest (CRCIF) is listed as an Endangered Ecological Community under the NSW TSC Act and as a Critically Endangered Ecological Community under the EPBC Act. CRCIF is comprised of open-forest to low woodland structure usually occurring on clay soils on Tertiary alluvium, or on shale soils on Wianamatta Shale including the Birrong Soil Landscape and associated

shale lowlands. CRCIF has been extensively cleared for urban and rural developments. About 7% of the original distribution is estimated to remain.

Within the Vineyard Precinct a small area of CRCIF is located in the north-western corner of the site. This vegetation was found to be in good condition with canopy species including Broad-leaved Red Ironbark (*Eucalyptus fibrosa*) and *Eucalyptus curvula*. The shrub layer was variable but dominated by *Melaleuca decora.* Ground cover species included Couch grass (*Cynodon dactylon*), *Dillwyina* spp. *and Bryophyllum spp.*.

Within the precinct there is a total of 5.3 ha of field validated CRCIF (**Table 2**).

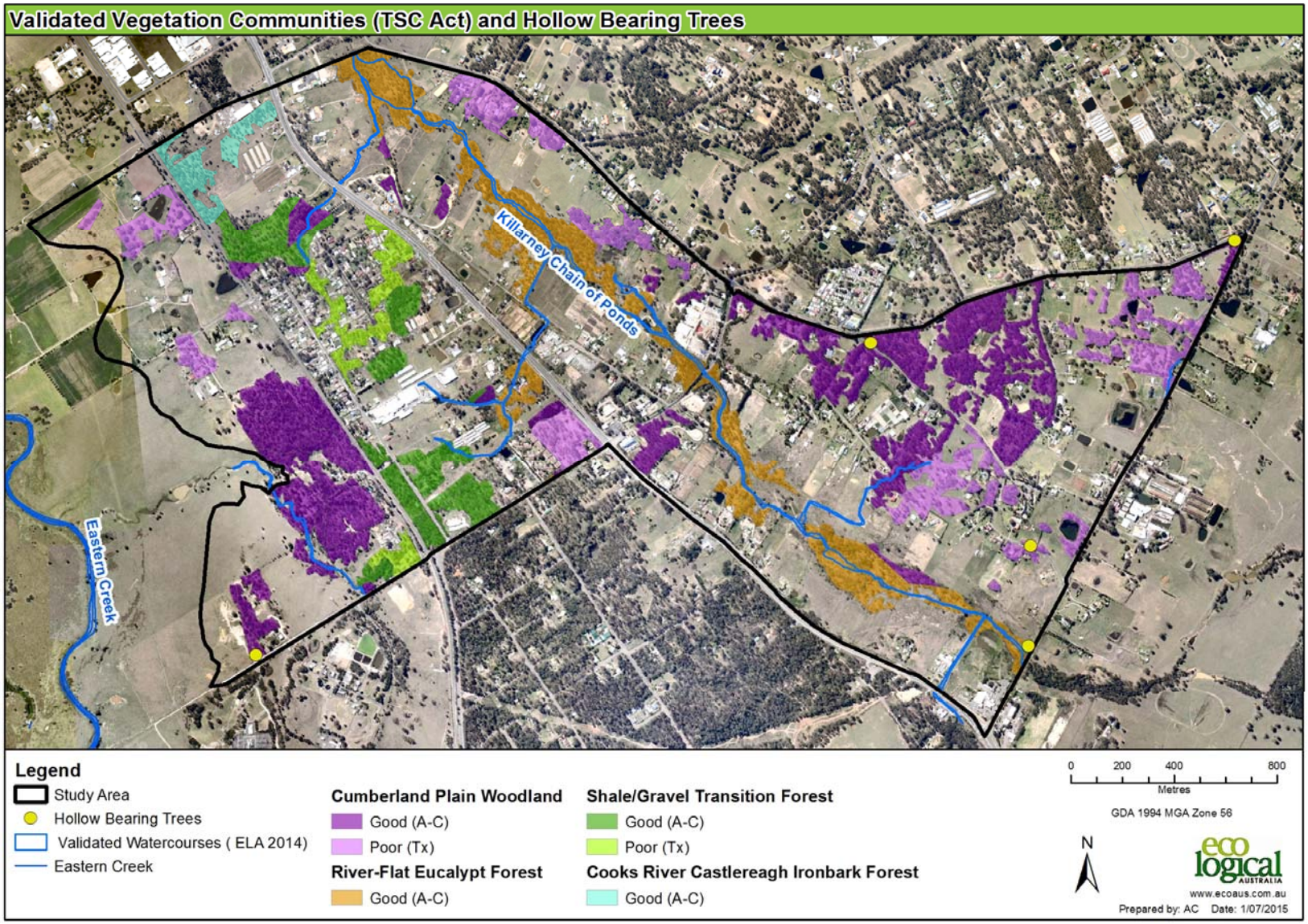

Figure 3 TSC Act Field Validated Vegetation Communities and Condition Classes and Location of Hollow Bearing Trees

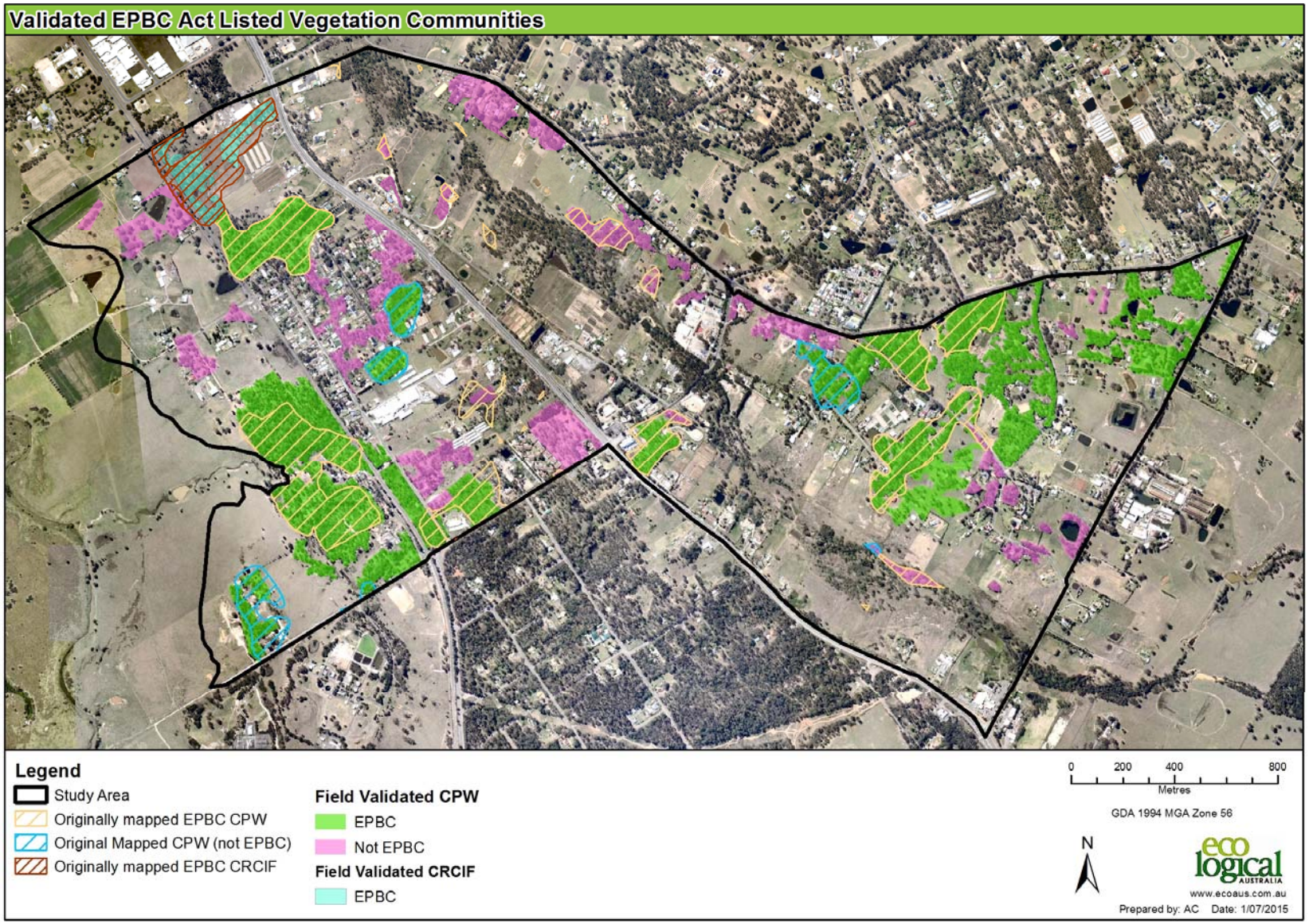

Figure 4: EPBC Act Vegetation Communities and condition classes

3.4.4 Vegetation Community and Condition Assessment Area Calculations

Area calculations of each vegetation community within the study area are provided in **Table 2** and **Table** 3.

Table 2: A summary of area occupied by TSC listed vegetation communities and their TSC condition.

VEGETATION COMMUNITY	CONDITION*		
TSC Act listed vegetation communities (Non-Certified Land Only)	A, B, C (Good)	Tx (Poor)	Total
Cumberland Plain Woodland	10.6	6.6	17.2
River-Flat Eucalypt Forest	37.3	0	37.3
Shale/Gravel Transition Forest	3.6	4.0	7.6
Cooks River Castlereagh Ironbark Forest	0	0	0
TSC Act Listed vegetation communities (Certified Land Only)	A, B, C (Good)	Tx (Poor)	Total
Cumberland Plain Woodland	52.0	28.1	80.1
River-Flat Eucalypt Forest	3.0	0	3.0
Shale/Gravel Transition Forest	15.8	3.9	19.7
Cooks River Castlereagh Ironbark Forest	5.3	0	5.3
Total (Certified and Non-Certified land)	127.6	42.6	170.2

* Condition code details can be found in Appendix B

Table 3: A Summary of area occupied by EPBC Listed vegetation communities

EPBC Listed Vegetation Communities	EPBC CPW	NON-EPBC CPW
Non-Certified Land		
Cumberland Plain Woodland (including SGTF)	11.5	13.2
Cooks River Castlereagh Ironbark Forest	0	0
Certified Land		
Cumberland Plain Woodland (including SGTF)	74.9	24.9
Cooks River Castlereagh Ironbark Forest	5.3	0
Total	86.4	38.1

3.5 Validated existing native vegetation area calculations

The (Draft) Growth Centres Conservation Plan (2007) mapped areas of ENV as per the results of the NSW National Parks and Wildlife Service (NPWS) Cumberland Plain Vegetation Mapping Project (2002). The original mapping showed the presence of three endangered ecological communities within the precinct, Cumberland Plain Woodland (CPW), River-Flat Eucalypt Forest (RFEF) and Shale Sandstone Transition Forest (SSTF).

The Conservation Plan mapped 118.4 ha of ENV within the current boundary of the Vineyard Precinct, of which 62.1 ha was located within non-certified areas and 56.3 ha within certified areas. Subsequent site inspections have ***validated*** the presence of 93.0 ha of ENV within the Precinct. The 93.0 ha is comprised of 50.8 ha in the non-certified and 42.2 ha in the certified lands.

In addition to the originally mapped and now validated ENV, additional areas of vegetation were found on-site that are classified as ***Additional High Conservation Value Vegetation*** (AHCVV). AHCVV is vegetation that was not mapped in the Conservation Plan but meets the specified ecological criteria (for ENV) of

a) having 10% or greater over-storey canopy cover present, and

b) patch size equal to or greater than 0.5ha.

Field inspections revealed an additional 77.2 ha of AHCVV, of which 11.3 ha is in non-certified lands and 5.9 ha is in certified lands.

Table 4: Amount of ENV and AHCVV in Vineyard Precinct

VINEYARD PRECINCT	CERTIFIED LAND (ha)	NON-CERTIFIED LAND (ha)	TOTAL (ha)
Conservation Plan ENV	56.3	62.1	118.4
Field Validated Conservation Plan ENV	42.2	50.8	93.0
Additional Native Vegetation (AHCVV)	65.9	11.3	77.2
Total Validated ENV + Validated AHCVV	108.1	62.1	170.2

The area of "Field Validated Conservation Plan ENV" is 25.4 ha less than the original Conservation Plan ENV. The ENV mapped within the Conservation Plan was based on desktop analysis of the NPWS Cumberland Plain Vegetation Mapping Project (2002). As such, discrepancy between the Conservation Plan ENV and the field validated ENV has likely occurred due to a number of factors, including:

- Changes in vegetation community boundaries due to increased accuracy of mapping from ground truthing compared to desktop analysis at a broader scale,
- Potential vegetation clearing since the previous mapping was completed,

Figure 5 is an overlay of the originally mapped ENV areas from the Growth Centres Conservation Plan, the field validated ENV plus the AHCVV found on site. A total of 170.2 ha of ENV and AHCVV is present on site, of which 62.1 is located on non-certified lands and 108.1 ha is on certified lands. In order to maintain parity with the Growth Centres 2000 hectare protection target it will be necessary to protect 62.1 ha of ENV on site. As only 50.8 ha of validated ENV is located on non-certified land, the balance (11.3 ha) may need to come from certified lands.

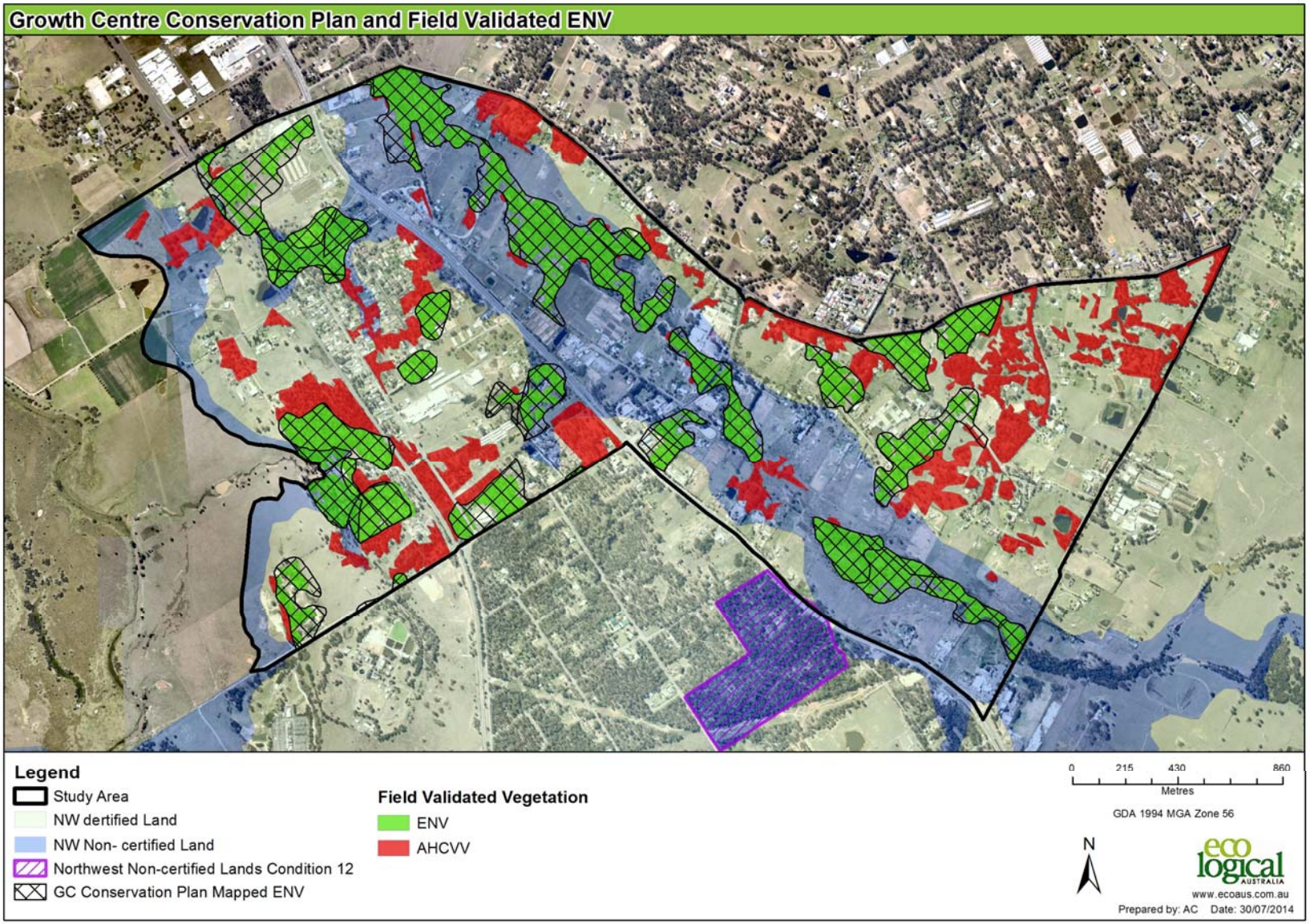

Figure 5: Mapped and Validated ENV plus AHCVV within the Vineyard Precinct

3.6 Flora

The field survey undertaken within the study area identified 55 flora species, comprised of 28 native and 27 exotic species. A flora list for the Precinct is presented in **Appendix C**. This is not a comprehensive list of *all* flora species likely to be present within the study area.

A list of threatened flora species known to occur within a 10 km radius of the study area has been collated (**Appendix D**). During the field survey no species listed under either the TSC or EPBC Act were recorded. Four threatened flora species and one threatened fauna species have previously been recorded within the study area, *Dillwynia tenuifolia*, *Pultenaea parviflora*, *Micromyrtus minutiflora*, *Grevillea juniperina* subsp. *juniperia* (Juniper-leaved Grevillea) and *Meridolum corneovirens* (Cumberland Plain Land Snail). Ground truthing during field survey did not record any of the above species, however as stated above, the resultant species list cannot be considered comprehensive given the access issues encountered with project.

Threatened flora species were targeted during traverses in suitable/potential habitat of the entire study area, where access was available. Approximately 50 person hours were utilised in completing the vegetation surveys for the site.

Noxious Weeds

Two plant species identified within the study area are listed as noxious weeds within the Hawkesbury LGA. The noxious weeds present and their management class are presented in **Table 5** below as well as whether the species is listed as a Weed of National Significance. It is very likely that other noxious weeds are present within the precinct that were not detected during field survey.

Table 5: Noxious weeds present in Vineyard Precinct.

NOXIUOS WEED SPECIES	NOXIOUS WEED CLASS	WONS
African olive (Olea europaea)	4	N
Blackberry (*Rubus fruticosus*)	4	Y
Prickly Pear (*Opuntia sp)*	4	Y

3.7 Fauna

The field survey identified 37 fauna species, including 28 bird species (24 native species and four exotic), one exotic fish, 7 exotic mammals, and one native reptile. Of the native species observed, a fauna list for the study area is presented in **Appendix C** and a list of threatened fauna species known to occur within a 10 km radius of the study area has been collated (**Appendix D**).

Based on the **Appendix D** species list, the following threatened fauna species are known, likely or have the potential to occur on site;

Table 6: Potential Threatened Species

SPECIES	TSC ACT	EPBC ACT
Amphibians		
Green and Golden Bell Frog (*Litoria aurea*)	X	X
Birds		
Australasian Bittern (*Botaurus poiciloptilus)*	X	X
Cattle Egret (*Ardea ibis)*		X
Great Egret (*Ardea alba)*		X
Little Lorikeet (*Glossopsitta pusilla*)	X	
Little Eagle (*Hieraaetus morphnoides*)	X	
Powerful Owl (*Ninox strenua*)	X	
Rainbow Bee-eater (*Merops ornatus)*		X
Square-tailed Kite (*Lophoictinia isura)*	X	
Swift Parrot (*Lathamus discolor*)	X	X
Varied Sittella (*Daphoenositta chrysoptera*)	X	
Invertebrates		
Cumberland Plain Land Snail (*Meridolum corneovirens)*	X	
Mammals		
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	X	
Eastern Freetail Bat (*Mormopterus norfolkensis*)	X	
Greater Broad-nosed bat (*Scoteanax rueppellii*)	X	
Grey-headed Flying-fox (*Pteropus poliocephalus*)	X	X
Large–eared Pied Bat (*Chalinolobus dwyeri*)	X	X
Little Bent-wing Bat (*Miniopterus australis)*		
Southern Myotis (*Myotis macropus*)	X	
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris)*	X	

Note: X indicates that the species is listed under that Act

The locations of threatened flora and fauna species recorded in the immediate vicinity of the Vineyard Precinct are shown in **Figure 6**.

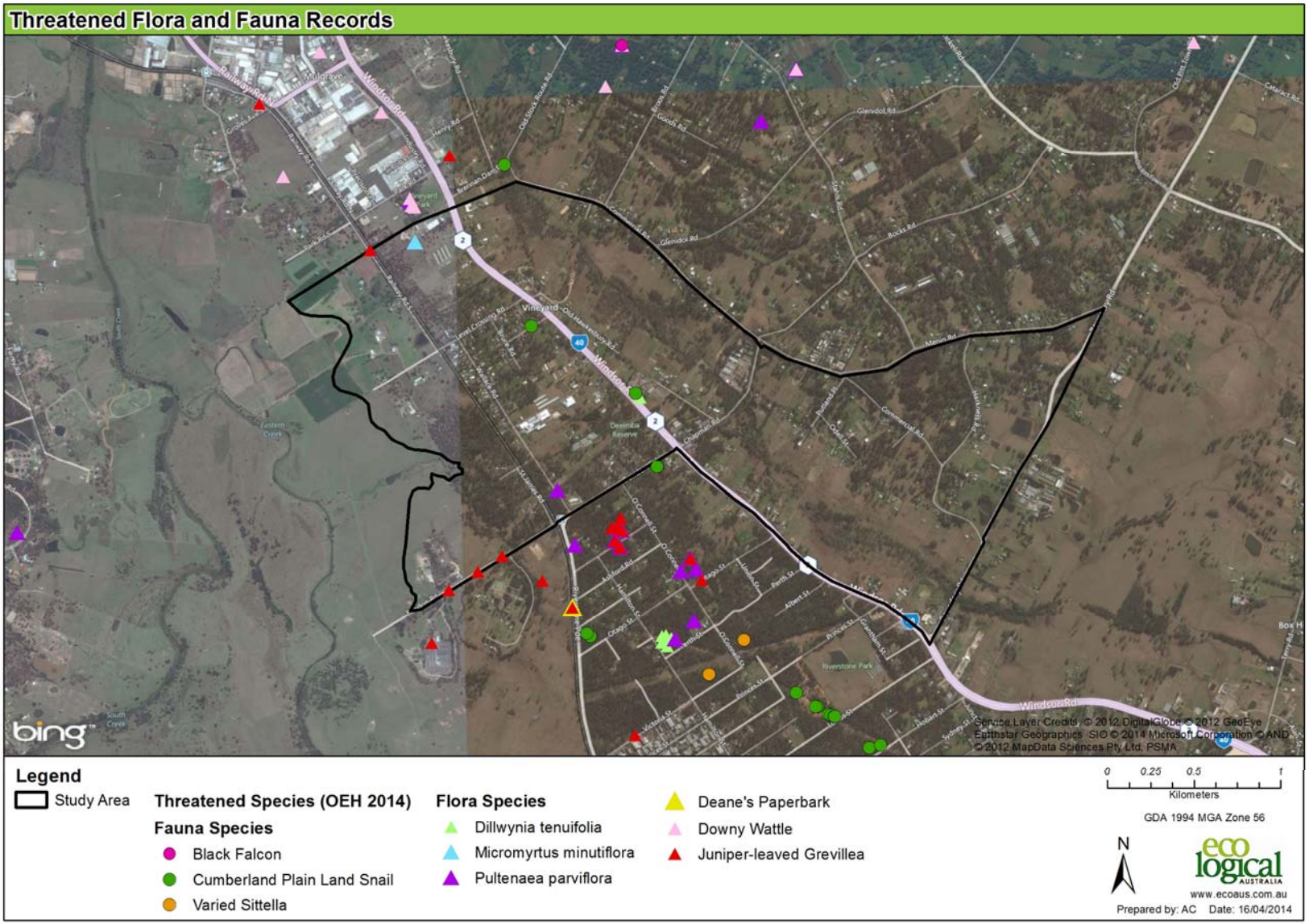

Figure 6: Location of Threatened Flora and Fauna Records in the precinct vicinity

3.8 Conservation Significance

All preliminary ecological site constraints have been combined to provide 3 main ecological conservation significance classes for the precinct, including riparian constraints which are discussed in more detail in **Section 4**. **Figure 7** illustrates the location and extent of each of these categories, which are:

Category 1: Non-certified ENV and AHCVV - All mapped and validated ENV plus the AHCVV validated on site during field investigations within the non-certified lands. These areas are not covered by the Biodiversity Certification Order and form offsetting sites for development activities within all Growth Centre Precincts. These lands should not be developed or impacted upon unless required for essential infrastructure. Any clearing of ENV / AHCVV within these areas will require offsets pursuant to Condition 8 of the Biodiversity Certification Order. As the vegetation within the non-certified lands is CPW and RFEF any impacts on these communities require assessment under either or both the NSW TSC Act and Commonwealth EPBC Act.

Category 2: Riparian Corridors - The main watercourse and their tributaries running south to north through the centre of the Precinct will be subject to future revegetation and restoration requirements to achieve a fully structured riparian vegetation community in order to both protect the bed and bank stability and provide an aquatic and terrestrial habitat link within and beyond the Precinct. Land uses within the designated riparian corridors are likely to be considerably restricted and the long term ownership and management of these areas is an issue that will need to be resolved.

The Riparian Corridors have been split into three subcategories:

- **(a)** Riparian corridor with existing vegetation and/or within non certified lands/reserves (High Conservation Significance)
- **(b)** Riparian Corridor with connections to larger areas of remnant vegetation (ENV) and/or regional watercourses (Moderate Conservation Significance)
- **(c)** Riparian Corridor that has been highly modified and in degraded condition

Category 3: Other Remnant Vegetation: While these areas are within currently certified lands, and are therefore potentially available for development because the impacts have been offset both within the non-certified areas and conservation offsetting outside the Growth Centres Precincts, they present sites of both **3(a)** high to moderate ecological value and which should be considered in the allocation of appropriate sympathetic land use zones such as open space, environmental conservation / environmental living etc, and **3(b)** exotic and/or poor condition vegetation.

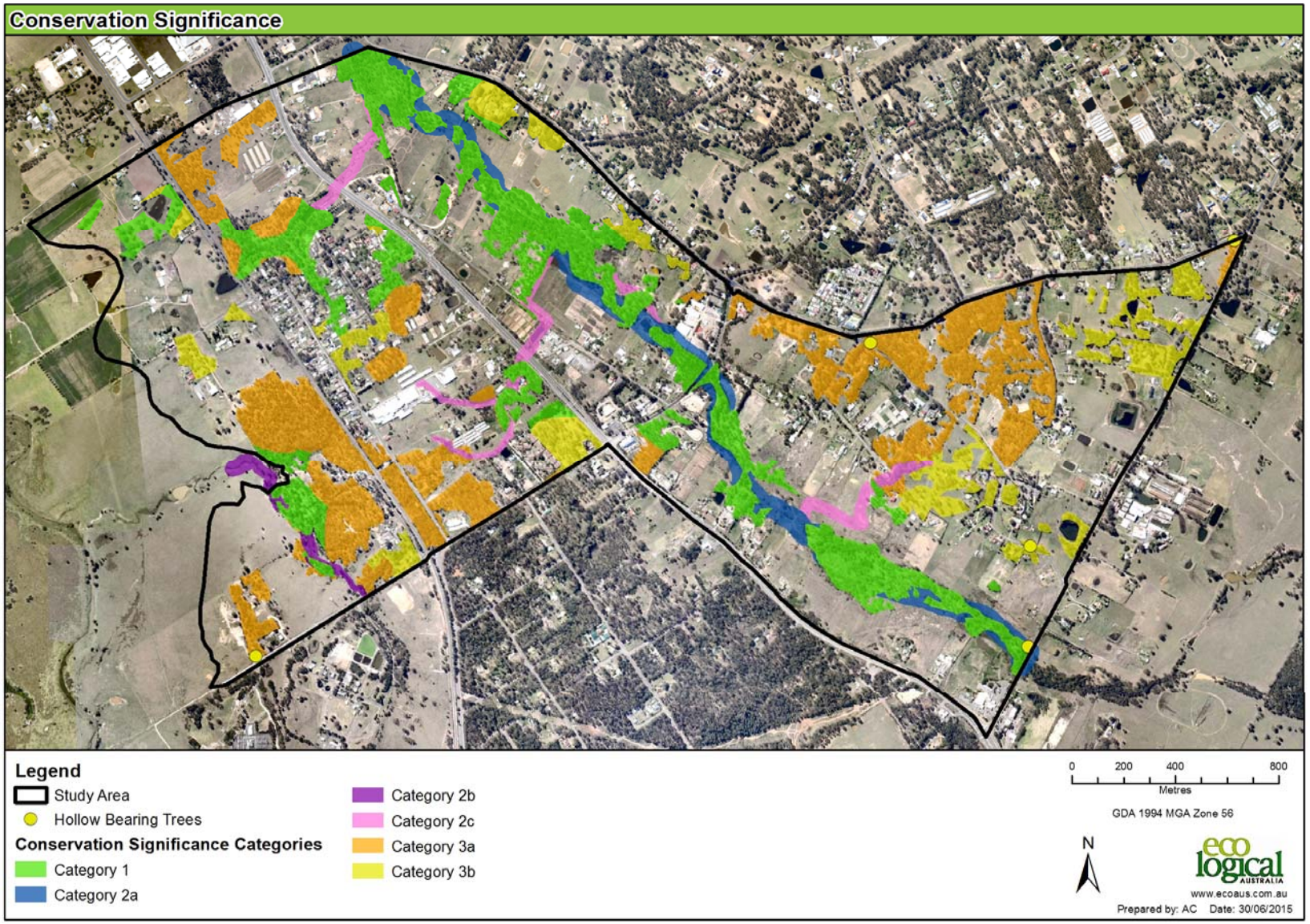

Figure 7: Conservation significance within the Vineyard Precinct

4 Riparian & Aquatic Assessment

4.1 Context

The Vineyard Precinct lies within the Eastern and South Creek sub catchments of the broader Hawkesbury-Nepean Catchment. The Hawkesbury-Nepean River system is the second-largest in NSW and has its headwaters located within largely pristine regions including the Blue Mountains World Heritage Area and Sydney Catchment Authority's lands in the NSW Southern Highlands. These upper reaches provide over 90% of Sydney's drinking water. Once into flatter, floodplain country, the Hawkesbury River flows eastward towards the ocean through rural and semi-rural areas of Western Sydney. These middle and lower reaches of the system are highly impacted and degraded, both directly through waterway modifications and indirectly through adjacent land use practises. Such modifications are typical of those found within the Vineyard Precinct.

4.2 Study Area

The 588 ha Vineyard Precinct contains sections of Killarney Chain of Ponds, its floodplain and its tributaries, together with a number of unnamed watercourses which drain to Killarney Chain of Ponds and to Eastern Creek, east of the site (**Figure 8**). Within the precinct there are numerous farm dams and other stream modifications typical of rural and rural residential development.

Figure 8: Vineyard Precinct drainage lines map

5 Methods

As required by statutory authorities, this riparian assessment follows the methodology outlined by the NSW Office of Water (NOW). This methodology is based on a Strahler Stream Order classification which identifies stream order, Riparian Corridor (RC) widths as measured from the Top of Bank (TOB) and Vegetated Riparian Zone (VRZ) widths.

Specifically this riparian assessment includes:

- Mapping of Top of Bank using a differential GPS,
- Classification of the condition of stream reaches within the study area,
- Categorisation of each stream using the Strahler stream order methodology,
- Application of VRZ widths based on stream order,
- Identification of Groundwater Dependant Ecosystems within the Precinct,
- Identification of key riparian areas recommended for protection and rehabilitation.

5.1 Field investigation - Top of Bank mapping and conditions assessment

The riparian categorisation and corridor mapping has been carried out in accordance with the Strahler stream order methodology. This was based on all 'blue lines' appearing on the 1:25,000 topographic map series, combined with field assessment data and analysis of top of bank results. The NOW require their 1:25,000 stream mapping to be assessed and validated under the WM Act.

The key outcome of this assessment is to classify watercourses within the Precinct and to identify the required riparian corridor widths. All streams identified from 1:25,000 mapping were assessed using a combination of aerial photography interpretation and field inspection and validation. Drainage lines that were not classified in this assessment are deemed to be of limited riparian value, or do not meet the definition of a river, and are therefore suitable for engineered drainage solutions.

A survey of the Top of Bank (ToB) for all accessible watercourses in the Precinct was conducted by an experienced aquatic/riparian ecologist and environmental scientist with a differential GPS (accuracy 50 – 70 cm) on the 7th, 11th and 12th of February 2014. The ToB mapping completed in the field was verified by cross-checking with up-to-date, high resolution satellite imagery and where necessary TOB data collected was manually amended. Where access was restricted, reaches were visually assessed from adjoining properties where access was available and/or from roadside verges. This approach was common to many of the reaches within the precinct where unrestricted access was not available. Reaches on or slightly beyond the boundary of the precinct were included in the assessment as it was determined that the required VRZ was likely to extend into the Precinct (e.g. Reach F).

The ToB mapping has been used as the basis for the initial riparian buffer delineation and riparian corridor boundary determination. The watercourses present in many parts of the study area are highly disturbed with some reaches having being channelised or diverted during previous urban development. For this reason and due to the lack of access to all land, the location and condition of the watercourses in some parts of the area have been inferred from contour data, high resolution aerial photography data and existing topographic map data. Accuracy of ToB mapping and condition assessment therefore cannot be guaranteed where access was not available.

Watercourse "systems" have been assigned to enable clear identification and descriptions of the relevant sections, sub-catchments, or groups of reaches. The condition of each system was assessed for key characteristics related to hydrology, physical form, water quality, aquatic habitat and streamside vegetation. Each reach was given an overall condition rating of:

- Near intact condition
- Good condition
- Moderate condition
- Degraded condition

A detailed assessment of the hydrology of each watercourse reach enabled the allocation of a stream order value as per the Strahler method. Using the Strahler system, numbering occurs from the top of the catchment with the smallest headwaters being assigned as 1st Order. Stream order number increases downstream through the catchment as same-order tributaries merge and form larger streams (**Figure 9**).

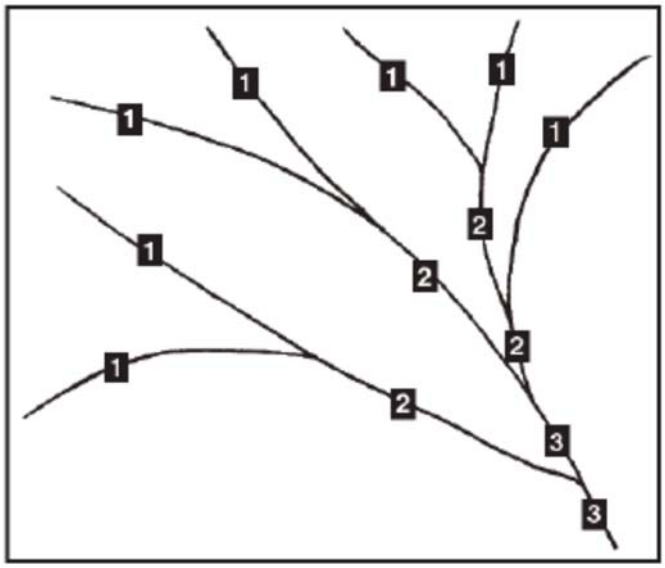

Figure 9: Strahler stream ordering system

Riparian corridor requirements in accordance with the NOW controlled activity guidelines for Riparian Corridors are outlined in **Table 7** The Vegetated Riparian Zone (VRZ) contains the areas formerly referred to as the core riparian zone (CRZ) and the vegetated buffer (VB).

Table 7: NOW riparian categories and buffer specifications

Watercourse type	VRZ width (each side of watercourse)	Total riparian corridor width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

5.2 Aquatic Assessment and Threatened Species

5.2.1 Threatened Species

Database searches were undertaken to identify threatened aquatic species that may occur within the precinct (**Table 8**).

A review of listed threatened species dependant on in stream habitat revealed that no aquatic threatened species are likely to occur within the habitats present in the study area. There are some areas of potential habitat for Green and Golden Bell Frog (*Litoria aurea*) such as existing farm dams with fringing emergent vegetation.

Table 8: Listed aquatic and amphibious species recorded in the region

Species	TSC Act	EPBC Act status	Likelihood of occurrence
Macquarie Perch (*Macquaria australasica)*	E	E	No
Australian Grayling (*Prototroctes maraena)*	-	V	No
Giant Burrowing Frog (*Heleioporus australiacus)*	-	V	No
Green and Golden Bell Frog (*Litoria aurea)*	-	V	Potential
Little John Tree Frog (*Litoria littlejohni)*	V	V	No
Stuttering Frog (*Mixophyes balbus)*	E	V	No
Red-crowned Toadlet (*Pseudophryne australis)*	V		No

5.2.2 Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDEs) are defined as ecosystems whose current species composition, structure and function are reliant on a supply of groundwater (Eamus, 2009) as opposed to surface water supplies from overland flow paths. The frequency of groundwater influence may range from daily to inter-annually, however it becomes clearly apparent when either the supply of groundwater or its quality (or both) is altered for a sufficient length of time to cause changes in plant function. Groundwater use by an ecological community or individual species does not necessarily imply groundwater dependence (Dressel et al 2010).

In Australia, the majority of ecosystems have little to no dependence on groundwater, although the full understanding of the role of groundwater in maintaining ecosystems is generally poor. The exception to this is wetland communities, for which it is thought that most have some level of dependence on groundwater resources (Hatton and Evans 1998).

GDEs are generally classified into six categories (SCCG 2006, SKM 2001):

- **Terrestrial vegetation** – forests and woodland which develop a permanent or seasonal dependence on groundwater, often by extending roots into the water table,
- **Base Flow in streams** – aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow,
- **Aquifer and cave systems** – aquatic ecosystems that occupy caves or aquifers,

- **Wetlands** – aquatic communities and fringing vegetation that depend on groundwater fed lakes and wetlands,
- **Estuarine and near shore marine ecosystems** – various ecosystems including mangroves, salt marsh and seagrass, whose ecological function has some dependence on groundwater discharge
- **Terrestrial fauna** – fauna species assemblages reliant on groundwater for drinking water.

A final category is also recognised – **not apparently dependant**. This category acknowledges that some ecosystems, particularly wetland and riparian vegetation, might superficially appear to be groundwater dependent while in fact they are dependant entirely on surface flows and or rainfall.

GDEs have varying degrees of dependency on groundwater. These range from total to occasional dependence and include (SCCG 2006, SKM 2001):

- **Entirely dependent** – ecosystems for which only a slight change in the groundwater regime will have catastrophic effects,
- **Highly dependent** – ecosystems for which moderate changes in the groundwater regime will result in significant changes to ecosystem distribution, health and or diversity. These ecosystems utilise both ground and surface water resources.
- **Proportionally dependant** – ecosystems for which changes in the groundwater regime result in significant changes to the ecosystem characteristics,
- **Opportunistically or minimally dependant** – ecosystems for which the reliance on groundwater is limited to seasonal or climatic variations. These ecosystems use surface water predominantly and if access to groundwater is prolonged, declines in ecosystem distribution, health, species composition or diversity may result.

GDE's within the Precinct were identified and mapped during both the riparian and terrestrial biodiversity assessment and field inspection.

5.2.3 Noxious weeds

Noxious weeds are those class of plants that are required by law to be controlled by all landholders in the area in which it has been declared noxious. In NSW, noxious weeds are listed under the NW Act for every LGA in the state. In the Hawkesbury LGA, there are 85 declared noxious weeds; of these ten are aquatic species:

- Willows (*Salix species*)
- Cabomba (*Cabomba species*)
- Senegal Tea Plant (*Gymnocoronis spilanthoides*)
- Anchored Water Hyacinth (*Eichhornia azurea*)
- Hydrocotyle/Water pennywort *(Hydrocotyle ranunculoides*)
- Eurasion Water Milfoil (*Myriophyllum spicatum*)
- Leafy Elodea (*Egeria densa*)
- Water Caltrop (*Trapa species*)
- Water Lettuce (*Pistia stratiotes*)
- Water Soldier (*Stratiotes aloides*)

During field survey and TOB mapping, records were made of all declared noxious aquatic weeds that were observed.

6 Results

6.1 Top of bank mapping and condition assessment

The results of ToB mapping and initial delineation of riparian buffers are shown in **Figure 10**. Each stream was broken into systems based on its general structure, sub-catchments, and clearly defined branches. The condition of each stream system is summarised in **Table 9**. A photographic record of the accessible reaches of each stream was also made and is summarised in **Appendix E**.

The overall condition of the surveyed length of watercourses within the precinct was generally degraded (5) or moderate (1). One (1) system was considered to be in a severely modified condition, with the remaining 5 systems either in a substantially (3) or severely (2) modified condition (**Table 9**).

Streamside vegetation along the length of each stream system was modified to some extent, with the majority of vegetation subject to major to severe modification, with the inclusion of dams, box culverts, piped sections and/or informal weirs for the extraction of water. While some sections were subject to bank erosion, most were reasonably well stabilised by streamside vegetation, although highly modified by exotic species. All the assessed systems had one or more vegetative strata dominated by exotic vegetation, with little native vegetation remaining. There were large areas of dense weed infestation of the mid-storey and understorey vegetation and remnant vegetation was rarely found in isolated patches or strips. Within the total length of the systems a significant proportion had been modified.

Across the precinct, only Killarney Chain of Ponds (System A) is considered to have good recovery potential. In this regard, System A is considered to be the highest priority for conservation. System A had about 50% of the native vegetation remaining, either in strips or along patches. Similarly, System C, a tributary of Eastern Creek has about 50% of the native vegetation remaining, though is slightly more modified than System A (**Figure 10**). In contrast, the remaining systems (B, D, E, and F), are located in a more urbanised and hence disturbed sub-catchment, impacted heavily by past broad scale native vegetation removal and establishment of exotic species and modified drainage regimes. These systems therefore reflected a more degraded condition due a heightened history of disturbance.

There were no watercourses assessed to be in intact, or near intact condition. Furthermore, none of the systems exhibited any evidence of excellent frog or good to excellent bird habitat.

The field surveys mapped a total of 6 systems with a total of 14 stream reaches: comprised of one 4th order stream, six 2nd order streams and seven 1st order streams (**Figure 10**). All but one of the reaches were considered to meet the definition of a stream, however some portions of reaches have been heavily modified by culverts, pipes, realignment and small dams/ponds. Stream F was found to not meet the definition of a creek and as such, will be removed from the assessment area.

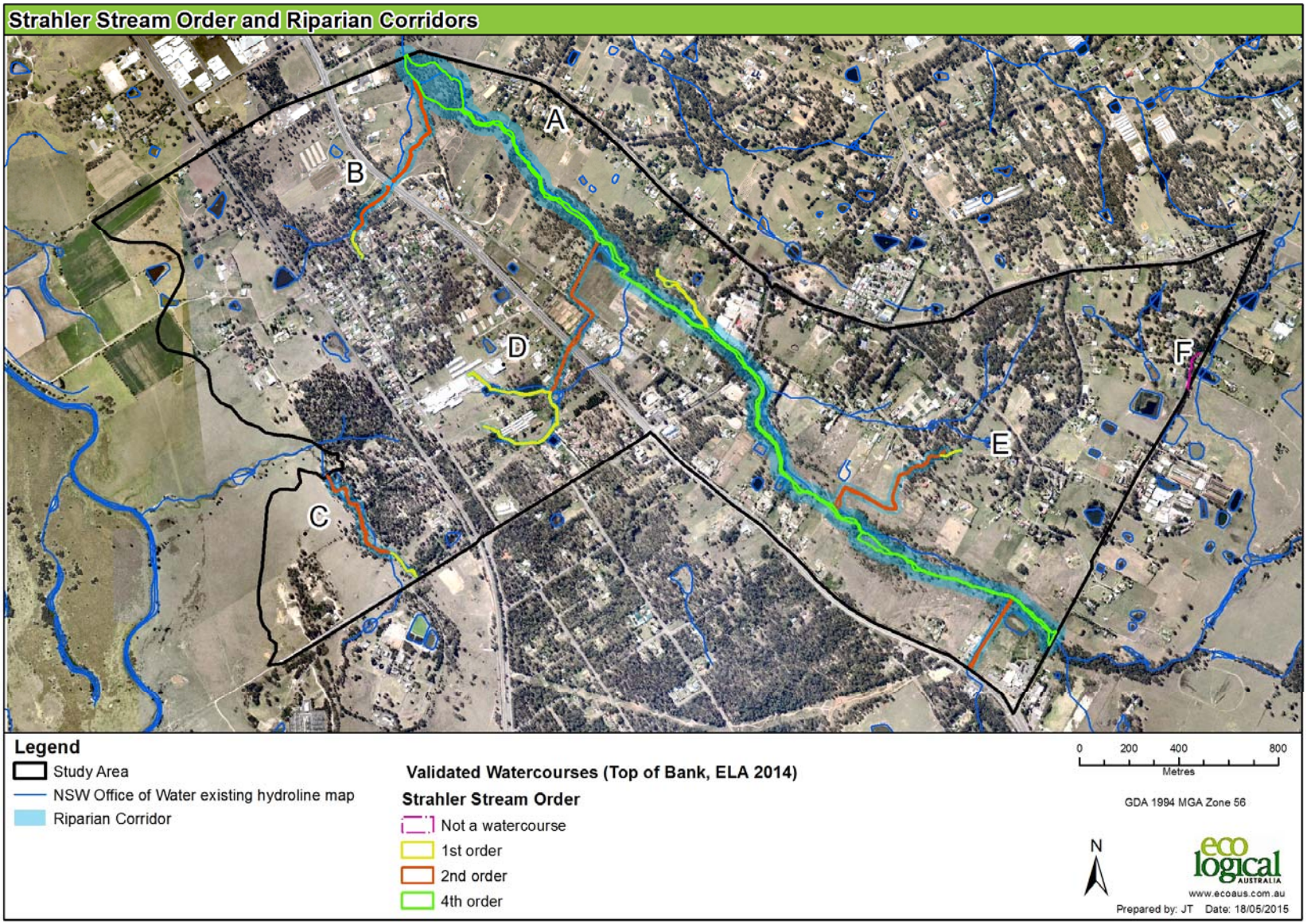

Figure 10: Strahler stream order and corresponding riparian corridors

Table 9: Water course condition assessment

System	System Name and Broad Description	Hydrology	Physical Form	Water Quality & Aquatic Habitat	Streamside Vegetation	Overall Condition
System A	Killarney Chain of Ponds. Between Boundary Rd and Old Stock Route Rd. 4th order, but possible 3rd order due to gaps in hydroline.	Creek. 4th order stream (Strahler). Unmodified channel. Minor barrier/s with fish passage during all flows. Mostly cleared catchment.	Bank slope = 30-70 degrees. Sheet erosion = 1-5%. Gully erosion = <1%. Slump erosion = 1-5%. Undercut erosion = 1-5%.	Moderate aquatic habitat with occasional in stream woody debris and aquatic vegetation. Clay substrate with occasional pools, and common native aquatic vegetation, though majority of water was stagnant. Average width of channel 1-3m with average stream depth of 10-20cm. Fish habitat = Class 2 - Moderate fish habitat. Bird habitat = Moderate. Frog habitat = Good.	Largely Modified About 50% of the native vegetation remains, either in strips or patches. One or more strata dominated by exotic species, high impact species present. More than one stratum completely altered from reference (lost or <10% remaining). Reduced cover (75-50%) of dominant strata, and/or only two age classes present. Very small quantities of debris present.	Moderate condition
System B	Tributary of Killarney Chain of Ponds. Level Crossing Rd to Old Hawkesbury Rd. Included two 1st order streams and one 2nd order creek. Upstream of Windsor Rd is overland flow and small dams. Minor drainage line from Level Crossing Rd. Lower section heavily modified by land uses.	Small drainage line. 2nd and 1st order streams (Strahler). Partially modified channel. Numerous low-flow barriers without fish passage. Mostly cleared catchment.	Bank slope = <30 degrees. Sheet erosion = <1%. Gully erosion = <1%. Slump erosion = <1%. Undercut erosion = <1%.	Poor aquatic habitat with no woody debris. Shallow, dry stream with no aquatic vegetation. Predominately clay substrate. Average width of channel 0-1m with stream depth dry. Fish habitat = Class 4 - Unlikely fish habitat. Bird habitat = Poor. Frog habitat = Poor.	Severely modified Little or no remaining native vegetation. One or more strata dominated by exotic species, high impact species present. Structure completely altered from reference. Reduced cover (<50%) of dominant strata, and only one age class present. Very small quantities of debris present.	Degraded condition

System	System Name and Broad Description	Hydrology	Physical Form	Water Quality & Aquatic Habitat	Streamside Vegetation	Overall Condition
System C	Tributary of Eastern Creek. From Bandon Rd at sewer works flowing north then west to Eastern Ck. Comprised one 1st order stream and one 2nd order stream in main channel. All other tributaries have no defined channel and are not creeks.	Creek. 2nd and 1st order stream (Strahler). Unmodified channel. One low-flow barrier. Mostly cleared catchment.	Bank slope = <30 degrees. Sheet erosion = <1%. Gully erosion = <1%. Slump erosion = <1%. Undercut erosion = <1%.	Moderate aquatic habitat with occasional in stream woody debris and aquatic vegetation. Clay substrate with occasional pools, and occasional native aquatic vegetation. Stagnant water. Average width of channel 1-3m with stream depth of <10cm. Fish habitat = Class 3 - Minimal fish habitat. Bird habitat = Moderate. Frog habitat = Moderate.	Substantially modified About 50% of the native vegetation remains, either in strips or patches. One or more strata dominated by exotic species, high impact species present. One stratum missing or extra, cover within remaining strata 50% lower or higher than reference. Reduced cover (75-50%) of dominant strata, and only one age class present. Quantities and/or cover of debris 50% higher or lower than reference.	Degraded condition
System D	Tributary of Killarney Chain of Ponds. From east of Wallace Rd to east of Old Hawkesbury Rd. Comprised two 1st order streams and one 2nd order creek. Poorly defined headwater channels with dams.	Small drainage line. 2nd and 1st order stream (Strahler). Mostly modified channel. Numerous low-flow barriers without fish passage. Mostly cleared catchment.	Bank slope = 30-70 degrees. Sheet erosion = <1%. Gully erosion = <1%. Slump erosion = <1%. Undercut erosion = <1%.	Limited habitat with average wetted channel width of 0-1 m. No water in channel. Occasional native aquatic vegetation. Rare in stream woody debris with dominant clay substrate. Fish habitat = Class 4 - Unlikely fish habitat. Bird habitat = Poor. Frog habitat = Poor.	Severely modified Little or no remaining native vegetation. One or more strata dominated by exotic species, high impact species present. Structure completely altered from reference. Reduced cover (<50%) of dominant strata, and only one age class present. Very small quantities of debris present.	Degraded condition

System	System Name and Broad Description	Hydrology	Physical Form	Water Quality & Aquatic Habitat	Streamside Vegetation	Overall Condition
System E	Tributary of Killarney Chain of Ponds. Small creek flowing from Treedale Dr. Comprised two 1st order and one 2nd order streams. Creeks very different to original hydroline with many diversions along roads, dams and infilling. Creek ends with overland flow to Killarney Chain of Ponds.	Small drainage line. 2nd and 1st order stream (Strahler). Mostly modified channel. No barriers to fish passage. Mostly cleared catchment.	Bank slope = 30-70 degrees. Sheet erosion = <1%. Gully erosion = <1%. Slump erosion = 1-5%. Undercut erosion = <1%.	Limited habitat with average wetted channel width of 0-1 m. No water in channel. No native aquatic vegetation. Rare in stream woody debris with dominant clay substrate. Fish habitat = Class 4 - Unlikely fish habitat. Bird habitat = Poor. Frog habitat = Poor.	Substantially modified Only small patches of well-separated native vegetation remain. One or more strata dominated by exotic species, high impact species present. More than one stratum completely altered from reference (lost or <10% remaining). Reduced cover (<50%) of dominant strata, and only one age class present. Quantities and/or cover of debris 50% higher or lower than reference.	Degraded condition
System F	Tributary of Killarney Chain of Ponds. Headwater creek east of Boundary Rd. Comprised one 2nd order stream in a very small channel near road. Drainage lines west of Boundary Rd have no defined channel, with only dams and paddocks. This stream was not found to fit the definition of a creek and will be removed..	Small drainage line. 2nd and 1st order stream (Strahler). Partially modified channel. No barriers to fish passage. Mostly cleared catchment.	Bank slope = <30 degrees. Sheet erosion = 1-5%. Gully erosion = <1%. Slump erosion = <1%. Undercut erosion = <1%.	Limited habitat with average wetted channel width of 0-1 m. No water in channel. No native aquatic vegetation. Rare in stream woody debris with dominant clay substrate. Fish habitat = Class 4 - Unlikely fish habitat. Bird habitat = Moderate. Frog habitat = Poor.	Substantially modified. Only small patches of well-separated native vegetation remain. One or more strata dominated by exotic species, high impact species present. One stratum missing or extra, cover within remaining strata 50% lower or higher than reference. Reduced cover (<50%) of dominant strata, and only one age class present. Very small quantities of debris present.	Degraded condition

6.2 Aquatic Habitat and Threatened Species

While many of the watercourses within the precinct are disturbed and in a degraded condition, they still provide some degree of habitat for aquatic species. Typical of urban and semi urban streams, most of the watercourses demonstrate the effects of urban stormwater flows including sedimentation and nutrient accumulation, the later most evident in the prevalence of exotic weed species within the various creek lines.

Roads, the addition of dams, and drainage works have also impacted on aquatic habit in the form of culverts and other modifications, particularly so for the systems flowing into System A (System B, D and E).

Nevertheless, the majority of water courses within the study area are relatively stable and well vegetated and have value as part of a series of vegetated riparian corridors which provide habitat for local flora and fauna, particularly System A.

Habitat for frogs and birds within the majority of the watercourses ranged between 'poor' and 'moderate' with some parts of System A exhibiting 'good' frog habitat (**Table 9**). In contrast, fish habitat was generally considered to be 'minimal' or 'unlikely' for all streams other than System A, which was assessed as having 'moderate' fish habitat. These results reflect the various barriers to fish passage within the area (culverts, dams, informal weirs etc.).

Regardless, there are a host of common aquatic species including eels, yabbies and macroinvertebrates that rely on the health of aquatic habitat for their ongoing survival. Aquatic habitat is an important component of overall ecosystem health and contributes to the diversity and viability of terrestrial habitat. It is recommended that future urban development considers the provision of good quality instream habitat, longitudinal connectivity and fringing riparian vegetation. In addition, erosion and sediment control should be a key requirement during construction, and Water Sensitive Urban Design (WSUD) principles applied to help protect downstream environments.

6.2.1 Threatened Species

Relevant database searches identified only one aquatic threatened species that was considered to have the potential to occur within the precinct; Green and Golden Bell Frog (*Litoria aurea*) (**Table 8**). While the species was not observed during field investigations, opportunities to further enhance areas of suitable habitat during the development of the ILP in the form of appropriately designed WSUD features should be considered.

6.2.2 GDE

GDEs mapped in the study Area (**Figure 11**) are confined to the River-Flat Eucalypt Forest vegetation type. These vegetation types correlate to the Biometric Vegetation Type River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and Southeast Corner bioregions and were validated during field survey undertaken as part of the biodiversity assessment for the Precinct. These vegetation types may utilise groundwater fed base flows associated with shallower aquifer's linked to Reach A, and small portions of Reaches B and D.

The dependence on groundwater varies greatly with each community and its position in the landscape. There is little available information on level of groundwater dependency of theses patches of River-Flat Eucalypt Forest vegetation within the precinct. However, as a safeguard for future planning, freshwater GDEs such as streams, riparian zones and wetlands should be grouped as highly dependent, particularly during base flows.

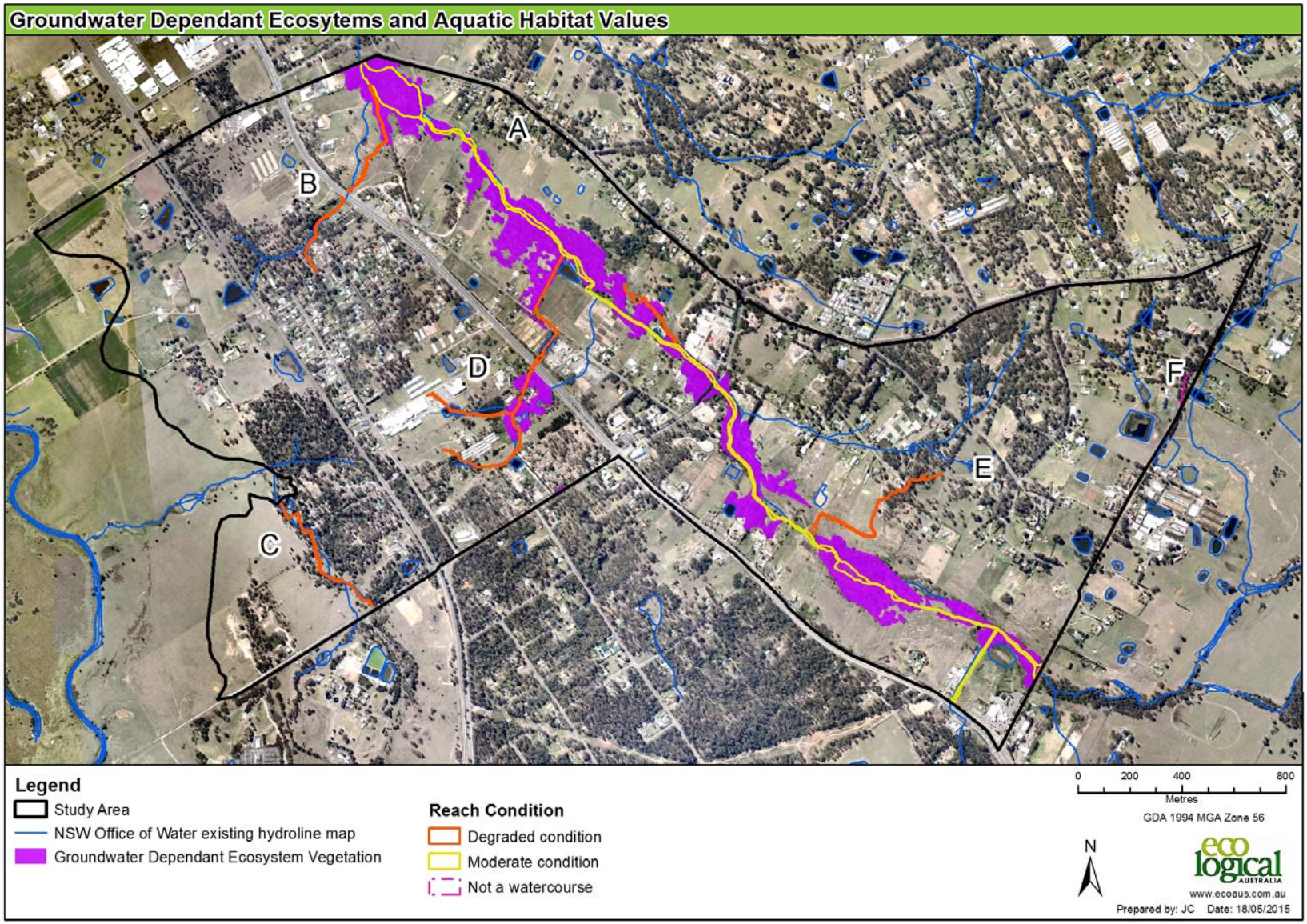

Figure 11: Groundwater Dependant Ecosystem and Aquatic Habitat values

6.2.3 Noxious weeds

Ten species of aquatic noxious weeds were identified as having the potential to occur within the precinct (**Section 5.2.3**). Moreover, given that not all watercourses or sections of watercourse could be accessed, it is possible that these species may in fact occur more broadly within the precinct. In this context, a precautionary approach should be taken during future riparian corridor works and or maintenance activities, and should any of the noxious species be identified their location should be accurately mapped and appropriate control techniques employed.

6.3 Conservation potential

A summary of conservation significance of the stream systems is presented in **Figure 12**. The conservation and recovery potential for most streams is considered to be low, particularly those that are located within more urbanised and modified landscapes (System B, D, E and F) (**Figure 12**). These systems were the most degraded within the precinct, serving as tributaries to higher value streams. Their natural geomorphic condition has been completely altered as a result of being partially channelled, piped or realigned, or the downstream environment has been substantially modified by urban development

Recovery and conservation potential for System A is considered high due to a higher complexity of habitat features, abundance of native vegetation species, and a less disrupted hydrology. The recovery potential of System C is recorded as moderate as it presents a relatively unmodified channel, retains moderate aquatic habitat and good connectivity with a stand of regenerating bushland approximately of 40,000 m^2 and the larger Eastern Creek catchment to the west.

The remaining stream systems (Systems B, D, E and F) have lower conservation priority where the natural geomorphic condition has been completely altered as a result of being partially channelled, piped or realigned, or the downstream environment has been substantially modified by urban development (e.g. sections of System B becomes part of a piped stormwater system). Other lower impact modifications such as culverts and dams are also common throughout the study area.

In the context of the broader precinct rezoning, where possible the higher value riparian corridors (i.e. System A and System C) should be retained in public ownership, zoned and managed as conservation lands/infrastructure (drainage).

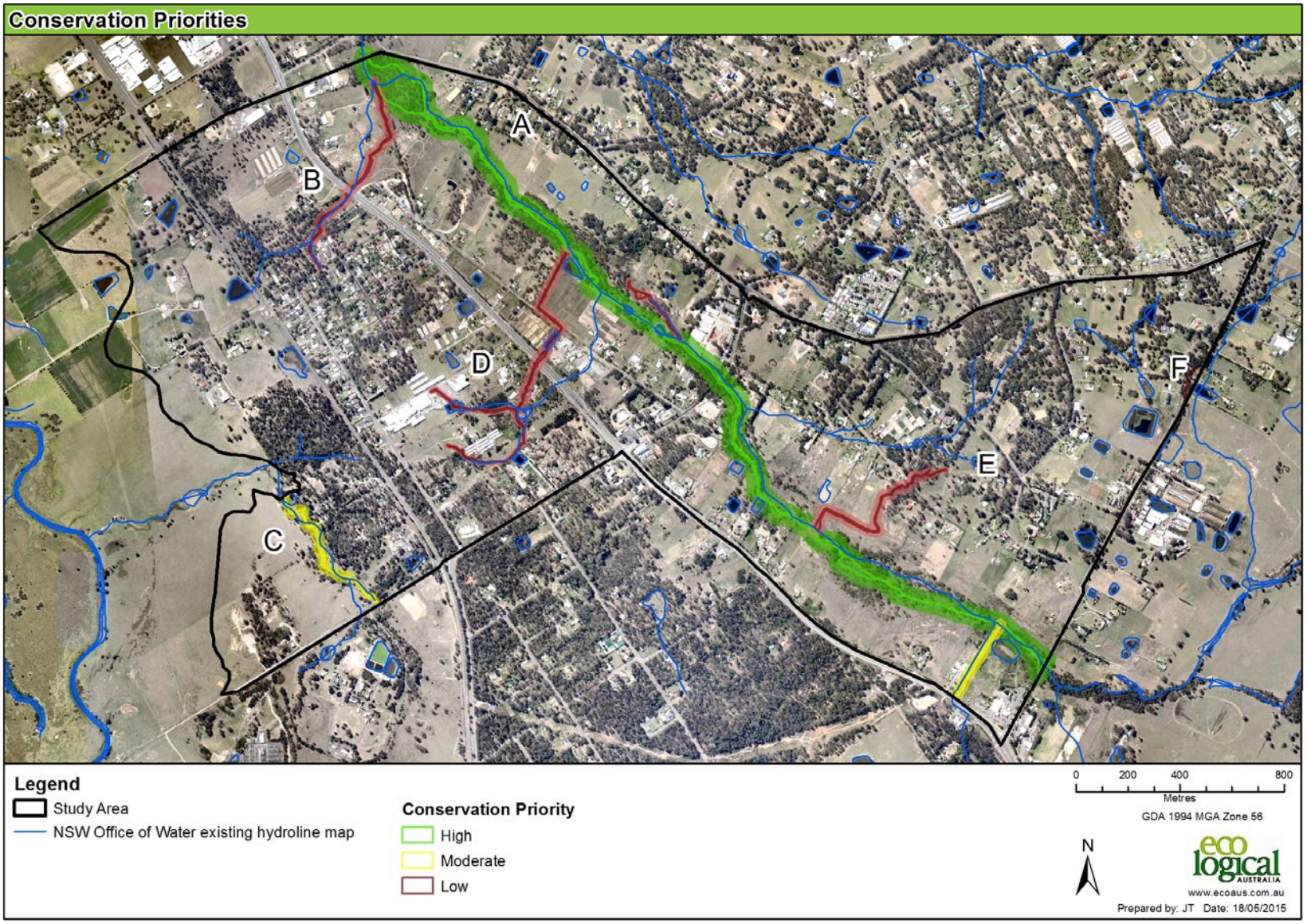

Figure 12: Watercourse conservation priority

7 Riparian Vegetation Management Study

This section of the report draws on the outcomes of the field assessment, identified conservation priorities, and recovery potential of the watercourses within the precinct. This section does not provide detailed procedures for the ongoing rehabilitation and management of watercourses and riparian vegetation, but instead provides broad guidance with regard to future urban development within the Precinct. The guidance that is provided has been prepared recognising that many of the watercourses within the study area are located immediately adjacent to, or within, existing residential properties where the opportunities to establish recognised riparian corridors are more limited. The priorities for riparian corridor conservation are identified in **Section 6.3** and depicted in **Table 9** and **Figure 12**.

With the likely NOW requirements for riparian corridor restoration, the aquatic and riparian habitat of the existing watercourses within the study area will improve over time as development works progress and more natural vegetation and flow regimes are re-established, particularly with the more disturbed watercourses of the Precinct. How this may be achieved is discussed below. Given the current state of some watercourses that have been highly modified and or channelised there may be opportunity for these reaches to be removed and replaced with suitable engineered water management solutions (**Figure 10**).

It is likely that future development will require stormwater detention areas and other WSUD features to maintain natural flow regimes and water quality outcomes within the study area. Such features will serve an important role in re-establishing or enhancing habitat within the study area, particularly for those watercourses that have been more heavily modified by channelling or realignment in areas adjacent to existing urban development. Opportunities for such works will need to be considered in terms of the availability of suitable land and modelled flow regimes as the future development footprint is refined within the ILP. Land ownership will be an important consideration in this regard, especially for those watercourses that are located immediately adjacent to existing residential development and where the opportunities to install WSUD features will be more limited.

Numerous dams exist within the study area, along reaches of all the Systems. The dams should be considered with regard to their impact on natural flow regimes as well as the provision of aquatic habitat, however, they are all the result of altered drainage and it is likely that natural drainage regimes will be maintained if the dams are removed. Future stormwater/hydrology modelling within the precinct should still consider the role of these dams within the intended urban landscape (as defined by the ILP) to ensure both that natural flow and habitat regimes are maintained at current levels as a minimum, or enhanced. Similarly, should the dams be removed, dewatering should take place in accordance with detailed dewatering plans to manage and minimise impacts on the existing aquatic flora and fauna. Should this occur, it is recommended that any dewatering of the dam be staged so that any aquatic fauna utilising it have the opportunity to seek other habitat. Examples of compensatory habitat could include appropriately designed wet basins containing similar habitat features to the dams which are removed.

The patches of potential GDEs within the study area are generally located along System A (**Figure 11**). In this regard the role and function of these important ecosystems is somewhat apparent within the study area. System A is noted to be of high conservation priority, therefore the proposed rezoning presents an opportunity to recognise and enhance these important environmental features as a component of the broader riparian network of the precinct. It is therefore recommended that where possible these areas of vegetation be retained and appropriately integrated with the ILP and future

urban development. If groundwater extraction is proposed as any part of future development proposals, impacts on these GDE's would need to be further assessed.

7.1.1 Riparian Ownership and Management Options

Land ownership within the study area is fragmented and in some cases proposed riparian corridors would impact on existing residential properties and other forms of urban land use. Where it can be achieved riparian corridors should be in public ownership, which would increase the likelihood of achieving consistent environmental outcomes, and provide integrated uses and access for the community. Hawkesbury City Council may accept the handover of riparian areas if certain management conditions are met and should be further explored during the development of the ILP.

Where possible, drainage and detention structures should be owned and managed by Hawkesbury City Council. These areas can then be revegetated and managed as a naturalised feature. It is assumed that in accordance with the WM Act a vegetation management plan will be required and prepared to the satisfaction of NOW and Hawkesbury City Council for future development applications which impact on these areas.

Where public ownership cannot be achieved, consideration of suitable zoning and planning controls should be made in order to facilitate appropriate riparian land management outcomes.

7.1.2 Water Management Act

It is possible for DPE to seek an exemption for the entire study area from the requirement under the WM Act to obtain Controlled Activity Approvals. This would streamline the development assessment process through the removal of the need for referral to NOW under the NSW EP&A Act provisions for Integrated Development. Such an outcome has been achieved for other large rezoning proposals within the Growth Centres and a similar approach could also be considered for the Vineyard Precinct with the development of a waterfront land strategy.

Further review of appropriate planning mechanisms (zoning and development controls) will need to be carried out by NOW, Hawkesbury City Council and DPE in order to determine a set of controls which will be appropriate for the Vineyard Precinct.

It is recommended that a Riparian Lands Map be included within the amended LEP and linked to the WM Act in a way that defines waterfront land within the precinct as being limited to the extent of the Riparian Lands identified. It is noted that confirmation of stream locations and ToB may be a condition for areas of identified Riparian Lands where access was not possible for this project.

7.2 Management of Riparian Protected Areas

The NOW has developed controlled activity guidelines that enable applicants to determine relevant approval requirements for controlled activities under the WM Act. The guidelines include a series of urban design principles and recommendations in relation to certain activities on waterfront land. The key elements of these guidelines in relation to the study area are presented below.

7.2.1 Urban Development Principles

The controlled activity guidelines do not encompass specific planning controls however they do contain objectives and a guide to works and activities generally allowable on waterfront land. The overarching objective of controlled activity provisions of the WM Act is to establish and preserve the integrity of riparian corridors. Ideally, the environmental functionality of riparian corridors should be restored and maintained by applying the following principles:

- Seek to maintain or recreate a riparian corridor / vegetated riparian zone with fully structured native vegetation in accordance with the riparian corridor requirements (refer to **Table 7**),
- Seek to minimise disturbance and harm to the recommended riparian corridor / vegetated riparian zone,
- Minimise the number of creek crossings and provide a perimeter road separating development from the riparian corridor / vegetated riparian zone,
- Locate infrastructure and services outside the riparian corridor / vegetated riparian zone,
- Where services or infrastructure are located within riparian corridors, co-locate facilities in one concentrated area to minimise overall disturbance and breaks in corridor continuity,
- Treat stormwater runoff before discharging it into the riparian corridor.

NOW does allow for a range of works and land uses within the outer (landward) edge of riparian corridors so long as they have minimal environmental harm. Activities which may be permissible are presented in **Table 10** below. The following principles are contained within the NOW guidelines and are to be considered in conjunction with the matrix presented in **Table 10**.

- Riparian Corridor offsetting for non-riparian corridor uses: Non-riparian uses, such as Asset Protection Zones are allowed in the outer 50% of the vegetated riparian zone, so long as offsets are provided in accordance with the averaging rule (see **Figure 13**),
- Cycleways and Paths: Cycleways or pedestrian paths no wider than 4m (total disturbance footprint) can be built in the outer 50% of the vegetated riparian zone,
- Detention Basins: detention basins can be built in the outer 50% of the vegetated riparian zones or online (where indicated in the NOW Controlled Activity Guidelines for a) Outlet structures and b) Instream work. Online basins must:
    - Be dry and vegetated,
    - Be for temporary flood detention only with no permanent water holding,
    - Have an equivalent vegetated riparian zone for the corresponding watercourse order, and
    - Not be used for water quality treatment purposes,
- Stormwater outlet structures and essential services: Stormwater outlets or essential services are allowed in the riparian corridor. Works for essential services on a 4th order or greater stream are to be undertaken by directional drilling or tied to existing crossings (refer to NOW Controlled Activity Guidelines for a) Laying pipes and cables in watercourses and b) Outlet Structures),
- Stream alignment: Indicates that a watercourse may be re-aligned (refer to NOW Controlled Activity Guidelines for Instream Works),
- Road Crossings: Indicates permitted road crossing methods (refer to NOW Controlled Activity Guidelines for Watercourse Crossings and DPI (Fisheries) Policy and Guidelines for Fish Friendly Waterway Crossings for Class 1 and 2 Waterways).

Works not associated with the establishment and maintenance of riparian corridors can be authorised within the outer riparian corridor provided that the average width of the vegetated riparian zone can be achieved over the length of the watercourse within the development site. That is, where appropriate, 50% of the outer vegetated riparian zone width may be used for non-riparian uses provided that an equivalent area is offset on site and is adequately connected to the riparian corridor vegetation. The inner 50% of the vegetated riparian zone is required to be fully protected and vegetated with native endemic riparian species, and satisfy the minimum area requirements to maintain bed and bank

stability. The averaging rule (**Figure 13**) should generally be applied to cleared waterfront land. Development proposals involving waterfront lands that contain existing native vegetation should seek to preserve the existing vegetation in accordance with the riparian corridor widths outlined in **Table 10**.

Table 10: NOW riparian corridor matrix

Requirements & allowable uses	Stream order			
	1st	2nd	3rd	4th +
Vegetated Riparian Zone (VRZ) Width	10 m each bank	20 m each bank	30 m each bank	40 m each bank
Riparian Corridor Offsetting for Non-Riparian Corridor uses	✓	✓	✓	✓
Cycleways and Pathways	✓	✓	✓	✓
Detention Basins - Only within outer 50% VRZ - Online	 ✓ ✓	 ✓ ✓	 ✓	 ✓
Stormwater Outlet Structures & Essential Services	✓	✓	✓	✓
Stream Re-alignment	✓			
Road Crossings - Any - Culvert - Bridge	 ✓	 ✓	 ✓ ✓	 ✓ ✓

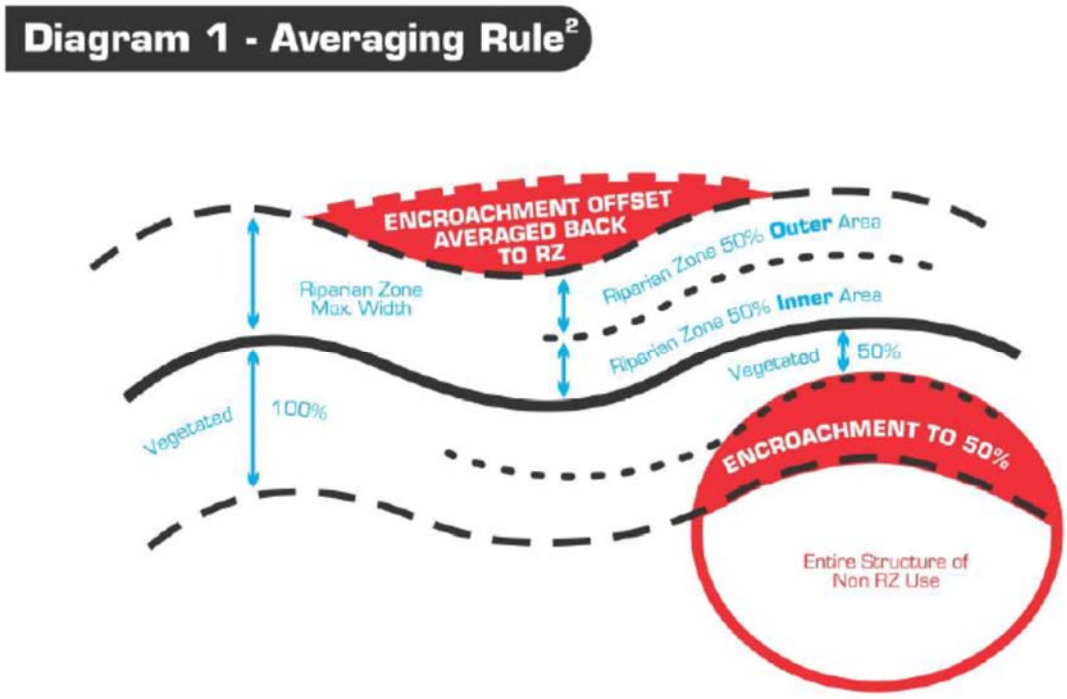

Figure 13: Averaging Rule (Source NOW Controlled Activity Riparian Corridor Guidelines)

8 Conservation and Management Recommendations for consideration in the development of the ILP

The outcomes of this assessment, including those features that are considered to have higher conservation significance and depicted in **Figure 7**, should be used to guide the master planning process and the refinement of the ILP.

While the Biodiversity Certification and Strategic Assessment approvals that have been conferred on the Growth Centres enable the removal of vegetation within certified lands, the precinct nonetheless contains relatively large areas of good quality vegetation (ENV) on certified lands. In this regard, in addition to non-certified areas, land uses surrounding detention basins, riparian corridors and parks will need to be carefully managed in order to appropriately manage the ecological integrity of the precinct. Opportunities to maximise ecological values across the site will also be available through the rehabilitation and revegetation of detention basins and the potential for retention of remnant vegetation in areas zoned for public or private open space, drainage and education infrastructure, and possibly environmental conservation and environmental living.

While fragmented landownership may constrain the development of suitable riparian corridors in some parts of the precinct, proposed detention basins should result in sections of land along the riparian corridors with detention basins being revegetated and rehabilitated and retained in public ownership. These areas could provide potential habitat for fauna and strengthen habitat connectivity. Use of local provenance species for revegetation and weed management will be important in these areas to ensure ecosystem functionality is maximised and downstream impacts are minimised. Vegetation management plans for these areas will be need to be prepared to the satisfaction of NOW/OEH.

It is recommended that water quality and flood detention devices etc, are located in existing areas of low ecological constraint on certified lands, to minimise the loss of existing habitat across the site. Similarly, areas of open space that will serve as passive recreation areas (and therefore have the potential to retain remnant vegetation) should also be located within certified lands to maximise potential habitat/ENV retention across the site.

Biodiversity Management Recommendations include:

- Maximise retention of ENV and AHCVV within non-certified lands to avoid further assessments under the TSC and or EPBC Acts,
- Maximise retention of ENV and AHCVV within certified lands and plan for the location of conservation reserves, public open space, visual buffers and other passive land uses in these areas,
- Adequate Riparian Protection Areas along each retained watercourse, with co-location of water quality and quantity treatment facilities,
- Retention of habitat trees and other native vegetation onsite through strategic location of sympathetic land use zones (such as open space, education, drainage etc). Similarly, incorporation of hollow bearing trees into streetscape areas is recommended to provide contiguous corridors that allow wildlife to migrate safely through built up areas.

Specific riparian and aquatic design considerations include;

- Adequate Riparian Protection Areas along Killarney Chain of Ponds Creek, with co-location of water treatment/detention facilities to maintain or increase the effective riparian corridor width,
- Embellishment of existing native riparian and aquatic vegetation and restoration of the aquatic habitat of the watercourses as part of a riparian corridor management plan,
- Integration of GDE's as part of the broader riparian corridor network within the precinct,
- Incorporation of open space within areas of higher aquatic habitat quality where possible, or creation of new wetland and aquatic habitat to replace areas lost for infrastructure,
- Use of local provenance wetland species for detention basin design with specific consideration of establishing suitable wetland/aquatic habitat,
- Appropriate use of large woody debris to re-introduce instream habitat,
- Control of peak flows to reduce erosion impacts and improve water quality through the implementation of WSUD,
- Design and placement of sewer infrastructure to reduce the potential impact of overflows within riparian environments.

While there are generally no significant aquatic habitat constraints that should impact upon the master plan design, given the potential for Green and Golden Bell Frog to occur within the study area opportunities to further enhance areas of suitable habitat during the development of the ILP in the form of appropriately designed WSUD features should be considered.

In accordance with Condition 12 of the Biodiversity Certification Order, ENV should not be removed, or considered for removal, on land where this condition applies without further consultation and concurrence of the OEH.

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Appendix A : Detailed Statutory Framework

Commonwealth

Environment Protection & Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (*EPBC Act*) establishes a process for assessing the environmental impact of activities and developments where 'matters of national environmental significance' (MNES) may be affected. The *EPBC Act* lists endangered ecological communities, threatened and migratory species that have the potential to occur, or are known to occur on a site.

The approval of both stages of the strategic assessment occurred on the 28th February, 2012. This approval essentially means that the Commonwealth is satisfied that the conservation and development outcomes that will be achieved through development of the Growth Centres Precincts will satisfy their requirements for environmental protection under the EPBC Act. So that, provided development activity proceeds in accordance with the Growth Centres requirements (such as the Biodiversity Certification Order, the Growth Centres SEPP and DCPs, Growth Centres Development Code etc) then there is ***no requirement*** to assess the impact of development activities on matters of National Environmental Significance (NES) and hence ***no requirement*** for referral of activities to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC). The requirement for assessment and approval of threatened species and endangered ecological communities under the EPBC Act has now been "turned off" by the approval of the Strategic Assessment.

State

Environmental Planning and Assessment Act 1979 (EP&A Act)

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for the state, providing a framework for the overall environmental planning and assessment of development proposals. Various legislative instruments, such as the NSW *Threatened Species Conservation Act 1995* (TSC Act), are integrated with EP&A Act and have been reviewed separately.

In determining a development application, the consent authority is required to take into consideration the matters listed under Section 79C of the EP&A Act that are relevant to the application. Key considerations include:

- Any environmental planning instrument, including drafts
- The likely impacts of the development
- The suitability of the site for the development
- Any submissions made in accordance with the EP&A Act or regulations
- The public interest

Threatened Species Conservation Act 1995 (TSC Act)

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The TSC Act is integrated with the EP&A Act and requires consideration of whether a development (Part 4 of the EP&A Act 1974) or an activity (Part 5 of the EP&A Act) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

The schedules of the Act list species, populations and communities as endangered or vulnerable. New species, populations and communities are continually being added to the schedules of the TSC Act. All developments, land use changes or activities need to be assessed to determine if they will have the potential to significantly impact on species, populations or communities listed under the Act.

Bio-certification was introduced under the TSC Act (s.126G) to confer certification on an environmental planning instrument if the Minister is satisfied that it will lead to the overall improvement or maintenance of biodiversity values – typically at a landscape scale. The effect of granting certification is that any development or activity requiring consent (Under Part 4 and 5 of the EP&A Act respectively) is automatically – development that is not likely to significantly affect threatened species. This certification removes the need to address threatened species considerations and the assessment of significance or seven part tests (s.5A of the EP&A Act), including the prepare species impact statements (SIS).

Where Parts 3A, 4 or 5 are not applicable, a licence under s.91 of the TSC Act from Office of Environment and Heritage must be obtained for actions (such as bush regeneration) that have the potential impact on threatened species.

The Growth Centres SEPP (see below) impacts the application of the TSC Act within Vineyard Precinct, which is discussed further below.

Threatened Species Conservation Amendment (Special Provisions) Act 2008

This Act passed by NSW Parliament on 24 June 2008 confirms bio-certification of the Growth Centres SEPP by amending the TSC Act. The Act also amends the Local Government Act 1993 with respect to rates payable on land subject to conservation agreements within the Growth Centres.

State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP)

The Growth Centres State Environmental Planning Policy (SEPP) (referred to as the 'Growth Centres SEPP') has been 'bio-certified' by order of the Minister for the Environment under s.126G of the *TSC Act*. The mechanism for achieving this is outlined in the *Growth Centres Conservation Plan* (Eco Logical Australia, 2007) and the conditions for bio-certification are documented in the Ministers order for consent[2]. Bio-certification negates the requirement for impact assessment under s.5A of the *Environmental Planning and Assessment Act, 1979* thus turning off the requirements for seven part tests or species impact statements.

The areas within Vineyard Precinct that are non-certified are shown in **Figure 1**of the report.

Each precinct needs to be assessed against the conditions of the Biodiversity Conservation Order to ensure that the planned rezoning and subsequent development of the precinct complies. This is undertaken through the completion of a Biodiversity Certification Consistency Report.

Fisheries Management Act 1994 (FM Act)

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

[2] http://www.environment.nsw.gov.au/resources/nature/biocertordwsgcentres.pdf

marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history. This includes insects, molluscs (eg. Oysters), crustaceans, echinoderms, and aquatic polychaetes (eg. Beachworms), but does not include whales, mammals, reptiles, birds, amphibians or species specifically excluded (eg. Some dragonflies are protected under the TSC Act instead of the FM Act). Under this act, if any activity occurs that will block fish passage, then a permit under this Act will be required.

Water Management Act 2000

The NSW *Water Management Act 2000* has replaced the provisions of the *Rivers and Foreshores Improvement Act 1948*. The *Water Management Act 2000* and *Water Act 1912* control the extraction of water, the use of water, the construction of works such as dams and weirs and the carrying out of activities in or near water sources in New South Wales. 'Water sources' are defined very broadly and include any river, lake, estuary, place where water occurs naturally on or below the surface of the ground and coastal waters.

If a 'controlled activity' is proposed on 'waterfront land', an approval is required under the Water Management Act (s91). 'Controlled activities' include:

- the construction of buildings or carrying out of works;
- the removal of material or vegetation from land by excavation or any other means;
- the deposition of material on land by landfill or otherwise; or
- any activity that affects the quantity or flow of water in a water source.

'Waterfront land' is defined as the bed of any river or lake, and any land lying between the river or lake and a line drawn parallel to and forty metres (40m) inland from either the highest bank or shore (in relation to non-tidal waters) or the mean high water mark (in relation to tidal waters). It is an offence to carry out a controlled activity on waterfront land except in accordance with an approval.

Noxious Weed Act 1993

The objectives of the NSW *Noxious Weeds Act 1993* are to identify which noxious weeds require control measures, identify control measures suitable to those species and to specify the responsibilities of both public and private landholders for noxious weed control.

State Environmental Planning Policy No.19 – Bushland in Urban Areas

This NSW State Environmental Planning Policy (SEPP) aims to protect and preserve bushland within selected local government areas. 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.

Growth Centres Development Code

The Growth Centres Development Code was produced by the former Growth Centres Commission (GCC) in 2006. The Development Code was produced to guide the planning and urban design in the northwest and southwest Growth Centres.

The Development Code includes objectives and provisions that support the retention of as much native vegetation, habitat and riparian areas within the precinct through incorporation into land use planning outcomes such as lower density development in these areas, subdivision patterns, road design, local parks, and other areas required to be set aside for community uses without adversely affecting the development yield of areas.

As a requirement under the Development Code, the Vineyard precinct will need to demonstrate how the biodiversity and other values of areas identified by the SEPP will be protected, maintained and enhanced. Key issues will include boundary management (eg. Buffers to surrounding development), bush fire and water sensitive urban design (WSUD) (GCC 2006).

Appendix B Methodology

Literature Review

A desktop literature review was undertaken by ELA to determine the location and extent of previous surveys, identify the representative spectrum of flora and fauna within the study area and identify the presence of any threatened species, populations and ecological communities listed under the TSC Act and the Commonwealth EPBC Act that could potentially occur within the study area. To this end, the following documentation and mapping was reviewed:

- Topographic maps
- Aerial photography of the study area including historic aerials from 1947, 1961 and 1981;
- A search of the NSW OEH Bionet Atlas
- EPBC online Protected Matters Database Search
- Preliminary results from Draft Part 3A project: Water related Services for the northwest and southwest Growth Centres Cumberland Ecology (2010)
- 'Growth Centres Conservation Plan' prepared by Eco Logical Australia (2007) for NSW Growth Centres Commission;
- Western Sydney Vegetation Mapping (NPWS 2002a); and
- Western Sydney Condition and Conservation Significance Mapping (NPWS 2002b).

Likelihood of Occurrence

Appendix D identifies the threatened species returned by the NSW OEH Bionet Atlas database and EPBC online Protected Matters database searches (based on a 10km radius from the study area) together with an assessment of the likelihood of occurrence for each species. Each species likely occurrence was determined by records in the area, habitat availability and knowledge of the species' ecology.

Five terms for the likelihood of occurrence of species are used in this report. The terms for likelihood of occurrence are defined below:

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

Terrestrial Biodiversity Assessment

METHODS

Field survey across the study area was conducted on the 10 February and 18 March 2014. The field survey was undertaken by Lucas McKinnon, Bruce Mullins, Rodney Armstead and Tim Withers of Eco Logical Australia. Approximately 50 person hours were utilised in completing the survey.

The purpose of the field survey was to:

- validate vegetation community types and their extent
- validate mapped ENV
- record or estimate recovery potential (according to Perkins 2000)
- confirm vegetation formation (according to Keith 2004)
- record the presence of hollow bearing trees
- record opportunistic fauna sightings and fauna habitat assessment.
- identify whether the vegetation conforms to an EPBC Act list threatened ecological community
- note dominant flora species, where possible.

Where possible, sites were traversed on foot. However, property access was very limited, requiring that most field survey be conducted remotely (ie, looking over the fence and using binoculars). This has affected the ability of the field survey to locate threatened species and hollow bearing trees, and determine accurately areas of EPBC Act list threatened ecological communities for all parts of the study.

Weather conditions during field surveys

DATE	MIN TEMP (°C)	MAX TEMP (°C)	RAINFALL (mm)
10 February 2014	18.8	30.3	0
18 March 2014	11.5	30.2	0

Weather observations were taken from www.bom.gov.au Richmond Station 067105)

Vegetation Community Validation

Validation of vegetation mapping was undertaken using NPWS (2002) vegetation mapping, aerial photography and field survey.

Due to limited access, vegetation community validation was based on the visible upper and mid strata, with some assumptions made for portions of the polygon that were not visible. Where there was sufficient evidence, some vegetation community types were changed from NPWS (2002), however, it was not possible to undertake quadrat surveys and data analysis for these community changes.

Limited access also affected the assessment of EPBC Act list threatened vegetation communities. Condition criteria for EBPC list Cumberland Plain Woodland is assigned based on patch size and perennial understorey cover. While patch size can easily be determined remotely, an assessment of

vegetation cover requires a meander across the site. The table below outlines the EPBC Act condition criteria. A remote assessment was undertaken for most polygons, with assessments of vegetation made from property boundaries, with some assumptions made regarding the uniformity of vegetation ground cover across the polygon. This assessment was based on land use, paddock size, visible portions of the polygon and NPWS (2002) conservation significance assessment (CSA) data.

Wherever possible, dominant flora were noted to help confirm vegetation type and conservation significance.

Condition Thresholds for Cumberland Plain Woodland ecological community (NSW).

CODE	CANOPY DENSITY	DESCRIPTION
A	>10%	Relatively intact native tree canopy
B	<10%	Larger areas of remnant vegetation with a low or discontinuous canopy. Often found on the disturbed edges of larger remnants.
C	<10%	Areas of native vegetation that do not have a Eucalypt canopy cover.
Tx	<10%	Areas of native trees with very discontinuous canopy cover.
Txr	<10%	Areas of Tx (as above) located in areas where there is a combination of urban and rural activities such as rural residential development.

Source: Table 4 in the Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain Western Sydney (NPWS 2002).

Condition Thresholds for Patches that meet the Description for the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community (Commonwealth).

CATEGORY AND RATIONALE	THRESHOLDS
A. Core thresholds that apply under most circumstances: patches with an understorey dominated by Natives and a minimum size that is functional and consistent with the minimum mapping unit size applied in NSW.	Minimum patch[3] size is ≥0.5ha; **AND** ≥50% of the perennial understorey vegetation cover[4] is made up of native species.
OR	
B. Larger patches which are inherently valuable due to their rarity.	The patch size is ≥5ha; **AND** ≥30% of the perennial understorey vegetation cover is made up of native species.
OR	
C. Patches with connectivity to other large native vegetation	The patch size is ≥0.5 ha; **AND**

CATEGORY AND RATIONALE	THRESHOLDS
remnants in the landscape.	≥30% of the perennial understorey vegetation cover is made up of native species; **AND** The patch is contiguous[5] with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥5ha in area.
OR	
D. Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.	The patch size is ≥0.5 ha in size; **AND** ≥30% of the perennial understorey vegetation cover is made up of native species; **AND** The patch has at least one tree with hollows per hectare or at least one large tree (≥80 cm dbh) per hectare from the upper tree layer species outlined in the Description and Appendix A.

[3] A *patch* is defined as a discrete and continuous area that comprises the ecological community, outlined in the Description. Patches should be assessed at a scale of 0.04 ha or equivalent (e.g. 20m x 20m plot). The number of plots (or quadrats or survey transects) per patch must take into consideration the size, shape and condition across the site. Permanent man-made structures, such as roads and buildings, are typically excluded from a patch but a patch may include small-scale disturbances, such as tracks or breaks or other small-scale variations in native vegetation that do not significantly alter the overall functionality of the ecological community, for instance the easy movement of wildlife or dispersal of spores, seeds and other plant propagules.

[4] Perennial understorey vegetation cover includes vascular plant species of the ground and shrub layers (as outlined in the Description and Appendix A) with a life-cycle of more than two growing seasons (Australian Biological Resources Study, 2007). Measurements of perennial understorey vegetation cover exclude annuals, cryptogams, leaf litter or exposed soil (although these are included in a patch of the ecological community when they do no alter functionality as per footnote 3 and the Description and Condition Thresholds are met).

[5] Contiguous means the woodland patch is continuous with, or in close proximity (within 100 m), of another patch of vegetation that is dominated by native species in each vegetation layer present.

Source: DEWHA (2009a) Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on an Amendment to the List of Threatened Ecological Communities under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Threatened Flora Surveys

Where access was granted, random meander surveys were conducted within the vegetation communities located within the site to identify the presence of threatened flora species. Target species for the random meander were:

- *Grevillea juniperina* subsp. juniperina

Threatened Fauna Surveys

Habitat assessment for threatened fauna surveys were undertaken within the study area where access was permitted. This included using a GPS to record the coordinates for hollow bearing trees, however, given limited access there may be more within the precinct.

Incidental sighting of all species were recorded.

Appendix C Flora and Fauna Lists

Family	SCIENTIFIC NAME	COMMON NAME	Status
Asclepiadaceae	*Araujia sericifera*	Moth Vine	Native
Asteraceae	*Bidens pilosa*	Cobblers Pegs	Exotic
	Cirsium vulgare *	Spear thistle	Exotic
	Onopordum acanthium	Scotch Thistle	Exotic
Casuarinaceae	*Allocasuarina littoralis*	Black Sheoak	Native
	Casuarina cunninghamiana		Native
	Casuarina glauca	Swamp she-oak	Native
Chenopodiaceae	*Einadia nutans*	Climbing saltbush	Native
Commelinaceae	*Tradescantia*		Exotic
Convolvulaceae	*Dichondra spp.*		Native
Crassulaceae	*Bryophyllum delagoense (Kalanchoe delagoensis)*	Mother of millions	Exotic
Fabaceae (Caesalpinioideae)	*Senna sp.*		Exotic
Fabaceae (Faboideae)	*Acacia deanei*	Green Wattle	Native
	Acacia parramattensis		Native
	Dillwynia spp.		Native
	Glycine tabacina	Glycine	Native
Fabaceae (Mimosoideae)	*Adiantum aethiopicum*		Exotic
Malvaceae	*Modiola spp.*		Exotic
	*Sida rhombifolia**	Paddy's Lucerne	Exotic
Myrtaceae	*Corymbia maculata*	Spotted Gum	Native
	Eucalyptus amplifolia	Cabbage gum	Native
	Eucalyptus crebra	Narrow-leaved iron bark	Native
	Eucalyptus curvula		Exotic
	Eucalyptus eugenioides	Thin-leaved stringybark	Native

	Eucalyptus fibrosa	Broad-leaved Red Ironbark	Native
	Eucalyptus moluccana	Grey box	Native
	Eucalyptus tereticornis	Forest Red Gum	Native
	Melaleuca decora		Native
	Melaleuca linariifolia	Snow-in-Summer	Native
Ochnaceae	*Ochna spp.*		Exotic
Oleaceae	*Olea europaea subsp. Cuspidata**	African olive/olive	Exotic
Orchidaceae	*Bryophyllum spp.*		Exotic
Pinaceae	*Pinus spp.*		Exotic
	Pinus spp.		Exotic
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	Native
Poaceae	*Aristida sp.*		Native
	Bromus cartharticus *	Whiskey Grass	Exotic
	Chloris gayana	Rhodes grass	Exotic
	Cymbopogon spp.		Native
	Cynodon dactylon	Couch grass	Exotic
	Eragrostis curvula	African lovegrass	Exotic
	Microlaena stipoides	Weeping Rye Grass	Native
	Paspalum dilatatum	Paspalum	Exotic
	*Pennisetum clandestinum**	Kikuyu grass	Exotic
	Setaria spp.		Exotic
	Sporobolus creber	Slender Rat's Tail Grass	Native
Polygonaceae	*Persicaria spp.*		Native
	Persicaria spp.		Native
	Rumex spp.		Native
Proteaceae	*Grevillea robusta*	Silky Oak	Exotic
Rosaceae	*Rubus fruticosus spp. Agg.* *	Blackberry	Exotic

Santalaceae	*Exocarpos spp.*		Native
Sapindaceae	*Cardiospermum sp.*	Balloon Vine	Exotic
Typhaceae	*Typha sp.*		Exotic
Verbenaceae	*Verbena bonariensis**	Purpletop	Exotic

CLASS	SCIENTIFIC NAME	COMMON NAME	Status
Birds	*Acridotheres tristis*	Common Myna	Exotic
	Anas gracilis	Grey Teal	Native
	Anas superciliosa	Pacific Black Duck	Native
	Ardea ibis	Cattle Egret	Native
	Ardea intermedia	Intermediate Egret	Native
	Ardea pacifica	White-necked Heron	Native
	Aythya australis	Hardhead	Native
	Chenonetta jubata	Australian Wood Duck	Native
	Coracina novaehollandiae	Black-faced Cuckoo-shrike	Native
	Corvus coronoides	Australian Raven	Native
	Corcorax melanorhamphos	White-winged Chough	Native
	Cracticus torquatus	Grey Butcherbird	Native
	Dacelo novaeguineae	Laughing Kookaburra	Native
	Dicaeum hirundinaceum	Mistletoebird	Native
	Fulica sp.	Coot	Native
	Gallus gallus domesticus	Chickens	Exotic
	Grallina cyanoleuca	Magpie-lark	Native
	Gymnorhina tibicen	Australian Magpie	Native
	Haliastur sphenurus	Whistling Kite	Native
	Manorina melanocephala	Noisy Miner	Native
	Manorina melanophrys	Bell Miner	Native
	Ocyphaps lophotes	Crested Pigeon	Native
	Philemon corniculatus	Noisy Friarbird	Native
	Porphyrio porphyrio	Purple Swamphen	Native
	Pycnonotus jocosus	Red-whiskered Bulbul	Exotic
	Rhipidura leucophrys	Willy Wagtail	Native
	Streptopelia chinensis	Spotted Turtledove	Exotic

	Vanellus miles	Masked Lapwing	Native
Fish	*Gambusia affinis*	Mosquitofish	Exotic
Mammals	*Bos primigenius*	Cows	Exotic
	Canis lupus familiaris	Dog	Exotic
	Capra aegagrus hircus	Goats	Exotic
	Equus ferus caballus	Horses	Exotic
	Lama glama	Llama	Exotic
	Lepus curpaeums	Rabbits	Exotic
	Ovis aries	Sheep	Exotic
Reptiles	*Eulamprus quoyii*	Eastern Water Skink	Native

Appendix D Likelihood of Occurrence Table

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Acacia bynoeana	Bynoe's Wattle	E	V	*Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains, and has recently been found in the Colymea and Parma Creek areas west of Nowra. It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels (DECC 2007).	No
Acacia gordonii	*Acacia gordonii*	E	E	*Acacia gordonii* is restricted to the northwest of Sydney, occurring in the lower Blue Mountains in the west, and in the Maroota/Glenorie area in the east, within the Hawkesbury, Blue Mountains and Baulkham Hills local government areas. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops (DECC 2007).	No
Acacia pubescens	Downy Wattle	V	V	*Acacia pubescens* occurs on the NSW Central Coast in Western Sydney, mainly in the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. It is associated with Cumberland Plains Woodlands, Shale / Gravel Forest and Shale / Sandstone Transition Forest growing on clay soils, often with ironstone gravel (NPWS 1997; Benson and McDougall 1996).	No
Allocasuarina glareicola	*Allocasuarina glareicola*	E	E	*Allocasuarina glareicola* is primarily restricted to the Richmond district on the northwest Cumberland Plain, with an outlier population found at Voyager Point. It grows in Castlereagh woodland on lateritic soil (DECC 2007).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Asterolasia elegans	*Asterolasia elegans*	E	E	*Asterolasia elegans* is restricted to a few localities on the NSW Central Coast north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs. It is found in sheltered forests on mid- to lower slopes and valleys, in or adjacent to gullies (DECC 2007).	No
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	*Cryptostylis hunteriana* is known from a range of vegetation communities including swamp-heath and woodland (DECC 2007). The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (DECC 2007). ell (2001) has identified Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland as potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (DECC 2007; Bell 2001).	No
Darwinia biflora	*Darwinia biflora*	V	V	*Darwinia biflora* is an erect or spreading shrub to 80cm high associated with habitats where weathered shale capped ridges intergrade with Hawkesbury Sandstone, where soils have a high clay content (NPWS 1997).	No
Dillwynia tenuifolia	*Dillwynia tenuifolia*	V	V	*Dillwynia tenuifolia* has a core distribution within the Cumberland Plain, where it may be locally abundant within scrubby, dry heath areas within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (DECC 2007). It may also be common in the ecotone between these areas and Castlereagh Scribbly Gum Woodland (DECC 2007).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Epacris purpurascens var. *purpurascens*	*Epacris purpurascens* var. *purpurascens*	V		*Epacris purpurascens* var. *purpurascens* has been recorded between Gosford in the north to Avon Dam in the south, in a range of habitats, but most have a strong shale soil influence (DECC 2007).	No
Eucalyptus sp. Cattai		E		*Eucalyptus* sp. Cattai occurs in the area between Colo Heights and Castle Hill, north-western Sydney. It occurs as a rare emergent in scrub, heath and low woodland on sandy soils, usually as isolated individuals or occasionally in small groups. The sites at which it occurs are generally flat and on ridge tops and associated soils are laterised clays overlying sandstone (DECC 2007).	No
Genoplesium baueri	Bauer's Midge Orchid or Yellow Gnat-orchid	E	E	Known from coastal areas from northern Sydney south to the Nowra district. Previous records from the Hunter Valley and Nelson Bay are now thought to be erroneous. Grows in shrubby woodland in open forest on shallow sandy soils.	No
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	V		*Grevillea juniperina* subsp. *juniperina* is endemic to Western Sydney, centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. It grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium, typically containing lateritic gravels (DECC 2007).	Unlikely
Haloragis exalata subsp. exalata	Square Raspwort	V	V	*Haloragis exalata* has been recorded in 4 widely scattered localities in eastern NSW; the Central Coast, South Coast and North-Western Slopes botanical subdivisions of NSW; where it appears to require protected and shaded damp situations in riparian habitats (DECC 2007).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Hibbertia superans	*Hibbertia superans*	E		*Hibbertia superans* mainly occurs in the northwest Sydney region between Baulkham Hills and Wisemans Ferry, with a disjunct occurrence near Mt Boss (inland from Kempsey) on the Mid North Coast of NSW. In the Sydney region it occurs in dry sclerophyll forest on sandstone ridgetops while the northern occurrence is on granite (DECC 2007).	No
Lasiopetalum joyceae	*Lasiopetalum joyceae*	V	V	*Lasiopetalum joyceae* grows in ridgetop woodland, heath, woodland or open scrub, often with a clay influence (NPWS 1997).	No
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E		*Leucopogon fletcheri* subsp. *fletcheri* is restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains. It occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs (DECC 2007).	No
Marsdenia viridiflora subsp*. viridiflora*	*Marsdenia viridiflora* subsp*. viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	E2		This Endangered Population of *Marsdenia viridiflora* subsp. *viridiflora* occurs in the Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys areas of western Sydney. It grows in vine thickets and open shale woodland (DECC 2007).	Unlikely
Melaleuca deanei	Deane's Paperbark	V	V	Found in heath on sandstone (DECC 2007), and also associated with woodland on *broad* ridge tops and slopes on sandy loam and lateritic soils (Benson and McDougall 1998).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Micromyrtus minutiflora	*Micromyrtus minutiflora*	E		*Micromyrtus minutiflora* is restricted to the area between Richmond and Penrith in western Sydney on the Central Coast. It grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, and open forest on tertiary alluvium and consolidated river sediments (DECC 2007).	Unlikely
Olearia cordata	*Olearia cordata*	V	V	The species' habitat is woodland on exposed Hawkesbury Sandstone ridges (DECC 2007). Soils are shallow or skeletal and are usually neutral to slightly acidic (DECC 2007). Shale-influence may be a habitat attribute (Benson & McDougall 1994). Associated soil landscapes are Gymea and Hawkesbury. The species tends to prefer the more sheltered easterly aspects (DECC 2007). Associated flora includes *Angophora costata*, *A. bakeri*, *Eucalyptus punctata* and *Corymbia eximia* with understorey species including *Allocasuarina torulosa*, *Acacia linifolia*, *Persoonia linearis* and *Leucopogon muticus* along with various grasses (Maryott-Brown & Wilks 1993). There have also been listings of *E. eugenioides* as an associate; and *E. oblonga*, *E. notabilis* and *Leptospermum trinervium* as dominant species near Wollombi. Recent observation have noted *C. gummifera* and in northern areas, *Angophora euryphylla* as common canopy species (DECC 2007).	No
Pelargonium sp. Straitellum (G.W. Carr 10345)		E		In NSW, *Pelargonium* sp. Straitellum (G.W. Carr 10345) is known from the Southern Tablelands (PlantNet 2011). Otherwise, only known from the shores of Lake Omeo near Benambra in Victoria where it grows in cracking clay soil that is probably occasionally flooded (Walsh & Entwisle 1999).	No
Persoonia hirsuta	Hairy Geebung	E	E	*Persoonia hirsuta* occurs from Singleton in the north, south to Bargo and the Blue Mountains to the west (DECC 2007). It grows in dry sclerophyll eucalypt woodland and forest on sandstone (PlantNet 2011).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Persoonia nutans	Nodding Geebung	E	E	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland and sandy soils associated with tertiary alluvium, occasionally poorly drained (Benson and McDougall 2000). Endemic to the Western Sydney (Benson and McDougall 2000).	Unlikely
Pimelea curviflora var. *curviflora*	*Pimelea curviflora* var. *curviflora*	V	V	*Pimelea curviflora* var. *curviflora* is confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the northwest. It grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands (DECC 2007). Associated with the Duffys Forest Community, shale lenses on ridges in Hawkesbury sandstone geology (Pittwater Council 2000).	No
Pimelea spicata	Spiked Rice-flower	E	E	In western Sydney, *Pimelea spicata* occurs on an undulating topography of well structured clay soils, derived from Wianamatta shale (DEC 2004). It is associated with Cumberland Plains Woodland (CPW), in open woodland and grassland often in moist depressions or near creek lines (*Ibid.*). Has been located in disturbed areas that would have previously supported CPW (*Ibid.*).	Unlikely
Pterostylis gibbosa	Illawarra Greenhood	E	E	Known from a small number of populations in the upper Hunter Valley (Milbrodale), the Illawarra region (Albion Park and Yallah) and near Nowra (DECC 2007). Plants grow in a variety of woodland and open forest communities with shallow rocky soils.	No
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Terrestrial orchid predominantly found in Hawkesbury Sandstone Gully Forest growing in small pockets of soil that have formed in depressions in sandstone rock shelves (NPWS 1997). Known from Georges River National Park, Ingleburn, Holsworthy, Peter Meadows Creek, St Marys Tower (NSW Scientific Committee 1999).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Pultenaea parviflora	*Pultenaea parviflora*	E	V	May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays (DECC 2007). May also be common in ecotone between these communities and Castlereagh Scribbly Gum Woodland (*ibid.*). *Eucalyptus fibrosa* is usually the dominant canopy species (*ibid.*). *E. globoidea, E. longifolia, E. parramattensis, E. sclerophylla and E. sideroxylon* may also be present or co-dominant, with *Melaleuca decora* frequently forming a secondary canopy layer (*ibid.*). Associated species may include *Allocasuarina littoralis, Angophora bakeri, Aristida spp. Banksia spinulosa, Cryptandra spp., Daviesia ulicifolia, Entolasia stricta, Hakea sericea, Lissanthe strigosa, M. nodosa, Ozothamnus diosmifolius* and *Themeda australis* (*ibid.*). Often found in association with other threatened species such as *Dillwynia tenuifolia, Dodonaea falcata, Grevillea juniperina, Micromyrtus minutiflora, Persoonia nutans* and *Styphelia laeta* (*ibid.*). Flowering may occur between August and November (*ibid.*).	Unlikely
Syzygium paniculatum	Magenta Lilly Pilly	V	V	This species occupies a narrow coastal area between Bulahdelah and Conjola State Forests in NSW. On the Central Coast, it occurs on Quaternary gravels, sands, silts and clays, in riparian gallery rainforests and remnant littoral rainforest communities (Payne 1997). In the Ourimbah Creek valley, *S. paniculatum* occurs within gallery rainforest with *Alphitonia excelsa, Acmena smithii, Cryptocarya glaucescens, Toona ciliata, Syzygium oleosum* with emergent *Eucalyptus saligna*. At Wyrrabalong NP, *S. paniculatum* occurs in littoral rainforest as a co-dominant *with Ficus fraseri, Syzygium oleosum, Acmena smithii, Cassine australe*, and *Endiandra sieberi*. Payne (1991) reports that the species appears absent from Terrigal formation shales, on which the gully rainforests occur. *S. paniculatum* is summer flowering (November-February), with the fruits maturing in May (DECC 2007).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Tetratheca glandulosa	*Tetratheca glandulosa*	V	V	Associated with ridgetop woodland habits on yellow earths (Travers Morgan 1991) also in sandy or rocky heath and scrub (NPWS 1997). Often associated with sandstone / shale interface where soils have a stronger clay influence (NPWS 1997). Flowers July to November.	No
Zieria involucrata	*Zieria involucrata*	E	V	*Zieria involucrata* has a disjunct distribution north and west of Sydney, in the Baulkham Hills, Hawkesbury, Hornsby and Blue Mountains local government areas (DECC 2007). Associated with Sydney Sandstone Gully Forest on sheltered slopes and among gullies (NPWS 1997).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
FISH					
Macquarie australasica	Macquarie Perch	-	E1	Habitat for the Macquarie perch is on the bottom or mid-water in slow-flowing rivers with deep holes, typically in the upper reaches of forested catchments with intact riparian vegetation. Macquarie perch also do well in some upper catchment lakes. In some parts of its range, the species is reduced to taking refuge in small pools which persist in midland–upland areas through the drier summer periods	No
Prototroctes maraena	Australian Grayling	-	V	The historic distribution of the Australian Grayling included coastal streams from the Grose River southwards through NSW, Vic. and Tas. On mainland Australia, this species has been recorded from rivers flowing east and south of the main dividing ranges. This species spends only part of its lifecycle in freshwater, mainly inhabiting clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops but has also been found in muddy-bottomed, heavily silted habitat. Grayling migrate between freshwater streams and the ocean and as such it is generally accepted to be a diadromous (migratory between fresh and salt waters) species.	No
FROGS					
Heleioporus australiacus	Giant Burrowing Frog	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest (Ehmann 1997). Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy so that burrows can be constructed (Environment Australia 2000).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Litoria aurea	Green and Golden Bell Frog	E1	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke and White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2007). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DEC 2005). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–Eleocharis sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997). Ponds that are typically inhabited tend to be free from predatory fish such as *Gambusia holbrooki* (Mosquito Fish). Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. Inhabits marshes, dams and stream-sides, particularly those containing *Typha* spp. (Bullrushes) or *Eleocharis* spp. (Spikerushes).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Litoria littlejohni	Little John Tree Frog	V	V	It appears to be restricted to sandstone woodland and heath communities at mid to high altitude (NSW Scientific Committee 2000). It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer (NSW Scientific Committee 2000). Littlejohn's Tree Frog has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria (DECC 2007). It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It hunts either in shrubs or on the ground. Breeding is triggered by heavy rain and can occur from late winter to autumn, but is most likely to occur in spring when conditions are favourable. Males call from low vegetation close to slow flowing pools. Eggs and tadpoles are mostly found in slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools (DECC 2007).	No
Mixophyes balbus	Stuttering Frog	E1	V	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DECC 2007) that are generally characterised by deep leaf litter or thick cover from understorey vegetation (Ehmann 1997). Breeding habitats are streams and occasionally springs. Usually found fairly close to permanent running water (Robinson 1998). Not known from streams disturbed by humans (Ehmann 1997) or still water environments (NSW Scientific Committee 2002).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Pseudophryne australis	Red-crowned Toadlet	V	—	Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched outcroppings on Triassic sandstones of the Sydney Basin (DECC 2007). Within these geological formations, this species mainly occupies the upper parts of ridges, usually being restricted to within about 100 metres of the ridgetop. However they may also occur on plateaus or more level rock platforms along the ridgetop (DECC 2007). Associated with open forest to coastal heath (Ehmann 1997). Utilises small ephemeral drainage lines which feed water from the top of the ridge to the perennial creeks below for breeding, and are not usually found in the vicinity of permanent water (Ehmann 1997). Breeding sites are often characterised by clay-derived soils and generally found below the first sandstone escarpment in the talus slope (DECC 2007).	No
REPTILES					
Hoplocephalus bungaroides	Broad-headed Snake	E1	V	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin (DECC 2007). They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (Webb & Shine 1998b). Some of the canopy tree species found to regularly co-occur at known sites include *Corymbia eximia*, *C. gummifera*, *Eucalyptus sieberi*, *E. punctata* and *E.piperita* (DECC 2007).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
DIURNAL BIRDS					
Anthochaera phrygia	Regent Honeyeater	CE	E1, Mi	Regent Honeyeaters mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available, e.g. along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing Casuarina cunninghamiana (River Oak), and with Amyema cambagei (Needle-leaf Mistletoe), are also important for feeding and breeding. At times of food shortage, Honeyeaters also use other woodland types and wet lowland coastal forest dominated by Eucalyptus robusta (Swamp Mahogany) or E. maculata (Spotted Gum)(Webster & Menkhorst 1992). Regent Honeyeaters sometimes occur in coastal forest, especially in stands dominated by Swamp Mahogany and Spotted Gum, but also in those with Southern Mahogany E. botryoides, and in those on sandstone ranges with banksias Banksia in the understorey (Franklin et al. 1989; Menkhorst 1997c). They have been recorded in open forest including forest edges, wooded farmland and urban areas with mature eucalypts. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000). In NSW, most records are scattered on and around the Great Dividing Range, mainly on the northwest Plains, northwest Slopes and adjacent Northern Tablelands, to west of Armidale; the Central Tablelands and Southern Tablelands regions; and the Central Coast and Hunter Valley regions. The species is concentrated around two main locations, the Capertee Valley and the Bundarra-Barraba area, but Honeyeaters are also recorded along the coast in the Northern Rivers and Mid-North Coast Regions, and in the Illawarra and South Coast Regions, from Nowra south to Moruya, where small numbers are recorded in most years (Webster & Menkhorst 1992).	. Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Botaurus poiciloptilus	Australasian Bittern	E1	E1	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1990). Found along the east coast and in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers (Marchant & Higgins 1990). Reedbeds, swamps, streams, estuaries (Simpson & Day 2004). Favours permanent shallow waters, edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate. Also occurs in Lignum *Muehlenbeckia florulenta* and Canegrass *Eragrostis australasica* on inland wetlands (NSW Scientific Committee, 2010). In WA it probably occurs only on the western coastal plain between Lancelin and Busselton, in the southern coastal region from Augusta to east of Albany and inland to some wetlands in the jarrah forest belt, with small, isolated populations in swamps from west of Esperance eastwards to near Cape Arid (Marchant & Higgins 1990). The largest concentration in WA is said to occur in the Lake Muir wetlands complex (Jaensch et al. 1988).	Potential
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	—	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Chthonicola sagittata	Speckled Warbler	V	-	The Speckled Warbler is a small well-camouflaged very heavily streaked ground-dwelling bird related to the scrubwrens, reaching a length of 13cm. The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies (DECC 2007)	Unlikely
Circus assimilis	Spotted Harrier	V	-	The Spotted Harrier is found in mainland Australia and Indonesia. It is widespread but sparsely distributed. The Spotted Harrier is found in open wooded country in tropical and temperate Australia, particularly in arid and semi-arid areas (BIB, 2006).	No
Climacteris picumnus Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	—	Distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys. The Brown Treecreeper occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories. (NSW Scientific Committee 2001).	No
Daphoenositta chrysoptera	Varied Sittella	V	-	Varied Sitellas are endemic and widespread in mainland Australia. Varied Sitellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches (BirdsLife Australia 2014).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Dasyornis brachypterus	Eastern Bristlebird	E1	E1	Habitat is characterised by dense, low vegetation and includes sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a heathy understorey. In northern NSW occurs in open forest with tussocky grass understorey. All of these vegetation types are fire prone, aside from the rainforest habitatas utilised by the northern population as fire refuge. Age of habitat since fires (fire-age) is of paramount importance to this species; Illawarra and southern populations reach maximum densities in habitat that has not been burnt for at least 15 years; however, in the northern NSW population a lack of fire in grassy forest may be detrimental as grassy tussock nesting habitat becomes unsuitable after long periods without fire; northern NSW birds are usually found in habitats burnt five to 10 years previously.	No
Ephippiorhynchus asiaticus	Black-necked Stork	E1	—	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).	No
Epthianura albifrons	White-fronted Chat	V	-	Endemic to Australia, in particular southern regions of Australia (OEH 2012). In NSW it occupies temperate to arid habiats from foothills to 1000 m altitude (OEH 2012). In NSW the White-fronted Chat occurs in open habitats near the coast in close proximity to waterways including estuaries, saltmarsh or marshy wetlands (NSW Scientific Committee 2009).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Falco subinger	Black Falcon	V		The Black Falcon has broad range across inland regions New South Wales, where it has a sparse distributed. However, there are reports of 'Black Falcons' occurring on the tablelands and along the NSW coast. These reports are likely to represent Brown Falcons. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling over hundreds of kilometres (Marchant & Higgins 1993).	No
Glossopsitta pusilla	Little Lorikeet	V	-	In NSW, Little Lorikeets are distributed in forests and woodlands from the coast across the Divide, reaching west as far as Albury, Parkes, Dubbo and Narrabri. Occur in dry, open eucalypt forests and woodlands. Recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. Primarily feed on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* (White Box) and *E. melliodora* (Yellow Box) are particularly important food sources for pollen and nectar respectively (DECC 2007).	Potential
Grantiella picta	Painted Honeyeater	V	—	A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe (DECC 2007). It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring *Amyema* sp mistletoe (DECC 2007).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Hieraaetus morphnoides	Little Eagle	V	-	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland and forested The population of Little Eagle in NSW is considered to be a single population (DECCW 2010). This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality (NSWSC 2010).lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (BirdsLife Australia 2014).	Potential
Irediparra gallinacea	Comb-crested Jacana	V	—	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	No
Ixobrychus flavicollis	Black Bittern	V	—	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007)	No
Lathamus discolor	Swift Parrot	E	E1, Ma	Breeds in Tasmania between September and January. Feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Favoured feed trees include winter flowering species such as Swamp Mahogany (Eucalyptus robusta), Spotted Gum (Corymbia maculata), Red Bloodwood (C. gummifera), Mugga Ironbark (E. sideroxylon), White Box (E. albens) and Forest Red Gum (E. tereticornis) (DECC 2007). Box-ironbark habitat in drainage lines, and coastal forest in NSW is thought to provide critical food resources during periods of drought or low food abundance elsewhere (MacNally et al. 2000).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Lophoictinia isura	Square-tailed Kite	V	—	In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, DECC 2007). May be recorded inland along timbered watercourses (DECC 2007). In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt (Eucalyptus logifloria), Spotted Gum (E. maculata), or Peppermint Gum (E. elata, E. smithii) (DECC 2007).	Potential
Melanodryas cucullata *Melanodryas cucullata cucullata*	Hooded Robin Hooded Robin (south-eastern subspecies)	V	-	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests (Blakers et al. 1984). In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover (NSW Scientific Committee 2001). Hooded Robin home ranges are relatively large, averaging 18ha for birds from the New England Tableland (NSW Scientific Committee 2001).	Unlikely
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Predominantly associated with box-ironbark association woodlands and River Red Gum (NSW Scientific Committee, 2001). Also associated with drier coastal woodlands of the Cumberland Plain and the Hunter, Richmond and Clarence Valleys (NSW Scientific Committee, 2001).	Unlikely
Neophema pulchella	Turquoise Parrot	V	—	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (DECC 2007). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Oxyura australis	Blue-billed Duck	V	-	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DECC 2007). The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECC 2007).	Unlikely
Petroica boodang	Scarlet Robin	V	-	In NSW, occurs from the coast to the inland slopes, with some dispersing to open habitat of lower valleys and plains after breeding in July-January . In habits dry open eucalypt forest and woodland with a sparse shrub layer. Occasionally occurs in mallee, wet forest, wetlands or tea-tree swamps (DECC 2007).	Unlikely
Petroica phoenicea	Flame Robin	V	-	Endemic to SE Australia, and ranges from southeast Qld to southeast SA, including Tasmania. In NSW, birds breed from spring to late summer in upland tall moist eucalypt forests and woodlands, often on ridges and slopes, preferring clearings or areas with an open understorey dominated by native grass. Birds migrate to drier, more open forests, woodlands or grasslands in winter (DECC 2007).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Polytelis swainsonii	Superb Parrot	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. Mainly inhabits forests and woodlands dominated by eucalypts, especially River Red Gums (Eucalyptus camaldulensis) and box eucalypts such as Yellow Box (Eucalyptus melliodora) or Grey Box (E. microcarpa). The species also seasonally occurs in box-pine (Callitris) and Boree (Acacia pendula) woodlands (Webster 1988). They forage at or near the ground. Nest in hollows.	No
Rostratula australis (a.k.a. *R. benghalensis*)	Painted Snipe (Australian subspecies)	E	V	Utilises wet areas with grasses, lignum, low scrub or open timber, including shallow terrestrial wetlands, lakes, swamps, claypans, waterlogged grassland or saltmarsh, dams, rice crops, sewage farms etc. (DECC 2007). Builds sparse ground nest, in shallow wetlands with areas of bare wet mud with shrubs and trees nearby, Breeding can occur year-round, and is often in response to local conditions; most often between August and February (DECC 2007). Roosts during the day in dense vegetation (DECC 2007). Forages nocturnally on mud-flats and in shallow water on vegetation, seeds, insects, worms, molluscs, crustaceans and other invertebrates (DECC 2007, Marchant & Higgins 1993).	Unlikely
Stictonetta naevosa	Freckled Duck	V	—	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DECC 2007).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
NOCTURNAL BIRDS					
Ninox connivens	Barking Owl	V	—	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by Melaleuca species in the tropics (DECC 2007). It usually roosts in dense foliage in large trees such as River She-oak (Allocasuarina cunninghamiana), other Casuarina and Allocasuarina, eucalypts, Angophora, Acacia and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Unlikely
Ninox strenua	Powerful Owl	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Potential
Tyto novaehollandiae	Masked Owl	V	—	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DECC 2007) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Tyto tenebricosa	Sooty Owl	V	—	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994).	No
MAMMALS (EXCLUDING BATS)					
Dasyurus maculatus maculatus	Spotted-tailed Quoll (SE Mainland Population)	—	E1	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007), more frequently recorded near the ecotones of closed and open forest and in NSW within 200km of the coast. Preferred habitat is mature wet forest, especially in areas with rainfall 600 mm/year (Edgar & Belcher 2008; Mansergh 1984). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable (Catling et al. 1998). This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	No
Petrogale penicillata	Brush-tailed Rock-wallaby	E1	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	No
Phascolarctos cinereus	Koala	V-E2	-	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. *Eucalyptus tereticornis* is one of the Koala's preferred browsing species.	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Petaurus australis	Yellow-bellied Glider	V	—	This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter (Environment Australia 2000, Braithwaite 1985, DECC 2007). Large hollows within mature trees are required for shelter, nesting and breeding (DECC 2007).	No
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE Mainland Population)	—	V	Associated with dry coastal heath and dry and wet sclerophyll forests with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2010).	No
Pseudomys novaehollandiae	New Holland Mouse		V	This species has been recorded from Queensland to Tasmania, though with a sporadic and patchy distribution. Most records are coastal. However, populations have been recently recorded up to 400km inland. The species includes heathlands, woodands, open forest and paperbark swamps and on sandy, loamy or rocky soils (Kemper and Wilson 2008). In coastal populations the species seems to have a preference for sandy substrates, a heathy understorey of legumes less than one metre high and sparse ground litter. This species is generally recorded in regenerating burnt areas occurs that are one or two years post fire and rehabilitated sand-mined areas that are four to five years post-mining (Kemper and Wilson 2008).	No
MAMMALS (BATS)					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 2008, DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 2008, DECC 2007).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Prefers moist habitats with trees taller than 20m. Roosts in tree hollows but has also been found roosting in buildings or under loose bark (Churchill 2008, DECC 2007).	Unlikely
Miniopterus australis	Little Bent-wing Bat	V	—	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 2008). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (DECC 2007). Breeding occurs in caves, usually in association with M. schreibersii (Churchill 2008, DECC 2007).	Potential
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 2008). It forages above and below the tree canopy on small insects (Churchill 2008, DECC 2007). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Churchill 2008, DECC 2007).	Potential
Mormopterus norfolkensis	Eastern Freetail Bat	V	-	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (DECC 2007). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (DECC 2007).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Myotis macropus	Southern Myotis, Large-footed Myotis	V	-	Rarely recorded more than 100 km inland, this species forages over streams and pools and utilises a range of habitats from small creeks to large lakes and mangrove lined estuaries. Generally roosts close to waterbodies in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (DECC 2007).	Potential
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Potential
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies. Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	Potential
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 2008). Within denser vegetation types use is made of natural and man-made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 2008).	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
INVERTEBRATES					
Meridolum corneovirens	Cumberland (Large) Land Snail	E	-	Associated with open eucalypt forests, particularly Cumberland Plain Woodland described in Benson (2000). Found under fallen logs, debris and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass (NPWS 1997). Urban waste may also form suitable habitat (NPWS 1997).	Potential
MIGRATORY TERRESTRIAL SPECIES LISTED UNDER EPBC ACT					
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1990, Simpson & Day 2004). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1990).	Unlikely
Hirundapus caudacutus	White-throated Needletail	-	M	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1990, Simpson & Day 2004). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1990).	Unlikely
Merops ornatus	Rainbow Bee-eater	-	M	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Knight 2012). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (ibid). Nest is a chamber a the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (ibid).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Monarcha melanopsis	Black-faced Monarch	-	M	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984). May also be found in coastal scrub or damp gullies, and during migration, more open woodland habitats. Breeding migrant that arrives in coastal south-eastern Australia in September and returns north in March (BirdsLife Australia 2014).	No
Monarcha trivirgatus	Spectacled Monarch				No
Myiagra cyanoleuca	Satin Flycatcher	-	M	Associated with eucalypt forests, often near wetlands or watercourses but absent from rainforests (DotE 2014), Blakers et al. 1984); occurs in open forests, often at height (Simpson & Day 2004). Breed above 600m asl during Nov-Jan, and migrate north for winter (DotE 2014).	Unlikely
Rhipidura rufifrons	Rufous Fantail	-	M	The Rufous Fantail is a summer breeding migrant to southeastern Australia (Morcombe 2004). The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe 2004). Open country may be used by the Rufous Fantail during migration (Morcombe 2004).	No
Anthochaera Phrygia Formally (*Xanthomyza Phrygia)*	Regent Honeyeater	E	E	The Reagent Honeyeater has a number of fragmented breeding populations in NSW.	Unlikely
MIGRATORY WETLAND SPECIES LISTED UNDER EPBC ACT					
Ardea alba	Great Egret	-	M	The Great Egret is common and widespread in Australia (McKilligan 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan 2005).	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Ardea ibis	Cattle Egret	-	M	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan 2005).	Likely
Gallinago hardwickii	Latham's Snipe	-	M	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Higgins et al 2001). Occupies a variety of vegetation around wetlands (Higgins et al 2001) including wetland grasses and open wooded swamps (Simpson and Day 2004).	Unlikely
*Rostratula benghalensis (*a.k.a. *R. australis)*	Painted Snipe	-	M	See: Rostratula australis	Unlikely

Appendix E : Watercourse images recorded in the field

Watercourse		
System A		

System B		
System C		

System D		
System E		

System F		

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