Annangrove Road Light Industrial Area

Flora and Fauna Constraints Assessment

ATTACHMENT D

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ANNANGROVE ROAD LIGHT INDUSTRIAL AREA

Flora and Fauna Constraints Assessment

Prepared for
The Hills Shire Council

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Abbreviations

ABBREVIATION	DESCRIPTION
CPW	Cumberland Plain Woodland
EEC	Endangered Ecological Community
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
RFEF	River Flat Eucalypt Forest
ROTAP	Rare or Threatened Australian Plants
SEPP (SRGC) 2006	State Environmental Planning Policy (Sydney Region Growth Centres) 2006
SSGF	Sydney Sandstone Gully Forest
SSTF	Shale Sandstone Transition Forest
SSRW	Sydney Sandstone Ridgetop Woodland
TSC Act	*Threatened Species Conservation Act 1997*
WSGF	Western Sandstone Gully Forest

Executive Summary

Introduction

This Flora and Fauna Constraints Assessment for the Edwards Road Precinct has been prepared by Eco Logical Australia Pty Ltd (ELA) on behalf of The Hills Shire Council. The Hills Shire Council is seeking to develop a master plan that establishes a clear vision and concept for the Annangrove Road Light Industrial Area which includes the Edwards Road Precinct. This report documents the ecological values within the precinct, and ranks areas according to conservation value over the precinct.

The flora and fauna constraints assessment included a review of database records and relevant literature pertaining to the ecology of the study area and surrounding area, including previous flora and fauna assessments conducted by Hayes Environmental (2007) and Travers Environmental (2008). Existing vegetation mapping and other available GIS data were also reviewed. An assessment of the likely occurrence was made for threatened and migratory species identified from the database searches or considered to have the potential to occur within the locality.

Field surveys were undertaken by ELA ecologists on 10 and 13 April 2012. Surveys included vegetation community and condition mapping, and targeted searches for threatened flora considered likely to occur or with potential habitat in the study area. Targeted surveys for threatened fauna were not conducted, and habitat assessment was used to determine which threatened fauna species were likely to occur or that had potential to occur.

The flora and fauna constraints assessment of the study area was undertaken by GIS analysis, which assigned a high, moderate, low or very low ecological constraint to each mapped polygon within the study area. The analysis was based on the following input layers; the presence of endangered ecological communities (EECs) as listed under Commonwealth legislation; the presence of EECs as listed under State legislation; vegetation community condition as determined by the presence of weeds; vegetation community condition as determined by stratum characteristics; core vegetation and habitat connectivity; and habitat potentially supporting threatened or migratory species or Rare or Threatened Australian Plants (ROTAP). Ranked scores were assigned to polygons within each input layer. The analysis then overlaid the scores and polygon boundaries of each individual input layer to create a new single ecological constraints dataset.

Results

Three vegetation communities were mapped within the study area: Shale Sandstone Transition Forest (SSTF), River-Flat Eucalypt Forest (RFEF), and Cumberland Plain Woodland (CPW). CPW is listed as a critically endangered EEC under both the NSW *Threatened Species Conservation Act 1997* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), while SSTF is listed as an endangered EEC under both the TSC and EPBC Acts. RFEF is listed as an endangered EEC under the TSC Act. While CPW was mapped in the study area, it did not meet the listing criteria for CPW under the EPBC Act.

The condition of vegetation communities varied within the study area, both in terms of weed density and structure. Of the communities, CPW and RFEF were perhaps the most degraded; however, SSTF was

also degraded in parts, with the highest weed densities and modifications to the mid-storey occurring in the northern and eastern-most parts of the community.

No threatened flora species were recorded during the field survey, although Hayes Environmental (2007) recorded *Eucalyptus nicholii*, which was likely to have been planted. From the list of species previously recorded, 14 threatened flora species were considered as having the potential to occur within the study area. A total of 204 flora species were identified, which consisted of 143 native and 61 exotic species. . Additional exotic weeds and landscape plantings in the study area were observed but not recorded.

No threatened fauna species were recorded during the field survey, although *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Myotis macropus* (Large-footed Myotis), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) and *Pteropus poliocephalus* (Grey-headed Flying-fox) have previously been recorded (Hayes Environmental 2007, Travers Environmental 2008). From the list of species previously recorded, 23 threatened and 6 migratory fauna species were considered as having the potential to occur within the study area. A total of 44 fauna species were recorded via direct observation, animal signs, and by their calls (33 birds, eight mammals and three frogs). Of the species recorded, eight were exotic species.

There were a number of habitat elements for flora and fauna species present within the study area. The habitat elements available across the study area provided sheltering, foraging, and roosting habitat for a range of fauna groups. Intact canopy and mid-storey layers provided foraging habitat for birds, bats and arboreal mammals, and tree canopies provided sheltering habitat for birds. Hollow-bearing trees, stags and trees with flaking bark provided roosting and/or breeding habitat for birds, bats, and arboreal mammals. Leaf litter, woody debris and exposed sandstone outcrops provided foraging and sheltering habitat for ground dwelling mammals, reptiles and some frog species. Standing fresh water provided foraging and breeding habitat for frog species, foraging habitat for bat species, and foraging and sheltering habitat for water birds and fish.

Constraints Assessment

The constraints assessment found that the majority of vegetated areas were of high or moderate ecological value, with some vegetated areas of low ecological value. Therefore, the majority of vegetated areas were identified as having some level of constraint in terms of development.

Of the vegetation communities, SSTF and CPW were the only communities assessed as having high ecological value. In relation to SSTF, this was mostly due to the community being in good condition, but the community is also listed as an EEC at the Commonwealth level, was classified as core vegetation, and had the highest threatened/migratory flora and fauna habitat value of all the communities in the study area. Both RFEF and CPW had experienced greater degrees of weed degradation and structural disturbances compared to SSTF; the only areas where CPW was assessed as having high ecological value were where weed degradation was low and/or where the community was structurally intact. Also, RFEF is not listed at the Commonwealth level, and CPW in the study area did not meet the listing criteria for the community under the EPBC Act. Both RFEF and CPW classified as Support for Core rather than Core vegetation. Areas where SSTF were assessed as having moderate ecological value were generally those which supported a high density of weeds or had experienced structural or other disturbances.

Conservation and Management Recommendations

Given that vegetated areas in the study area were generally those areas with the highest ecological value, vegetated areas within the study area had the highest level of constraint in terms of development for industrial use and/or subdivision, although existing disturbances to vegetated areas influenced the degree of ecological value/developmental constraint. Conversely, areas that have already been cleared or developed and lacked intact native vegetation (as represented by intact canopy, mid-storey and under-storey layers) were generally those areas with the lowest ecological value, representing the lowest areas of constraint to development.

Despite this, information at the lot level identifying areas suitable for development, areas of biodiversity value, and priority areas for restoration, regeneration or revegetation was provided.

In terms of measures to protect existing biodiversity values, recommended measures would include avoidance and ameliorative measures, with compensatory strategies considered for any significant impacts that cannot be avoided or mitigated. Avoidance and ameliorative measures have been recommended. Any offsetting measures should be developed in accordance with the "Principles for the use of Biodiversity Offsets in NSW"; the Biobanking Assessment methodology can be used to develop proposed offsetting measures.

1 Introduction

The Annangrove Road Light Industrial Area covers a 120 ha patch of land between Rouse Hill and Box Hill. It was established in 1991 and is zoned as Light Industrial 4(b) under *Baulkham Hills Local Environmental Plan 2005*, and IN2 Light Industrial under the *Draft The Hills Local Environmental Plan 2010*; it has not been biodiversity certified (bio-certified) in comparison to land in the surrounding area, which has been bio-certified. Since its establishment, the Annangrove industrial area has been unsuccessful in attracting new industrial businesses. However, there is a significant opportunity to provide employment growth within the industrial area, due in part to its location near Windsor Road, the Rouse Hill Town Centre and the proposed Box Hill precinct.

The Hills Shire Council is seeking to develop a master plan that establishes a clear vision and concept for the Annangrove Road Light Industrial Area. As part of the master plan preparation, technical studies including a Flora and Fauna Constraints Assessment are required for the Edwards Road Precinct. The Edwards Road Precinct extends south along Annangrove Road from approximately 600 m south of Joylyn Road to Withers Road in Rouse Hill, with Cattai and Second Ponds Creek forming the eastern boundary (**Figure 1**).

Previous Flora and Fauna Assessments for the north of the Edwards Road Precinct, prepared in association with previous development applications (Hayes Environmental 2007, Travers Environmental 2008), identified the presence of a number of threatened species and Endangered Ecological Communities (EECs). Council seeks information on the extent and significance of vegetation and EECs, and their significance as habitat for threatened flora and fauna species, for the entire Edwards Road Precinct. The presence of threatened species and EECs will directly impact on the future zoning, subdivision pattern, and road layout of the area. Further, Council seeks conservation and management recommendations to inform precinct planning, addressing:

- Areas suitable for development with no further ecological constraints
- Areas of biodiversity value that should be considered for retention
- Measures to protect biodiversity values
- Priority areas that could be considered for restoration, regeneration or revegetation
- Any proposed mechanisms for implementation of these recommendations, and
- Measures to control ecological impacts identified on the site.

This report is a Flora and Fauna Constraints Assessment for the Edwards Road Precinct. It reports on the ecological values within the precinct, and ranks areas according to conservation value over the precinct. It also provides conservation and management recommendations to inform precinct planning according to Council's requirements (outlined above).

1.1 STUDY AREA AND LOCALITY

The Edwards Road Precinct, also referred to as the study area in this assessment, is located in Rouse Hill, NSW, in the central western part of The Hills Shire Local Government Area (LGA). It is approximately 70.54 ha in area, and is comprised of 34 land parcels (**Table 1**). The precinct extends south along Annangrove Road from approximately 600 m south of Joylyn Road to Withers Road, with Cattai and Second Ponds Creek forming the eastern boundary (**Figure 1**).

The majority of the precinct is currently vegetated, although parts have been cleared for a transmission line easement and other uses. Much of the adjacent land to the east is also currently vegetated, particularly around the northern parts of the precinct, despite the Light Industrial 4(b) and Special Uses 5(a) zoning under the *Baulkham Hills Local Environmental Plan 2005* in these areas, and the adjacent North Kellyville Precinct, included under the *SEPP (Sydney Region Growth Centres) 2006* (SEPP (SRGC) 2006). Residential development lies further to the south east of the study area past the areas zoned as Light Industrial 4(b) and Special Uses 5(a). Rural residential properties, zoned as Rural 1(a) under the *Baulkham Hills Local Environmental Plan 2005*, lie along the northern boundary of the study area, to the west of Annangrove Road.

A number of vegetation communities have been mapped in the Edwards Road Precinct including Cumberland Plain Woodland (CPW), Shale Sandstone Transition Forest (SSTF), and Western Sandstone Gully Forest (WSGF) (NPWS 2002a). CPW is listed as a critically endangered EEC under both the NSW *Threatened Species Conservation Act 1997* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), while SSTF is listed as an endangered EEC under both the TSC and EPBC Acts. WSGF is not currently listed as an EEC.

The underlying geology of the study area is Hawkesbury Sandstone, although Liverpool Group Shale has been mapped for the southern parts of the study area. Three soil landscapes have been mapped for the study area: Hawkesbury Colluvial, Gymea Erosional and Blacktown Residual soil landscapes (map units ha, gy and bt, respectively) (Chapman and Murphy 1989). The characteristics of the soil landscapes are as follows:

- Hawkesbury: shallow (<50 cm) discontinuous lithosols/siliceous sands associated with rock outcrop, earthy sands, yellow earths, and locally deep sands on the inside of benches and along joints and fractures. It is also characterised by localised yellow and red podzolic soils associated with shale lenses, and siliceous sands on narrow valley flats. These soils are derived from the underlying Hawkesbury Sandstone geology
- Gymea: shallow to moderately deep (30-100 cm) tallow earths and earthy sands on crests and the inside of benches, localised gleyed podzolic soils and yellow podzolic soils on shale lenses, and shallow to moderately deep (<100 cm) siliceous sands and leached sands along drainage lines, and
- Blacktown: shallow to moderately deep (<100 cm) red and brown podzolic soils on crests, upper slopes and well drained areas, and deep (150-300 cm) yellow podzolic soils and soloths on lower slopes and in areas of poor drainage.

The study area is located close to several parcels of reserved land. The closest national parks, Scheyville and Cattai, lie approximately 5.2 km and 10 km to the north of the study area, respectively, while the closest nature reserves, Castlereagh and Windsor Downs, lie approximately 9 km and 12 km to the west of the study area, respectively. Some reserved land also occurs to the east, including Berowra Valley Regional Park which is approximately 11 km away.

The study area consists of land that is generally level, although some parts are slightly undulating and become steeper near creeks. Three creeks, Second Ponds, Caddies and Cattai Creeks, flow around the southern and eastern perimeters of the study area. An ephemeral tributary of Second Ponds Creek flows through Lot 26 DP 834050, Lot 12 DP 835727, and Lot 1 DP 835727. Other waterbodies of note which lie in proximity to the study area include farm dams. One dam is present on Lot 32 DP 834050.

The climate of the area is typical of the Sydney region, which can generally be described as temperate.

Table 1: Details of Lots and DPs comprising the study area

LAND PARCEL NO *	STREET ADDRESS	LOT	DP	AREA
1	278 Annangrove Road	2	879450	1.73
2	282 Annangrove Road	2	1032790	7.85
3	284 Annangrove Road	10	563695	2.02
4	286 Annangrove Road	2	838278	1.51
5	288 Annangrove Road	3	222080	2.12
6	20 Edwards Road	2	222080	3.53
7	31 Edwards Road	2	225401	2.06
8	290-312 Annangrove Road	26	834050	12.09
9	290-312 Annangrove Road	12	835727	7.71
10	314 Annangrove Road	27	834050	1.24
11	316 Annangrove Road	28	834050	1.67
12	318 Annangrove Road	29	834050	1.66
13	320 Annangrove Road	30	834050	1.66
14	322 Annangrove Road		78246	1.55
15	324 Annangrove Road	32	834050	1.95
16	326 Annangrove Road	33	834050	1.62
17	328 Annangrove Road	34	834050	1.68
18	330 Annangrove Road	12	833069	1.72
19	332-334 Annangrove Road	13	833069	2.71
20	NA (part of drainage corridor)	1	1032790	4.27
21	NA	1	133473	1.03
22	NA (part of drainage corridor)	1	835727	1.39
23	NA (part of drainage corridor)	1	879450	0.29
24	NA (part of drainage corridor)	14	833069	0.92
25	NA (part of drainage corridor)	15	833069	0.31
26	NA (part of drainage corridor)	17	834050	0.35
27	NA (part of drainage corridor)	18	834050	0.4
28	NA (part of drainage corridor)	19	834050	0.62
29	NA (part of drainage corridor)	20	834050	0.46
30	NA (part of drainage corridor)	21	834050	0.31
31	NA (part of drainage corridor)	22	834050	0.31
32	NA (part of drainage corridor)	23	834050	0.4
33	NA (part of drainage corridor)	24	834050	0.54
34	NA (part of drainage corridor)	25	834050	0.86
			Total	70.54

* Numbering has no relationship to Lot/DP numbers

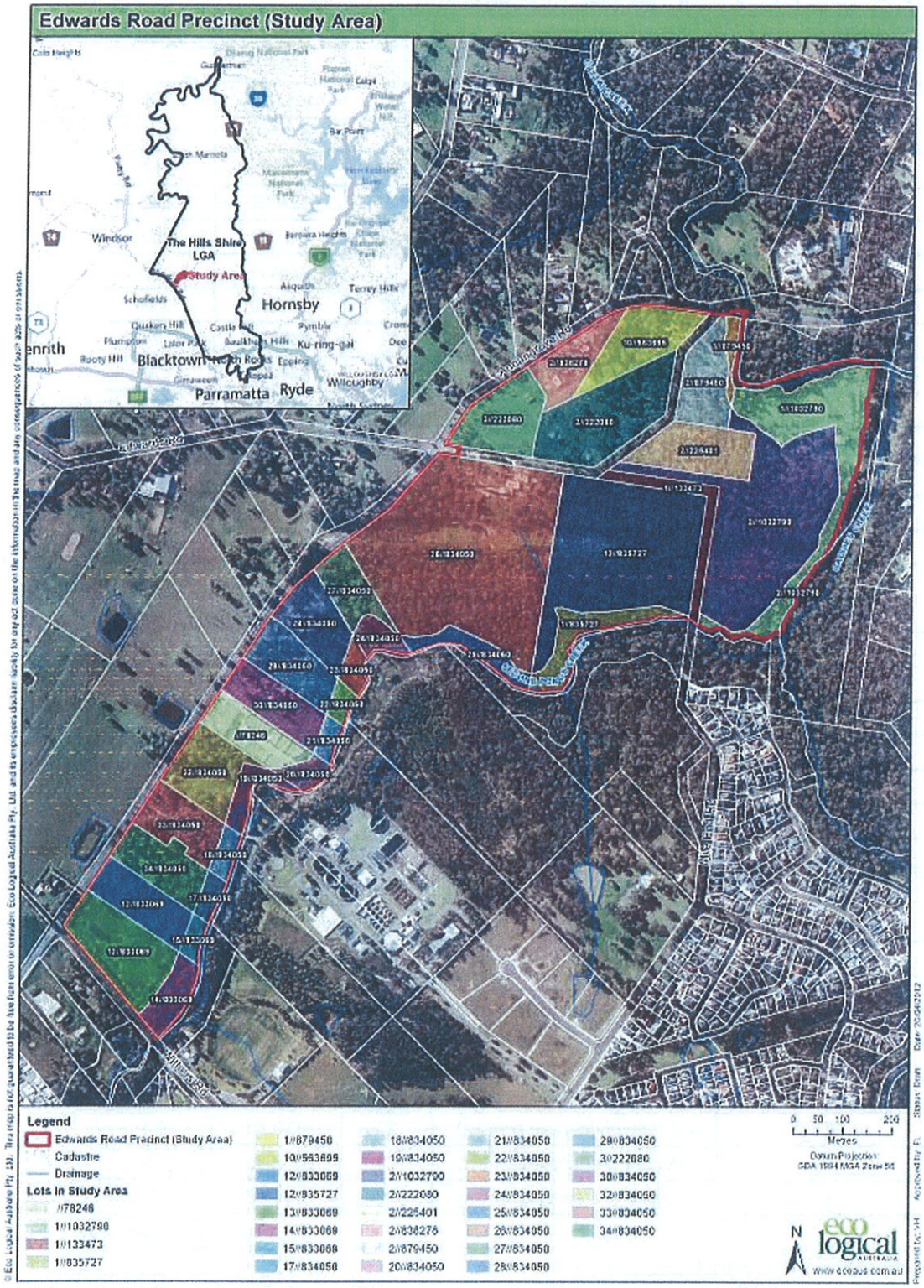

Figure 1: Location of the Edwards Road Precinct in Rouse Hill. Lot and DP numbers are shown

2 Methods

2.1 DATA AUDIT AND LITERATURE REVIEW

Database records and relevant literature pertaining to the ecology of the study area and surrounding area were reviewed. The material reviewed included:

- Office of Environment and Heritage (OEH) Atlas of NSW Wildlife. Search of data supplied September 2011, 10 km search radius) (OEH 2012)
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) Online search for Matters of National Environmental Significance (point search of coordinates with 10km buffer; see Appendix A) (Accessed 25 January 2011) (DSEWPAC 2012)
- The Hills Shire Council Vegetation Mapping (THSC 2005)
- DECC Vegetation of the Cumberland Plain, Final Edition – Vegetation and Core Habitat Mapping (DECC 2008);
- NPWS Vegetation of the Cumberland Plain – Vegetation and Core Habitat Mapping (NPWS 2002a)
- Native Vegetation Interpretation Guidelines for Western Sydney Vegetation (NPWS 2002b);
- Royal Botanic Garden (RBG) Online database, PlantNET (RBG 2012)
- *Flora and Fauna Assessment for the proposed industrial subdivision: Corner of Annangrove Road and Edwards Road, Rouse Hill* (Hayes Environmental 2007)
- *Flora and Fauna Constraints Analysis at Lot 2 and 4 DP 225401, Lot 2 DP 222080, Lot 10 DP 563695, and Lot 3 DP 879450 Crown Road, Rouse Hill* (Travers Environmental 2008), and
- Local plans including:
    - *Baulkham Hills Local Environmental Plan 2005* http://www.thehills.nsw.gov.au/Local-Environment-Plan.html
    - *Baulkham Hills Development Control Plan* http://www.thehills.nsw.gov.au/Development-Control-Plans.html
    - Draft *The Hills Local Environmental Plan 2010* http://www.thehills.nsw.gov.au/Draft-LEP-2010.html

High resolution aerial photographs (Virtual Earth and images provided by The Hills Shire Council) of the study area and surrounding area were also used to investigate the extent of vegetation cover, landscape features and land use in the area prior to field survey. In addition, relevant GIS datasets (soil, geology, drainage) were reviewed to guide the field survey component.

Species from both Atlas searches and searches for EPBC Act Matters of National Environmental Significance were combined to produce a list of threatened species that may occur within the study area ("subject species") (**Appendix A**). Likelihood of occurrences for threatened species, endangered populations and communities in the study area were then made based on location of database records, the likely presence or absence of suitable habitat on the subject site, and knowledge of the species' ecology. A list of potentially "affected species" was then identified (those that were defined as "yes", "likely" or having "potential" to occur in the study area – see overleaf).

Five terms for the likelihood of occurrence of species are used in this report, defined as follows:

- "yes" = the species was or has been observed in the study area
- "likely" = a medium to high probability that a species uses the study area
- "potential" = suitable habitat for a species occurs in the study area, 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 study area, and
- "no" = habitat in the study area and in its vicinity is unsuitable for the species.

Note that assessments for the likelihood of occurrence were made both prior to field survey and following field survey. The pre-survey assessments were performed to determine which species were "affected species", and hence determine which sorts of habitat to look for during field survey. The post-survey assessments to determine final "affected species" were made after observing the available habitat in the study area first hand.

2.2 SITE INSPECTION

Site inspection was conducted by two Eco Logical Australia (ELA) ecologists, Dr Enhua Lee and Jennie Powell, on 10 and 13 April 2012. Survey effort was approximately 32 person hours. Site inspection was conducted to validate vegetation mapping (as per THSC 2005, NPWS 2002a and DECC 2008), to determine the condition of vegetation communities, to determine the presence of threatened flora and fauna species, and to identify habitat features for threatened flora and fauna species within the study area.

Vegetation mapping was validated using a number of methods:

- Through comparisons of dominant canopy, mid-stratum and ground cover species present on the ground with those typical of the mapped vegetation communities (as provided in NPWS 2002b)
- Through assessments of similarities in the descriptions of vegetation communities and their occurrence in the landscape and on soils as provided in NPWS (2002b) with vegetation, landscape position and soils observed on the ground
- Using plot-based surveys (Biobanking plots: 20 x 20 m nested plots within 20m x 50 m plot). Four plot surveys were conducted (**Figure 2**), with one plot conducted per vegetation community less than 2 ha in area and two plots conducted per vegetation community between 2 and 50 ha in area. The exception was CPW where only one plot was conducted due to time constraints. However, CPW was also validated through traverses through the community. Information collected in Biobanking plots included quantitative data for native species richness (species were identified to the lowest taxonomic level possible and any unknown flora species were collected for later identification); native versus exotic species cover; the presence of hollow bearing trees and over-storey regeneration; and length of fallen logs in accordance with the Biobanking Assessment Methodology (Seidel and Briggs 2008), and
- Via traverses confirming the boundaries of vegetation communities and species assemblages. Where the boundaries of vegetation communities differed from existing vegetation mapping, these were modified on hard copy maps and marked with a hand-held GPS.

The condition of vegetation communities was determined by assigning a weed invasion category to each vegetation community (or part thereof where relevant) to indicate the level of weed invasion in the community. Invasion categories were assigned in accordance with the following criteria:

- Low weed invasion (< 5% foliage cover)
- Moderate weed invasion (6 - 25% foliage cover)
- High weed invasion (26 - 75% foliage cover), and
- Extreme weed invasion (> 75% foliage cover).

Also, the condition of vegetation communities was determined through the presence of structural layers within each vegetation community, with categories assigned as follows:

- Very High (intact canopy, mid-storey and ground layers present)
- High (intact canopy, mid-storey and ground layers present, but the patch is disturbed from paintball or minor under-scrubbing activities)
- Moderate (intact canopy present, but the patch has a depleted mid-storey layer and a highly modified ground layer)
- Moderate to Low (intact canopy present, but the patch lacks a mid-storey layer and has a highly compacted ground layer)
- Low (intact canopy present, but the patch lacks a mid-storey layer and has a highly modified/mown ground layer)
- Very Low (canopy absent, but mid-storey and ground layers present), and
- Extremely Low (canopy and mid-storey absent and the patch has a highly modified ground layer.

The boundaries of weed invasion and structural categories indicating condition were marked on hard copy maps and marked with a hand-held GPS.

The presence of threatened flora and fauna species identified as having the potential to occur in the study area (**Appendix A**) and the presence of their habitats was determined through targeted searches for those species and signs (scats, tracks, scratches, diggings) of those species and through notes made on habitat. The random meander method (Cropper 1993) was used to search for species, with meanders focussing on areas where threatened flora and fauna may be present. Where threatened species or important habitat features such as hollow-bearing trees, potential nesting or roosting sites, rock outcrops, winter-flowering eucalypts, and logs were observed along traverses, their locations were marked using a hand-held GPS for later mapping. However, the locations of all important habitat features observed were not recorded due to time constraints.

No active surveys were conducted for fauna. There was only limited habitat for *Meridolum corneovirens* (Cumberland Plain Land Snail) in CPW in the study area given the lack of a deep leaf litter layer at the base of trees.

During the survey, all fauna species and additional visible vascular flora encountered outside of plot surveys were recorded.

Temperatures were cool to mild on both field days, with the minimum and maximum temperatures for the 10 April recorded as 10.5°C and 18.1°C, respectively, and the minimum and maximum temperatures for the 13 April recorded as 9.4°C and 23.3°C, respectively (recordings taken from the nearest weather station to the subject site; BOM 2012). No rain fell during survey.

2.2.1 Survey Limitations

The survey was conducted in autumn, and no detailed fauna surveys targeting fauna groups were conducted due to the nature of the project (a constraints assessment rather than a study such as an impact assessment or biodiversity study). Thus, it is possible that flora and fauna species that may occur in the study area were not recorded due to the life cycle and behaviour of species and seasonal

considerations. Targeted surveys would need to be repeated over a number of seasons to more adequately capture the diversity of flora and fauna that could be present in the study area. Since this was not possible, habitat assessments were undertaken to predict the likely presence of species. A conservative approach was also taken in assuming the presence of species that could potentially occur in the study area (that is, species were assessed to have the potential to be present even if the potential for this was low).

2.3 ECOLOGICAL CONSTRAINTS ASSESSMENT

The ecological constraints assessment of the study area was made through GIS analysis, which assigned areas with a high, moderate, low, or very low ecological constraint. The analysis was based on the presence of EECs as listed under Commonwealth legislation; the presence of EECs as listed under State legislation; vegetation community condition as determined by the presence of weeds; vegetation community condition as determined by stratum characteristics; core vegetation and habitat connectivity; and habitat potentially supporting threatened, migratory or ROTAP species. These formed the six data input layers used in the analysis (**Table 2**).

Table 2: Data inputs and their scores assigned per category/class

DATA INPUT	CLASS	SCORE
Vegetation Community (EPBC Act)	Critically Endangered	2
	Endangered	1
	Not listed	0
Vegetation Community (TSC Act)	Critically Endangered	2
	Endangered	1
	Not listed	0
Condition (weed invasion categories)	Low weed invasion (< 5% foliage cover)	4
	Moderate weed invasion (6 - 25% foliage cover)	3
	High weed invasion (26 - 75% foliage cover)	2
	Extreme weed invasion (> 75% foliage cover)	1
	Cleared	0
Condition (categories according to stratum characteristics)	Very High (intact canopy, mid-storey and ground layers present)	6
	High (intact canopy, mid-storey and ground layers present, but the patch is disturbed from paintball or minor under-scrubbing activities)	5
	Moderate (intact canopy present, but the patch has a depleted mid-storey layer and a highly modified ground layer)	4
	Moderate to Low (intact canopy present, but the patch lacks a mid-storey layer and has a highly compacted ground layer)	3
	Low (intact canopy present, but the patch lacks a mid-storey layer and has a highly modified/mown ground layer)	2
	Very Low (canopy absent, but mid-storey and ground layers present)	1
	Extremely Low (canopy and mid-storey absent and the patch has a highly modified ground layer	0

DATA INPUT	CLASS	SCORE
Core vegetation and habitat connectivity	Core (patch > 10 ha and projected foliage cover of the canopy > 10%)	2
	Support for Core (patch supports Core habitat, buffering from edge effects and providing corridor connections. Patch is < 10 ha and projected foliage cover of the canopy may be < 10% or > 10%)	1
	Limited to no connectivity	0
Threatened/migratory Flora and Fauna Habitat Value	High	4
	Moderate	3
	Moderate to Low	2
	Low (not a vegetation community, but habitat present)	1
	Extremely Low (not a vegetation community and limited to no habitat present)	0

The data input layers were mostly created from vegetation validation and observations made for vegetation condition during field investigation, although one layer, 'Core vegetation and habitat connectivity', was created based on a combination of patch size and projected foliage cover of the canopy (generally following the *Western Sydney Conservation Significance Assessment Mapping*, and the rules as set out in *Guidelines for the Conservation Significance Assessment Mapping*; NPWS 2002c and d, respectively).

Vegetation community mapping formed the basis of two of the data input layers: 'Vegetation Community (EPBC Act)', and 'Vegetation Community (TSC Act)'. The remaining data input layers, 'Condition (weed invasion categories)', 'Condition (categories according to stratum characteristics)', 'Core vegetation and habitat connectivity', and 'Threatened/migratory Flora and Fauna Habitat Value' had separate spatial layers to the vegetation community mapping and included areas within the study area that did not support vegetation communities.

Given the 'Core vegetation and habitat connectivity' layer included areas that did not support vegetation communities, this layer differed slightly from the *Western Sydney Conservation Significance Assessment Mapping* (NPWS 2002c) which was based on mapped vegetation communities, excluding sandstone communities (see NPWS 2002d). It was decided that areas not supporting recognised vegetation communities should be included to account for connectivity across the study area through modified vegetation lacking a canopy or planted vegetation, as was the case in parts of the riparian area e.g. within Lot 20 in DP 834050.

Scores were assigned to each input layer to reflect different levels of importance of classes/categories within the mapped areas. Higher scores were assigned to classes/categories that had higher legislative significance, were in better ecological condition (e.g. had lower weed densities or had more intact stratums), provided more threatened/migratory flora and fauna habitat value, or were larger patches of vegetation. For each data input layer, scores started from zero and increased incrementally to the highest class/category present in the input layer (**Table 2**). As such, scores in each data input layer related to the categories/classes within the specific data layer, and had no relation to scores in other data layers.

The determination of scores for the Threatened/migratory Flora and Fauna Habitat Value data input layer was more involved than the other layers as it was derived through a stepped process. The process was as follows:

1. The likelihood of occurrence of each threatened species, identified through 10 km radius database searches around the study area and literature review, was determined per vegetation community based on knowledge of each threatened fauna species' habitat requirements, and observations made of habitat elements present in vegetation types during field survey (see Section 2.1 for the terms used and **Appendix C**)

2. In each vegetation community, the number of species with the same likelihood of occurrence and conservation significance status was tallied (only the likelihood terms "yes", "likely", and "potential" were considered). For example, in SSTF, two species were recorded with a likelihood of "yes" and a conservation significance status of EPBC (Vulnerable)

3. The tallied numbers of species with the same likelihood and conservation significance status were multiplied by a weighting based on conservation significance status. These weightings are shown in **Table 3.** For example, in SSTF, two species were recorded with a likelihood of "yes" and a conservation significance status of EPBC (Vulnerable). Therefore, the number 2 was multiplied by the appropriate weighting of 3, which resulted in a score of 6 for that combination of likelihood and conservation significance status in SSTF

Table 3: Weightings of conservation significance status for threatened and ROTAP (Briggs and Leigh 1995) species

STATUS	MULTIPLIER
EPBC (Endangered)	4
EPBC (Vulnerable)	3
EPBC (Migratory)	1
TSC (Endangered)	3
TSC (Vulnerable)	2
ROTAP	1

4. The final score for each vegetation community was obtained by summing the scores for each combination of likelihood and conservation significance status that had been modified by the weighting of conservation significance status

5. The final scores for the vegetation communities were relatively evenly spread and so the following levels of Threatened/migratory Flora and Fauna Habitat Value were identified:

    - High (final score above 100)
    - Moderate (final score between 70 and 100), and
    - Moderate to Low (final score below 70).

6. Two additional levels were defined for areas that did not classify as a vegetation community. These were:

    - Low (not a vegetation community, but habitat present), and
    - Extremely Low (not a vegetation community and limited to no habitat present).

Once the scores were identified and assigned to polygons in each input layer, the ecological constraint analysis was conducted. It was undertaken as a GIS analysis which combined all the spatial datasets into a single dataset. The analysis overlaid the scores and boundaries from each of the six individual input layers on top of each other and these were combined into a new single constraints dataset. The

constraints dataset contained six scores from each of the input layers for every polygon present and were summed into final scores ranging between zero and 18.

A frequency distribution histogram of the final scores for each polygon was created and examined to convert scores into final constraint categories (**Figure 3**). Final constraints scores were placed in groups of High, Moderate, Low or Very Low ecological constraint based on the occurrence of natural breaks in the data and an understanding of the ecological values of the study area gained from the site inspection. While this involves a measure of subjectivity, it ensures that the constraints analysis properly reflects what was observed during the site inspection. It was also more precautionary, encapsulating more polygons within the higher categories of high and moderate.

Figure 2: Location of Biobanking plots within the Edwards Road Precinct

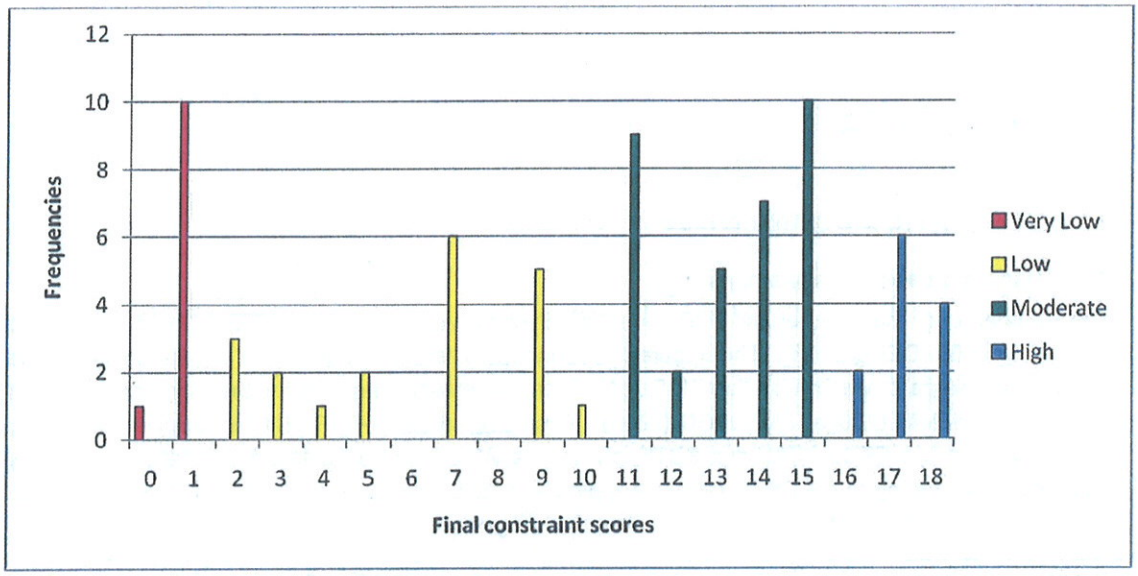

Figure 3: Frequency distribution of the final scores in the constraints layer

3 Results

3.1 VEGETATION COMMUNITIES

3.1.1 Data audit and literature review

The Vegetation of the Cumberland Plain, Western Sydney, was mapped in 2002 (NPWS 2002a) and updated in 2008 (DECC 2008). The updated 2008 mapping removed patches of vegetation which had a projected foliage cover of less than 10%. As such, vegetation mapping for the study area differed according to NPWS (2002a) and DECC (2008). According to the NPWS (2002a) mapping, the study area supported two EECs, CPW and SSTF, as well as WSGF and an unlisted vegetation community (**Figure 4**). According to the DECC (2008) mapping, the study area supported one EEC, SSTF, as well as WSGF and vegetation that had not been classified (**Figure 5**).

Vegetation mapping provided by The Hills Shire Council (THSC 2012) mapped three vegetation communities in the study area: CPW, SSTF, and Sydney Sandstone Gully Forest (SSGF). It also mapped vegetation that had not yet been classified (**Figure 6**).

Field validation by Hayes Environmental (2007) for Lot 26 in DP 834050, Lot 12 DP 835727, Lot 25 in DP 834050, and Lot 1 in DP 835727 in the north of the study area confirmed the presence of SSTF, but not the presence of WSGF which was mapped by NPWS (2002a) and DECC (2008) on these lots (**Figure 7**). Field validation by Travers Environmental (2008) for Lots 1 and 2 DP 1032790, Lot 2 DP 225401, Lot 2 DP 222080, Lot 2 DP 879450, Lot 1 DP 879450, and Lot 10 DP 563695 in the north east of the study area determined that SSTF and WSGF were not present as mapped by NPWS (2002a) and DECC (2008); rather, Sydney Sandstone Ridgetop Woodland (SSRW) was present over the majority of the lots. Further, Travers Environmental (2008) mapped disturbed open forest and disturbed gully forest on the lots, the latter of which was present in the south of Lot 1 in DP 1032790 and likely to once have been River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (RFEF) (**Figure 7**). RFEF is listed as an endangered EEC under the TSC Act.

3.1.2 Site inspection – presence and distribution of vegetation communities

Site inspection by ELA confirmed Hayes Environmental's (2007) assessment that SSTF was present in the north of the study area in Lot 26 in DP 834050, Lot 12 DP 835727, Lot 25 in DP 834050, and Lot 1 in DP 835727, and that WSGF mapped by NPWS (2002a) and DECC (2008), and CPW mapped by THSC (2012), were not present in these lots. Further, site inspection by ELA confirmed Travers Environmental's (2008) assessment that RFEF was present at the south of Lot 1 DP 1032790 (as opposed to WSGF mapped by NPWS (2002a) and DECC (2008)). However, ELA's site inspection found that SSTF was present within the majority of lots inspected by Travers Environmental (2008), and that SSRW did not occur in these lots. Further, ELA found that RFEF was present within the north east corner of Lot 1 DP 1032790, which was assessed by Travers Environmental's (2008) as supporting Disturbed Open Forest (*E. deanei/E. amplifolia*).

In the northern-most part of the study area, ELA validated unclassified vegetation (NPWS 2002a, DECC 2008) as SSTF. CPW, as listed under the TSC Act but not under the EPBC Act, was present in the southern parts of the study area, south from Lot 27 in DP 834050 to Lot 12 in DP 833069. RFEF was

present along the southern and south eastern boundaries of the study area within Lots 14 and 15 in DP 833069 and Lots 17 and 18 in DP834050.

The difference in the vegetation communities validated by ELA and Travers Environmental (2008) is based on the presence/absence of dominant tree species. Other parts of the vegetation validation of Travers Environmental (2008) and ELA were similar. Both validations used a combination of the underlying geology and the species assemblage. The assessment of the underlying geology based on mapping was the same (that the underlying geology and soils were transitional between shale and sandstone), with both Travers Environmental (2008) and ELA finding that the northern part of the study area had a strong sandstone influence. Further, the species assemblage recorded by Travers Environmental (2008) and ELA was similar (see Travers Environmental 2008 and section on SSTF below).

However, the final step of the vegetation validation was where Travers Environmental (2008) and ELA differed. ELA determined that the assemblage was more consistent with SSTF as described in NPWS (2002b). SSRW as described in NPWS (2002b) is dominated by *Corymbia gummifera* (Red Bloodwood) and *Eucalyptus sclerophylla* (Hard-leaved Scribbly Gum) with *Banksia serrata* (Old Man Banksia) frequently present. Other trees such as *Eucalyptus punctata* (Grey Gum), *E. oblonga* (Narrow-leaved Stringybark) and *Angophora costata* (Smooth-barked Apple) also occur. None of the dominant species of SSRW, *Corymbia gummifera*, *Banksia serrata*, *E. oblonga* or *Angophora costata* were recorded during survey and therefore ELA determined that the vegetation was closer to SSTF than to SSRW.

The extent of vegetation communities, as validated in the field, is shown in **Figure 8**. Results from Biobanking plots are presented in **Appendix B**. Vegetation communities found in the study area are described in the following sections.

Shale Sandstone Transition Forest

Shale Sandstone Transition Forest was characterised by a canopy of *Eucalyptus punctata*, *E. tereticornis* (Forest Red Gum), and *Angophora bakeri* (Narrow-leaved Apple), with *E. eugenioides* (Thin-leaved Stringybark), *E. crebra* (Narrow-leaved Ironbark), *E. fibrosa* (Red/Broad-leaved Ironbark), and *E. sclerophylla* occurring in varying densities through the community. The understorey within this community was composed of shrubs including *Persoonia linearis* (Narrow-leaved Geebung), *Acacia floribunda* (White Sally), *Allocasuarina littoralis* (Black She-oak), *Leptospermum trinervium*, *Pimelea linifolia*, *Exocarpos cupressiformis* (Native Cherry), *Gahnia sieberana*, *Ozothamnus diosmifolius* (White Dogwood), *Kunzea ambigua* (Tick Bush), *Leucopogon juniperinum*, *Lepidosperma laterale*, and *Lomandra longifolia* (Spiny-headed Mat-rush). Some weeds including *Olea europaea* subsp. *cuspidata* (African Olive) and *Ligustrum* sp. (Privet species) were also present in low densities. The ground layer comprised of a mixture of grasses and forbs including *Pomax umbellata*, *Cheilanthes sieberi*, *Pratia purpurascens* (Whiteroot), *Microlaena stipoides* (Weeping Grass), *Trachymene incisor*, *Entolasia stricta* (Wiry Panic), *Paspalidium distans*, *Acianthus fornicatus* (Pixie Caps), *Panicum simile* (Two-colour Panic), *Glycine clandestina*, and *Hibbertia diffusa*.

River Flat Eucalypt Forest

River Flat Eucalypt Forest was characterised by a canopy of *E. tereticornis* and *E. amplifolia* (Cabbage Gum), although *E. deanei* (Mountain Blue Gum/Deane's Gum) and *E. moluccana* (Grey Box) were also present in the community. The understorey was mostly comprised of *Olea europaea* subsp. *cuspidata*, *Ligustrum* sp., *Acacia parramattensis* (Parramatta Wattle), *Acacia floribunda*, *Acacia decurrens* (Black Wattle), and *Melaleuca decora*, with some other species such as *Melaleuca linariifolia* and *Bursaria spinosa* (Native Blackthorn) also present. The ground layer comprised of species including *Hydrocotyle*

peduncularis, *Centella asiatica* (Pennywort), *Oplismenus imbecillis*, *Microlaena stipoides*, *Pratia purpurascens*, *Dichondra repens*, *Entolasia marginata*, *Oxalis perennans*, *Galium gaudichaudii*, and *Pellaea falcata* (Sickle Fern).

Cumberland Plain Woodland (as listed under the TSC Act only)

Cumberland Plain Woodland was characterised by a canopy of mostly *E. tereticornis*, although some *E. moluccana* was present in very low densities, and *Angophora floribunda* (Rough Barked Apple) occurred in parts of the community. The understorey was mostly comprised of *Acacia decurrens*, and *Acacia parramattensis*, although *Bursaria spinosa* was also present with *Ozothamnus diosmifolius* occurring less frequently. Weeds including *Olea europaea* subsp. *cuspidata* and *Ligustrum* sp. were present. The ground layer was dominated by the grass species, *Microlaena stipoides* in areas where weeds were absent, although other species including *Pratia purpurascens*, *Entolasia marginata* (Bordered Panic), *Paspalidium distans*, *Cheilanthes sieberi*, *Glycine clandestina*, *Glycine tabacina*, *Solanum prinophyllum*, *Centella asiatica*, and *Hydrocotyle peduncularis* were present in these areas. A large portion of the community was dominated by weeds, and as such, the community did not meet the EPBC Act criteria for the community whereby at least 30 % cover of the under storey is comprised of perennial native species.

3.1.3 Site inspection – condition of vegetation communities

The condition of vegetation communities varied within the study area, both in terms of weed densities and structurally. **Figure 9** and **Figure 10** show the condition of the vegetation communities in relation to weed density and structural characteristics, respectively.

Of the communities, CPW and RFEF were perhaps the most degraded, with the majority of the two communities displaying high weed infestations (although RFEF in the southern parts of the study area was less degraded by weeds). CPW was also degraded through disturbance to the mid-storey and ground layer, where the mid-storey had been removed and the ground layer maintained as a lawn.

SSTF was also degraded in parts, with the highest weed densities and modifications to the mid-storey occurring in the northern and eastern-most parts of the community. As well, the community experienced disturbance from paintball activities within Lot 26 DP 834050 and Lot 12 DP 835727, with the ground layer completely absent and the ground heavily compacted in some areas.

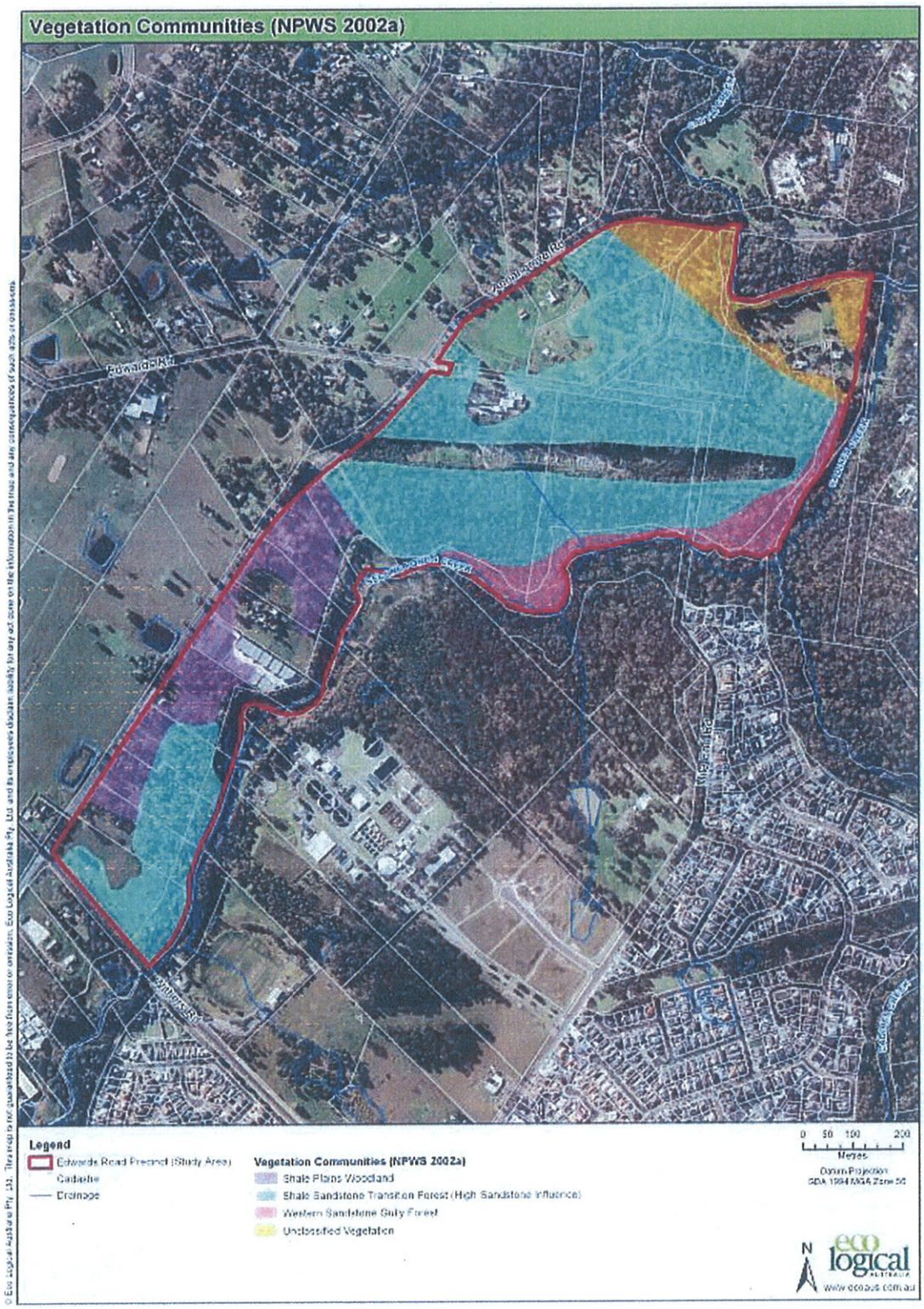

Figure 4: Vegetation communities (as per NPWS 2002a mapping) within the Edwards Road Precinct

Figure 5: Vegetation communities (as per DECC 2008 mapping) within the Edwards Road Precinct

Figure 6: Vegetation communities (as per THSC 2012 mapping) within the Edwards Road Precinct

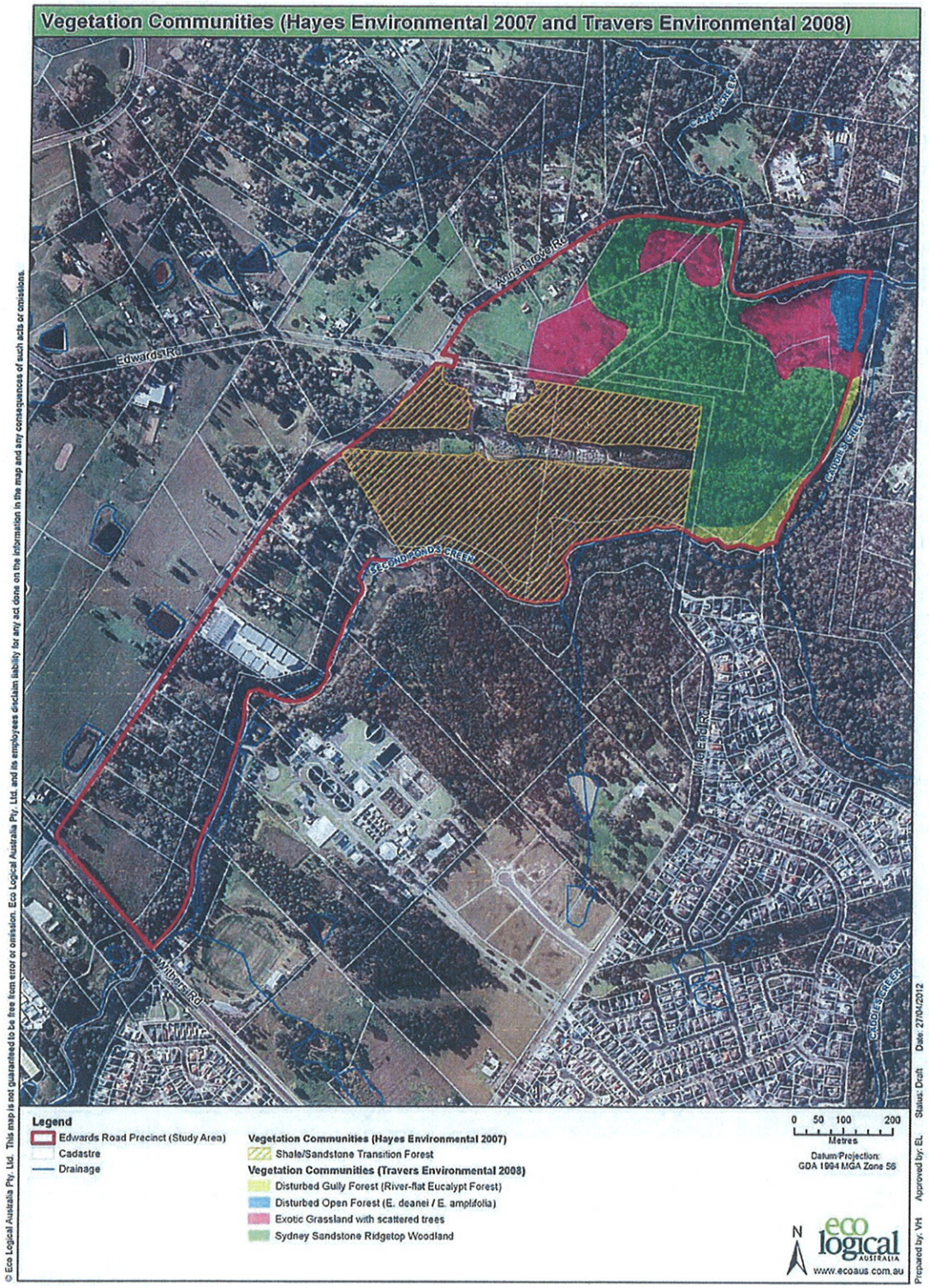

Figure 7: Vegetation communities as validated by Hayes Environmental (2007) and Travers Environmental (2008)

Figure 8: Vegetation communities as validated by ELA

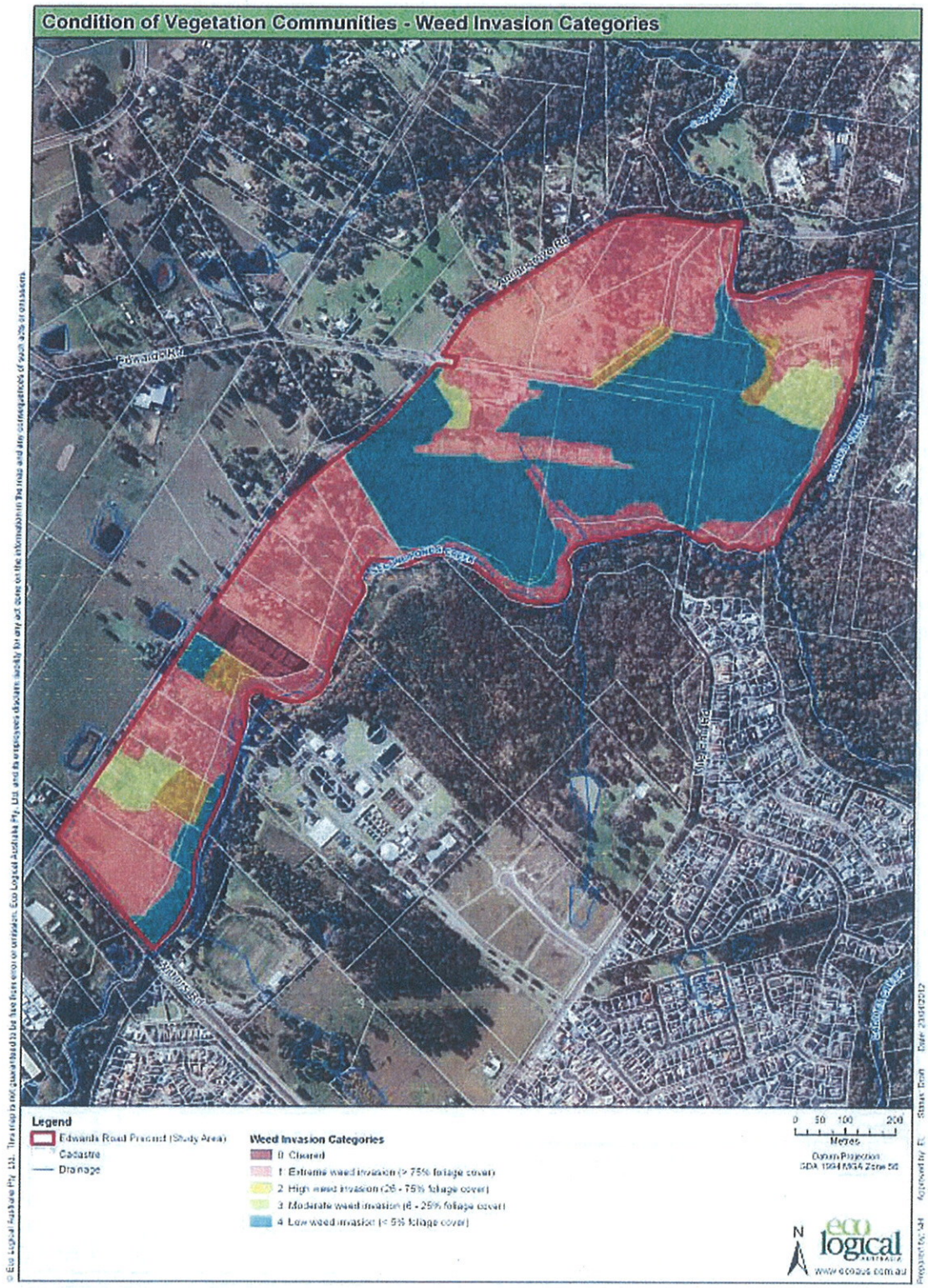

Figure 9: Condition of vegetation communities - weed invasion categories

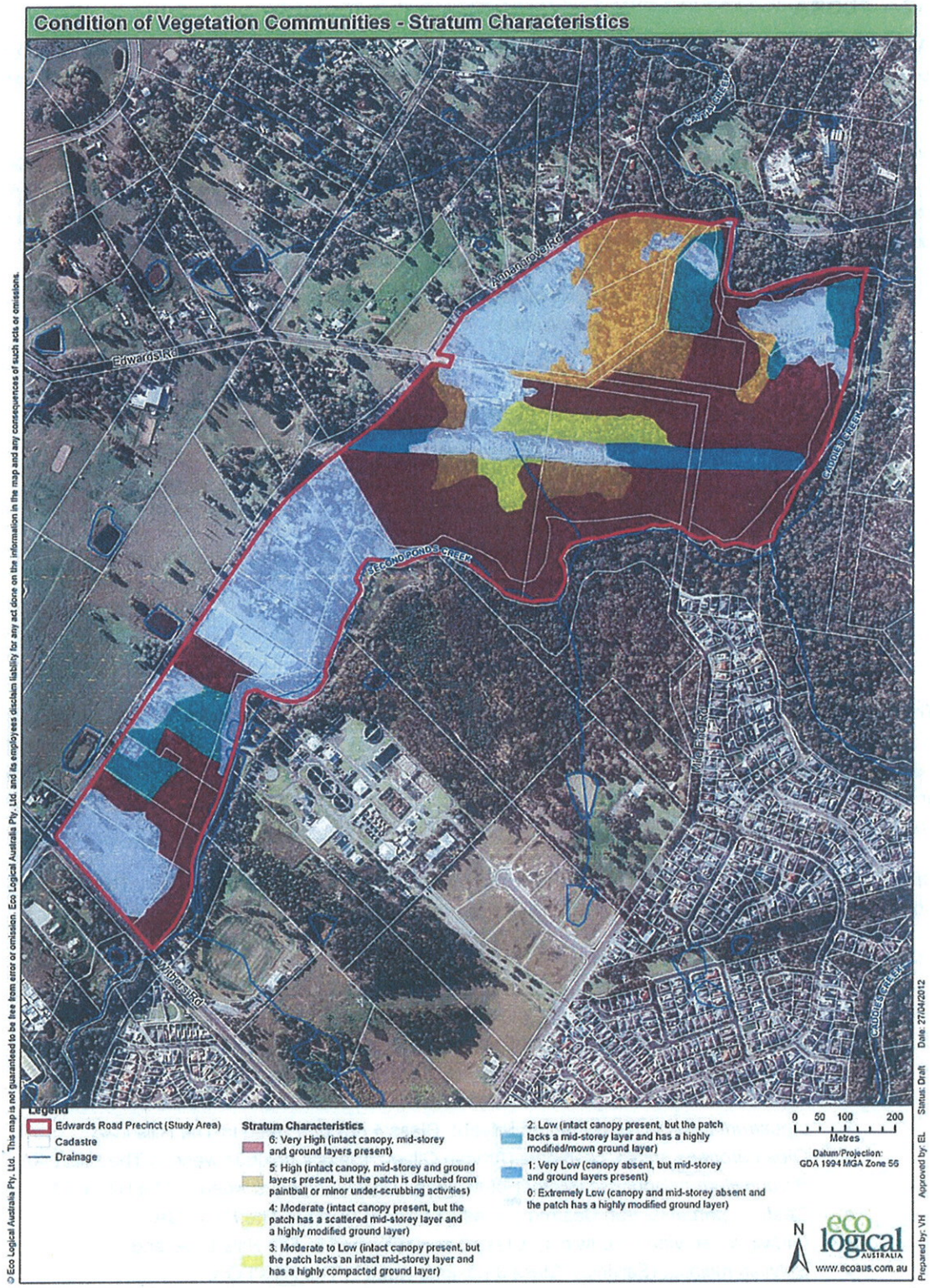

Figure 10: Condition of vegetation communities - categories according to stratum characteristics

3.2 FLORA

An assessment of the potential for threatened flora species to occur in the study area and a list of species previously recorded within the locality is included in **Appendix A**. **Figure 11** shows the locations of threatened flora species in the locality i.e. within a 10 km radius of the study area.

None of the flora species identified in **Appendix A** were recorded during the field survey, although Hayes Environmental (2007) recorded *Eucalyptus nicholii*, which was likely to have been planted. From the list of species previously recorded, 14 threatened flora species were considered as having the potential to occur within the study area:

- *Acacia bynoeana* (Bynoe's Wattle)
- *Acacia pubescens* (Downy Wattle)
- *Darwinia biflora*
- *Dillwynia tenuifolia*
- *Epacris purpurascens* var. *purpurascens*
- *Eucalyptus* sp. Cattai
- *Grevillea juniperina* subsp. *juniperina*
- *Hibbertia superans*
- *Lasiopetalum joyceae*
- *Leucopogon fletcheri* subsp. *fletcheri*
- *Persoonia hirsuta* (Hairy Geebung)
- *Pimelea curviflora* var. *curviflora*
- *Pimelea spicata* (Spiked Rice-flower), and
- *Tetratheca glandulosa.*

The potential for threatened flora to occur within the different vegetation communities (for the calculation of the flora and fauna habitat value input layer) is documented in **Appendix C**. A list of flora observed during the field survey is included in **Appendix D**. A total of 204 flora species comprised of 143 native and 61 exotic species were identified. Additional exotic weeds and landscape plantings in the study area were observed but not recorded.

Of the exotic species recorded, 11 are listed as noxious species for the Hawkesbury River County Council (which includes the Baulkham Hills LGA):

- *Salix spp.* (Willows): Class 5 noxious weed in the whole of NSW and in The Hills LGA
- *Rubus fruticosus* (Blackberry): Class 4 noxious weed in the whole of NSW and in The Hills Local Government Area (LGA)
- *Asparagus asparagoides* (Bridal Creeper): Class 4 noxious weed in The Hills LGA
- *Lantana camara* (Lantana): Class 4 noxious weed in The Hills LGA
- *Ligustrum lucidum* (Large-leaf Privet): Class 4 noxious weed in The Hills LGA
- *Ligustrum sinense* (Small-leafed Privet): Class 4 noxious weed in The Hills LGA
- *Olea europaea* subsp. *cuspidata* (African Olive): Class 4 noxious weed in The Hills LGA
- *Bryophyllum delagoense* (Mother-of-Millions): Class 3 noxious weed in The Hills LGA
- *Cestrum parqui* (Green Cestrum): Class 3 noxious weed in The Hills LGA
- *Ludwigia peruviana* (Ludwigia): Class 3 noxious weed in The Hills LGA, and
- *Salvinia molesta* (Salvinia): Class 3 noxious weed in The Hills LGA.

3.3 FAUNA

An assessment of the potential for threatened / migratory fauna species to occur in the study area and a list of species previously recorded within the locality has been included in **Appendix A**. **Figure 12** shows the locations of threatened/migratory fauna species in the locality.

None of the fauna species identified in **Appendix A** were recorded during the field survey, although *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) and *Myotis macropus* (Large-footed Myotis) were recorded by Hayes Environmental (2007) and Travers Environmental (2008), with *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) recorded by Hayes Environmental (2007) and *Pteropus poliocephalus* (Grey-headed Flying-fox) recorded by Travers Environmental (2008). From the list of species previously recorded, 23 threatened and 6 migratory fauna species were considered as having the potential to occur within the study area:

Threatened

- *Litoria aurea* (Green and Golden Bell Frog)
- *Anthochaera phrygia* (Regent Honeyeater)
- *Callocephalon fimbriatum* (Callocephalon fimbriatum)
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo)
- *Circus assimilis* (Spotted Harrier)
- *Daphoenositta chrysoptera* (Varied Sittella)
- *Hieraaetus morphnoides* (Little Eagle)
- *Glossopsitta pusilla* (Little Lorikeet)
- *Lathamus discolor* (Swift Parrot)
- *Lophoictinia isura* (Square-tailed Kite)
- *Melanodryas cucullata cucullata* (Hooded Robin – south eastern subspecies)
- *Melithreptus gularis gularis* (Black-chinned Honeyeater - eastern subspecies)
- *Petroica boodang* (Scarlet Robin)
- *Ninox connivens* (Barking Owl)
- *Ninox strenua* (Powerful Owl)
- *Tyto novaehollandiae* (Masked Owl)
- *Tyto tenebricosa* (Sooty Owl)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat)
- *Mormopterus norfolkensis* (East Coast Freetail Bat)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat), and
- *Meridolum corneovirens* (Cumberland Land Snail).

Migratory

- *Apus pacificus* (Fork-tailed Swift)
- *Hirundapus caudacutus* (White-throated Needletail)
- *Merops ornatus* (Rainbow Bee-eater)
- *Monarcha melanopsis* (Black-faced Monarch)
- *Myiagra cyanoleuca* (Satin Flycatcher), and
- *Rhipidura rufifrons* (Rufous Fantail).

The potential for threatened and migratory fauna occur within the different vegetation communities (for the calculation of the flora and fauna habitat value input layer) is documented in **Appendix C**. A list of

fauna observed during the field survey is included in **Appendix E**. A total of 44 fauna species were recorded via direct observation, animal signs, and by their calls (33 birds, eight mammals and three frogs). Of the species recorded, eight were exotic species.

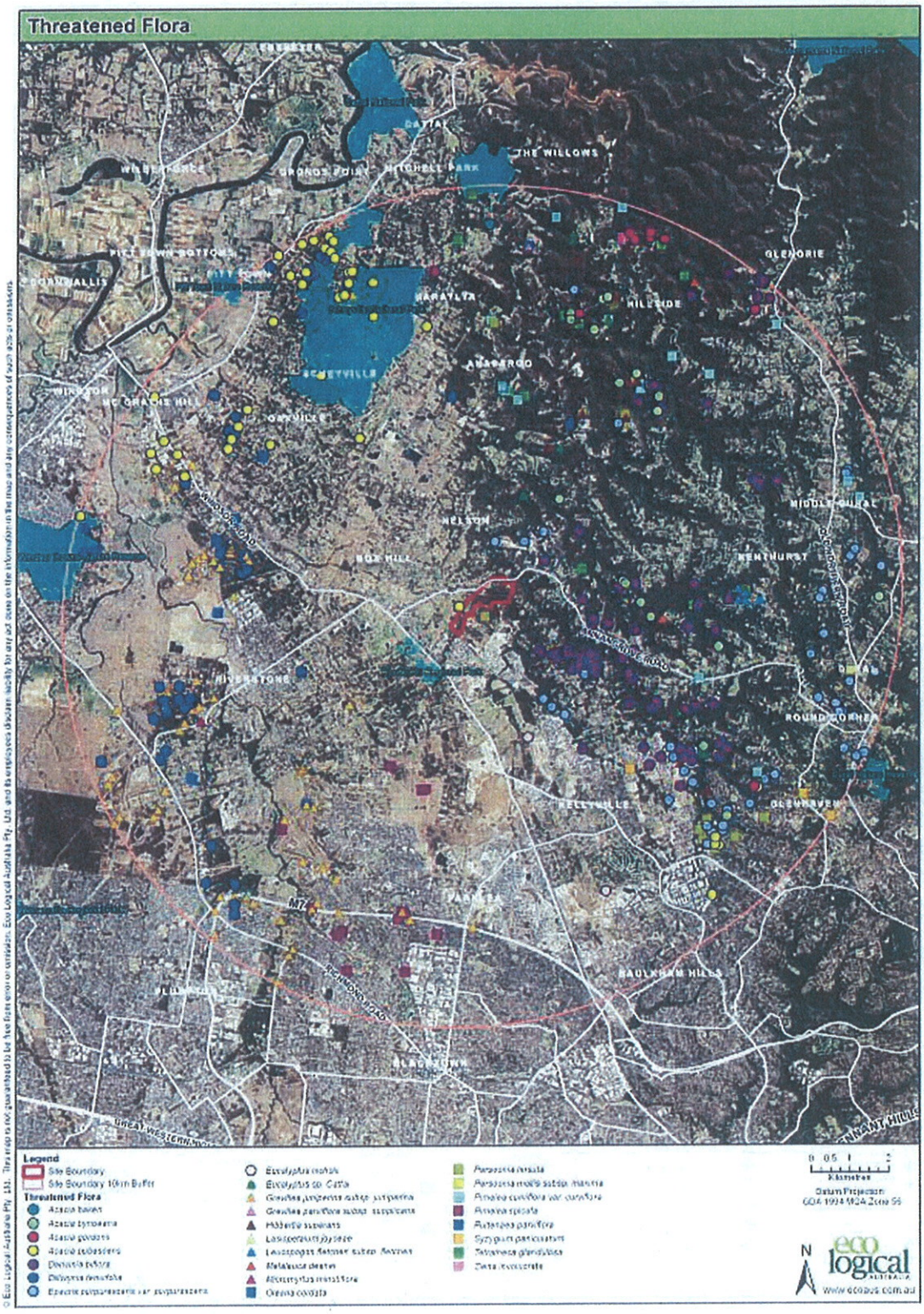

Figure 11: Threatened flora records in the locality (10 km radius)

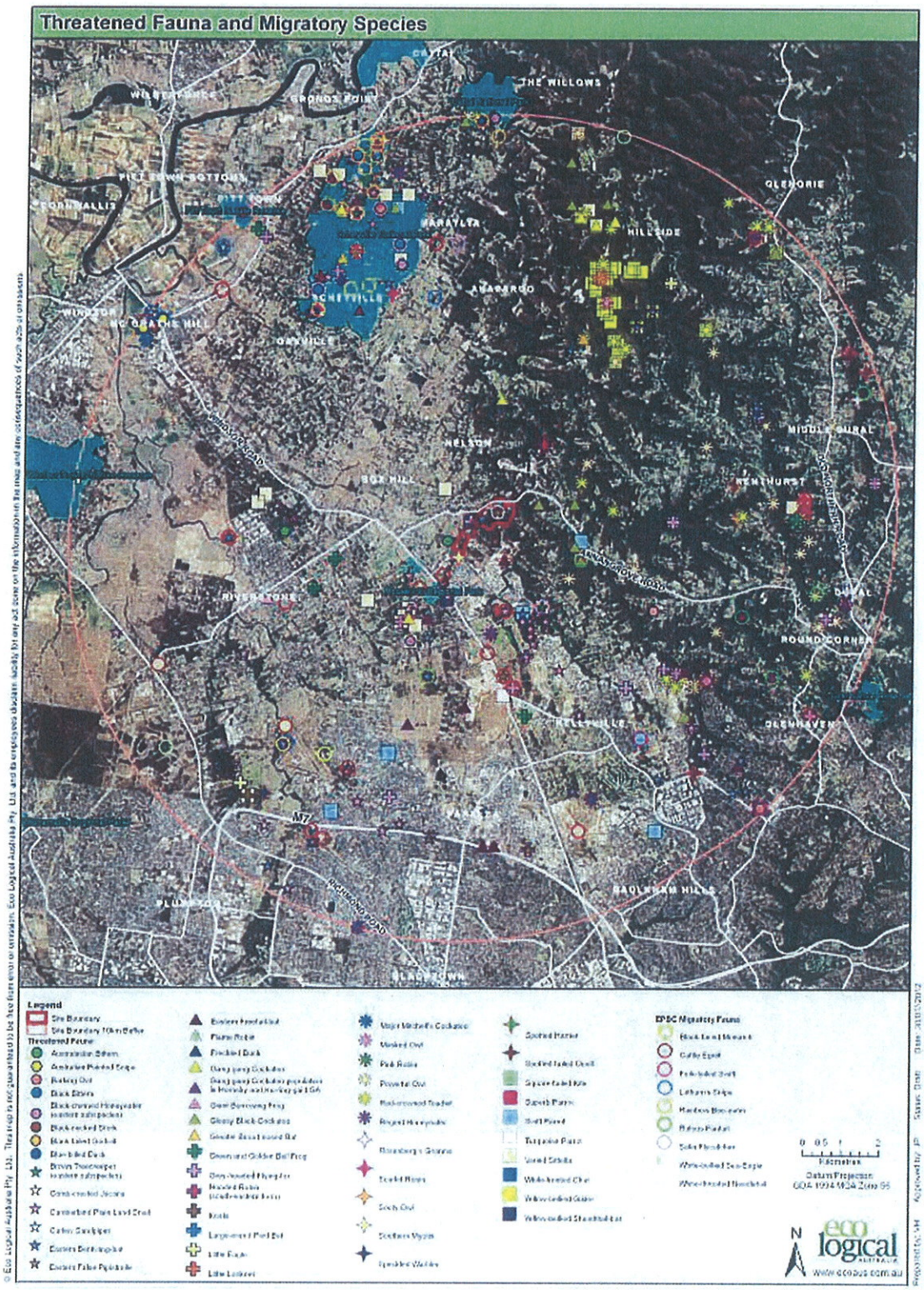

Figure 12: Threatened and migratory fauna records in the locality (10 km radius)

3.4 HABITAT ELEMENTS

There were a number of habitat elements present within the study area for flora and fauna species. Habitat elements in the study area included:

- Intact canopy layers within vegetation communities
- Intact and semi-intact shrub-layers within vegetation communities
- Stags supporting hollows
- Hollow-bearing trees
- Trees with flaking bark
- Leaf litter
- Woody debris (fallen logs and braches);
- Exposed sandstone outcrops, and
- Standing fresh water (within creeks).

The habitat elements available across the study area provided sheltering, foraging, and roosting habitat for a range of fauna groups. Intact canopy and mid-storey layers provided foraging habitat for birds, bats and arboreal mammals, with tree canopies providing sheltering habitat for birds. Hollow-bearing trees, stags and trees with flaking bark provided roosting and/or breeding habitat for birds, bats, and arboreal mammals. Leaf litter, woody debris and exposed sandstone outcrops provided foraging and sheltering habitat for ground dwelling mammals, reptiles and some frog species. Standing fresh water provided foraging and breeding habitat for frog species, foraging habitat for bat species, and foraging and sheltering habitat for water birds and fish.

With regards to threatened fauna species, canopy trees and shrubs may provide foraging habitat for woodland bird species, diurnal and nocturnal birds of prey, and bat species (see Section 3.3 for species with the potential to occur). Standing water may also provide foraging habitat for threatened microbat species. Fallen logs within CPW may provide habitat for Cumberland Land Snail.

3.5 THREATENED/MIGRATORY FLORA AND FAUNA HABITAT VALUE INPUT LAYER

The results of the species tallies per vegetation community (tallied from the assessment provided in **Appendix C**) multiplied by weightings to reflect their conservation significance and determine scores and final scores for the threatened/migratory flora and fauna habitat value input layer are shown in **Table 4**, **Table 5**, and **Table 6**.

Figure 13 shows the areas of high, moderate and low threatened/migratory flora and fauna habitat value.

Table 4: Results of score calculations for Shale Sandstone Transition Forest

LIKELIHOOD	STATUS	COUNTS OF SPECIES	MULTIPLIER	SCORE
Yes	EPBC (E)	0	4	0
	EPBC (V)	2	3	6
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	5	2	10
	ROTAP	0	1	0
Likely	EPBC (E)	0	4	0
	EPBC (V)	0	3	0
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	5	2	10
	ROTAP	0	1	0
Potential	EPBC (E)	3	4	12
	EPBC (V)	6	3	18
	EPBC (M)	5	1	5
	TSC (E)	7	3	21
	TSC (V)	19	2	38
	ROTAP	7	1	7
			FINAL SCORE	**127**

Table 5: Results of score calculations for Cumberland Plain Woodland

LIKELIHOOD	STATUS	COUNTS OF SPECIES	MULTIPLIER	SCORE
Yes	EPBC (E)	0	4	0
	EPBC (V)	1	3	3
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	4	2	8
	ROTAP	0	1	0
Likely	EPBC (E)	0	4	0
	EPBC (V)	0	3	0
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	5	2	10
	ROTAP	0	1	0
Potential	EPBC (E)	3	4	12
	EPBC (V)	2	3	6
	EPBC (M)	5	1	5
	TSC (E)	4	3	12
	TSC (V)	17	2	34
	ROTAP	4	1	4
			FINAL SCORE	**94**

Table 6: Results of score calculations for River Flat Eucalypt Forest

LIKELIHOOD	STATUS	COUNTS OF SPECIES	MULTIPLIER	SCORE
Yes	EPBC (E)	0	4	0
	EPBC (V)	1	3	3
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	4	2	8
	ROTAP	0	1	0
Likely	EPBC (E)	0	4	0
	EPBC (V)	0	3	0
	EPBC (M)	0	1	0
	TSC (E)	0	3	0
	TSC (V)	5	2	10
	ROTAP	0	1	0
Potential	EPBC (E)	2	4	8
	EPBC (V)	1	3	3
	EPBC (M)	7	1	7
	TSC (E)	3	3	9
	TSC (V)	10	2	20
	ROTAP	0	1	0
			FINAL SCORE	**68**

3.6 CORE VEGETATION AND HABITAT CONNECTIVITY INPUT LAYER

The result of the analysis for core vegetation and habitat connectivity is shown in **Figure 14**. They are based on the categories shown in **Table 2**.

Core Habitat and Support for Core areas shown in **Figure 14** include areas mapped by NPWS (2002c) as well as sandstone vegetation that was not mapped by NPWS (2002c) but was mapped as part of this report.

Within the study area Core Habitat includes areas of better quality vegetation, including endangered ecological communities. Areas of Support for Core provide connectivity between areas of Core habitat.

In a wider context, the Core Habitat and areas of Support for Core within the study area provide connectivity between areas of habitat that have been mapped in the local area. **Figure 15** shows the study area within this local context. It shows a composite of 3 mapping data sets. The mapping within the study area consists of the Core Habitat and Support for Core habitat mapped for this report. The remainder of the vegetation consist of the habitat mapping by NPWS (2002c) and the more broad-scale mapping of the Sydney Region by the Benson (1992).

In terms of connectivity with habitat outside of the study area, the Core Habitat in the north of the site forms part of a broad north/south corridor. The Core habitat and Support for Core areas within the study area also provide connectivity in an east-west direction.

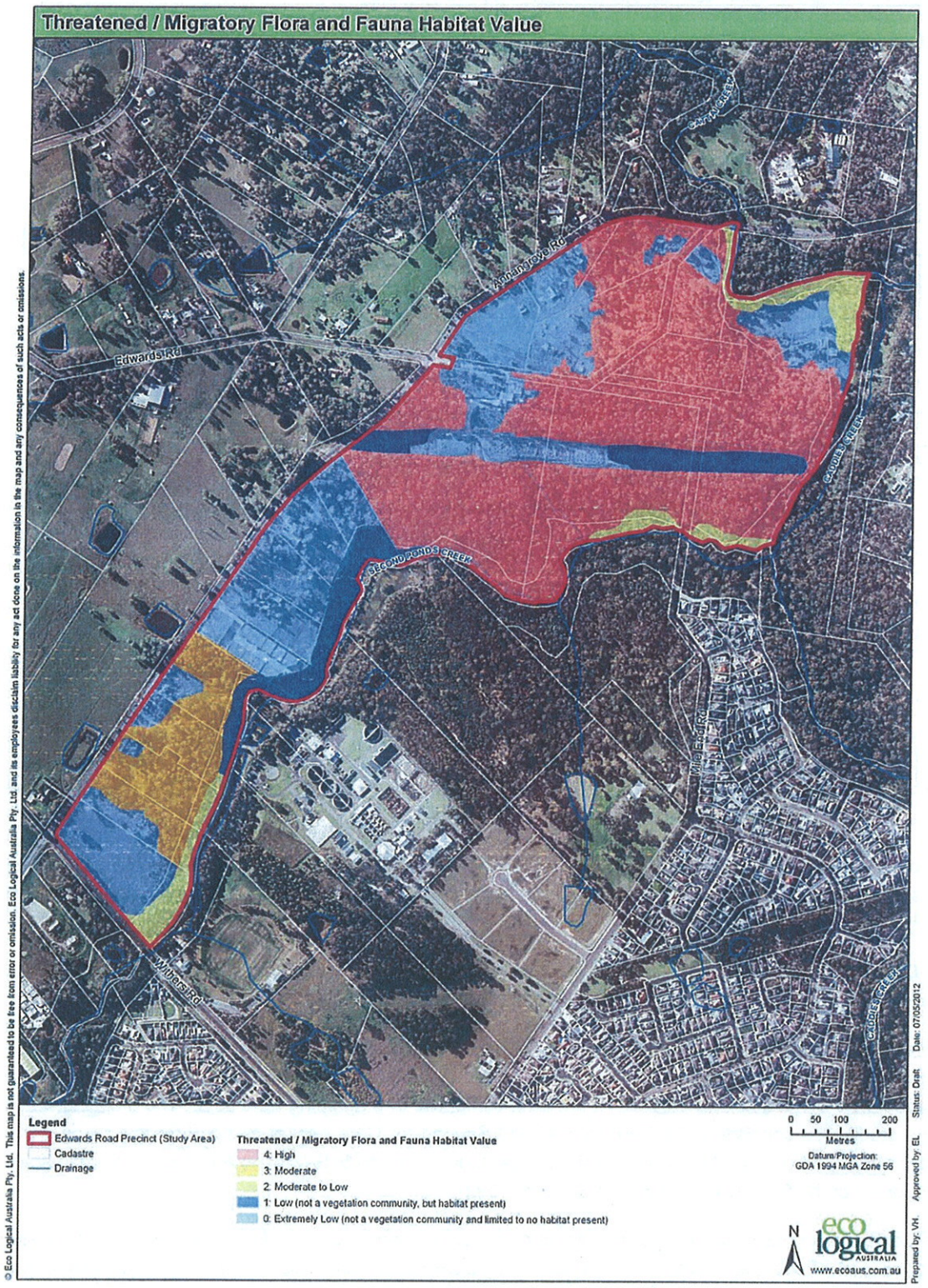

Figure 13: Areas of high, moderate and low threatened/migratory flora and fauna habitat value

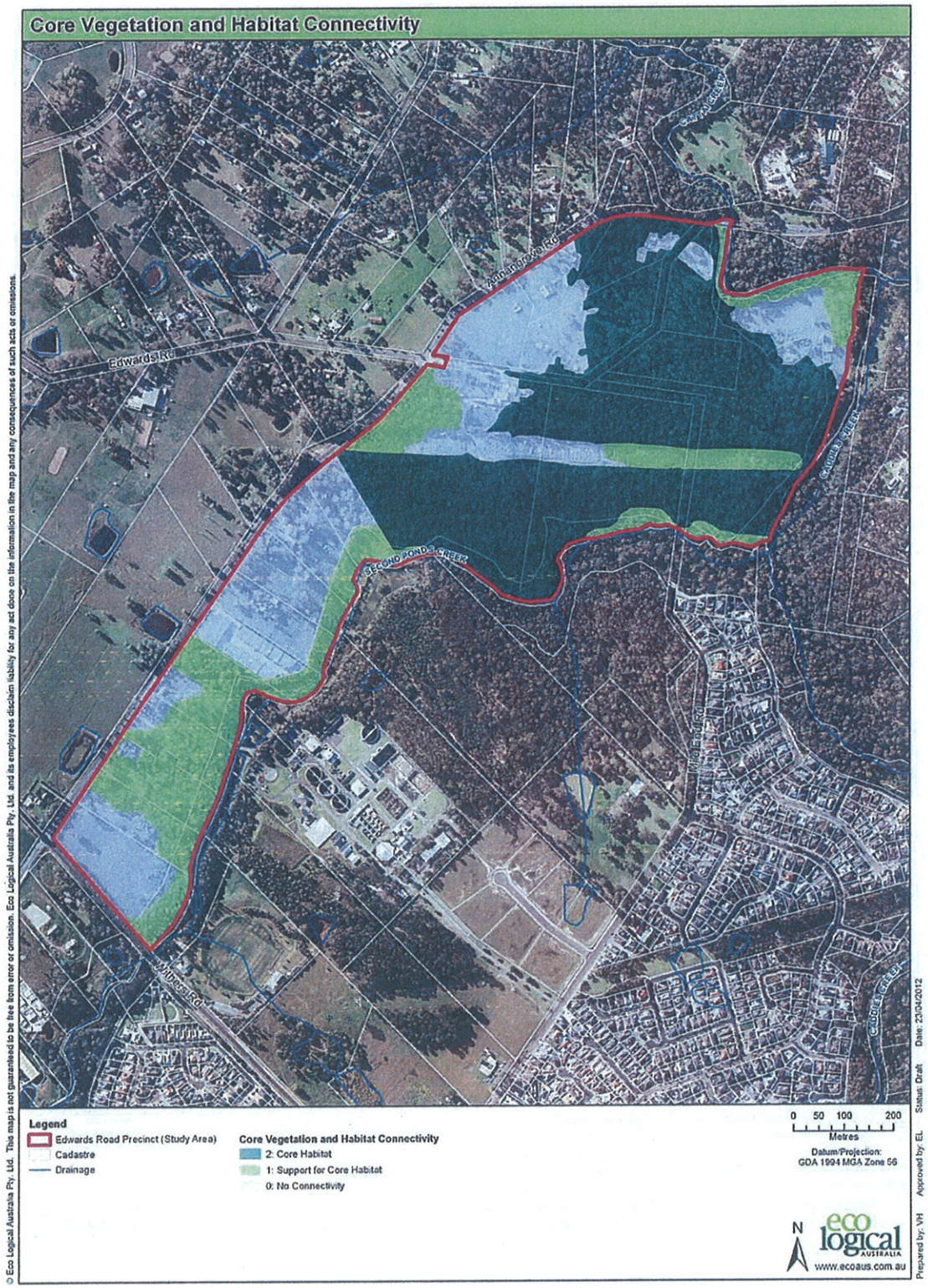

Figure 14: Core vegetation and habitat connectivity across the study area

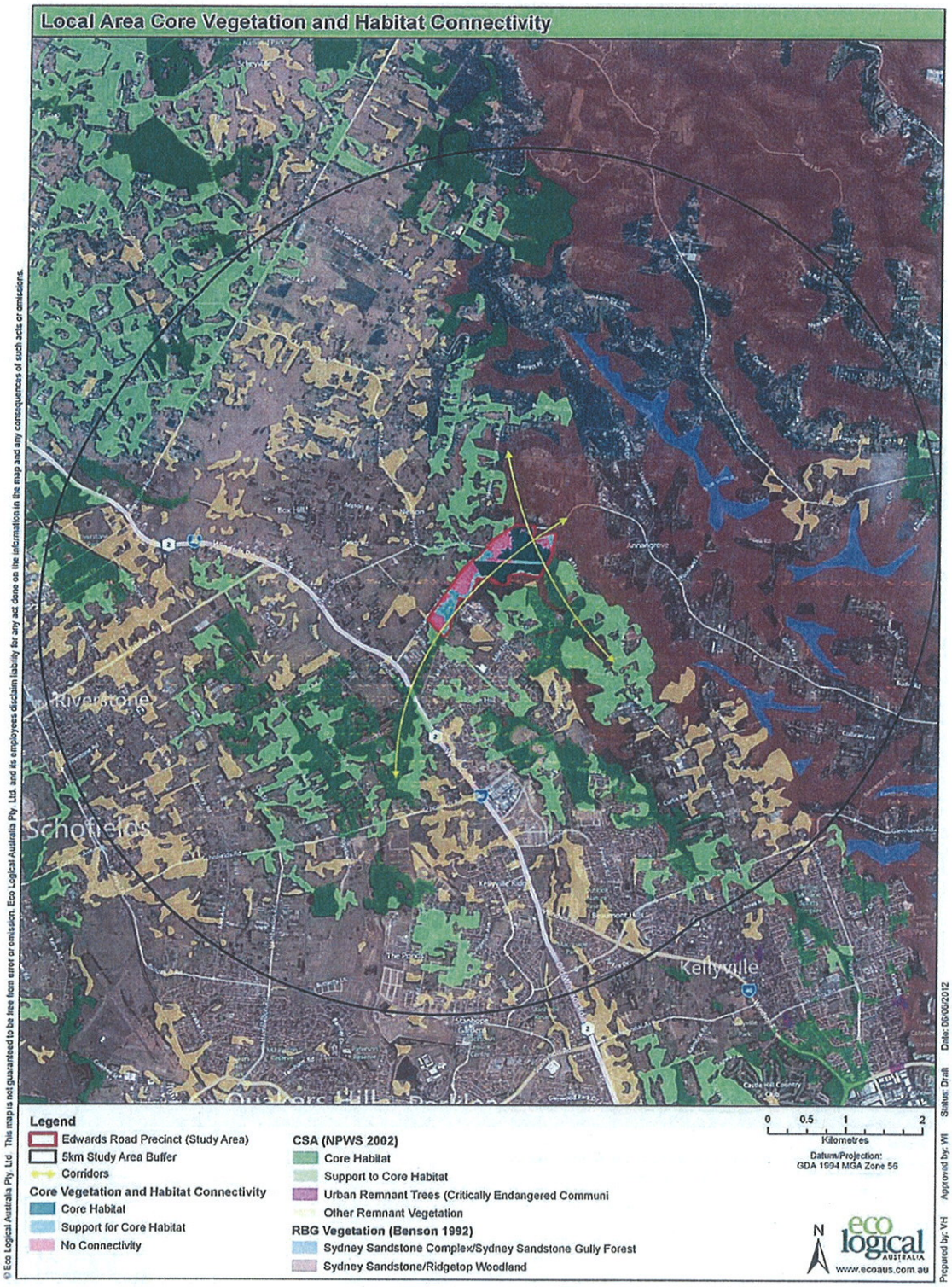

Figure 15: Core vegetation and habitat connectivity across the local area.

3.7 CONSTRAINTS ASSESSMENT

The result from the constraints assessment is shown in **Figure 16**. The constraints assessment found that the majority of vegetated areas were of high or moderate ecological value, with some vegetated areas of low ecological value. Therefore, the majority of vegetated areas were identified as having some level of constraint in terms of development.

Of the vegetation communities, SSTF and CPW were the only communities assessed as having high ecological value. In relation to SSTF, this was mostly due to the community being in good condition, but the community is also listed as an EEC at the Commonwealth level, was classified as core vegetation, and had the highest threatened/migratory flora and fauna habitat value of all the communities in the study area. Both RFEF and CPW had experienced greater degrees of weed degradation and structural disturbances compared to SSTF; the only areas where CPW was assessed as having high ecological value were where weed degradation was low and/or where the community was structurally intact. Also, RFEF is not listed at the Commonwealth level, and CPW in the study area did not meet the listing criteria for the community under the EPBC Act. Both RFEF and CPW classified as Support for Core rather than Core vegetation. Areas where SSTF were assessed as having moderate ecological value were generally those which supported a high density of weeds or had experienced structural or other disturbances.

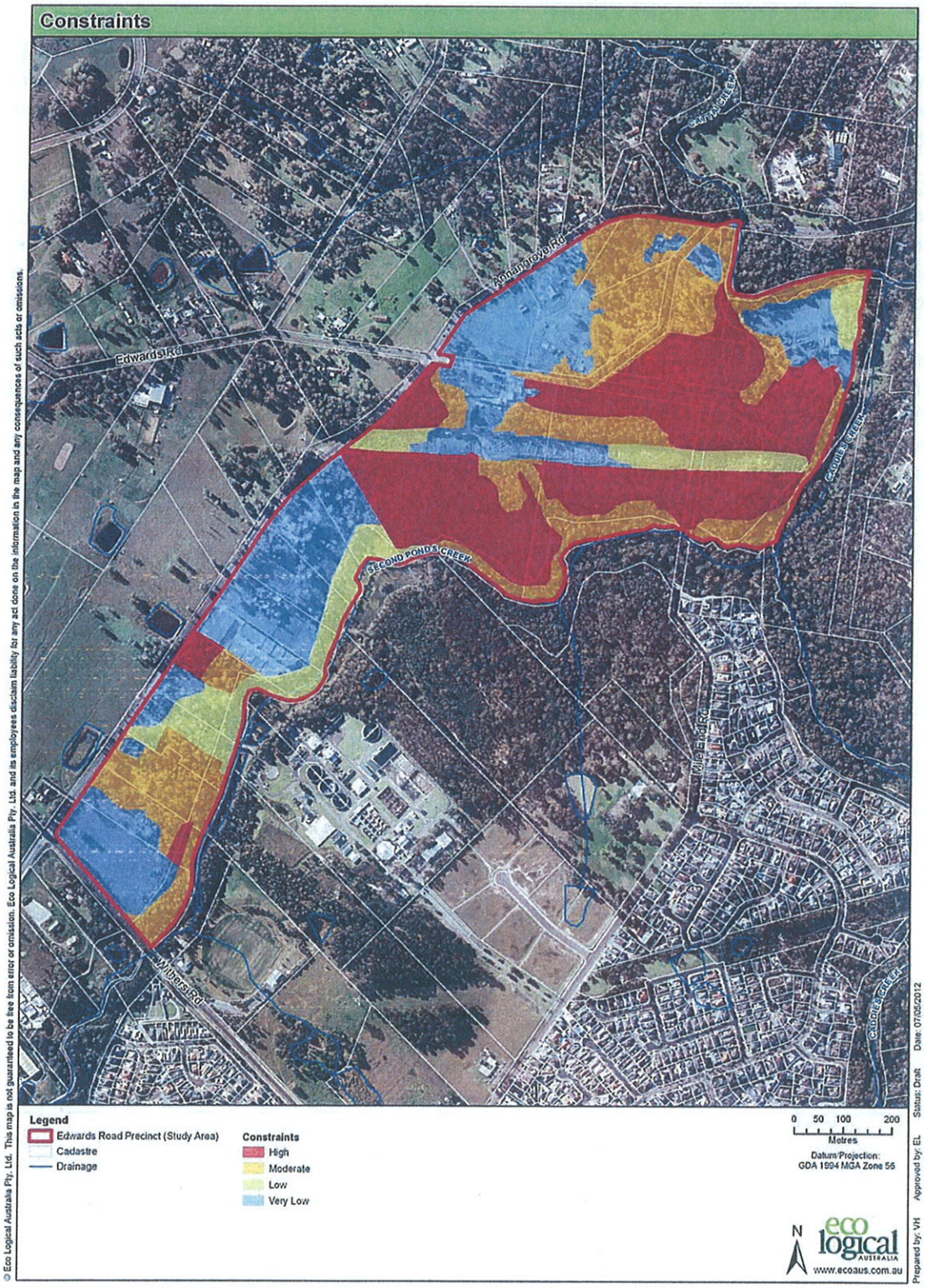

Figure 16: Results from the constraints analysis

4 Conservation and Management Recommendations

Given that vegetated areas in the study area were generally those areas with the highest ecological value, vegetated areas within the study area had the highest level of constraint in terms of development for industrial use and/or subdivision, although existing disturbances to vegetated areas influenced the degree of ecological value/developmental constraint. Conversely, areas that have already been cleared or developed and lacked intact native vegetation (as represented by intact canopy, mid-storey and under-storey layers) were generally those areas with the lowest ecological value, representing the lowest areas of constraint to development.

Despite the generalities that can be applied to the study area in terms of ecological value/developmental constraint, Council seeks specific conservation and management recommendations to inform precinct planning at the Lot level, addressing:

- Areas suitable for development with no further ecological constraints
- Areas of biodiversity value that should be considered for retention
- Measures to protect biodiversity values
- Priority areas that could be considered for restoration, regeneration or revegetation
- Any proposed mechanisms for implementation of these recommendations, and
- Measures to control ecological impacts identified on the site.

Information at the lot level identifying areas suitable for development, areas of biodiversity value, and priority areas for restoration, regeneration or revegetation is provided in **Table 7**. Areas suitable for development, areas of biodiversity value, and priority areas for restoration, regeneration or revegetation are illustrated in **Figure 17**, **Figure 18**, and **Figure 19**, respectively.

Table 7: Areas suitable for development, areas of biodiversity level, and priority areas for restoration, regeneration or revegetation

STREET ADDRESS	LOT	DP	SUITABLE FOR DEVELOPMENT	AREA OF BIODIVERSITY VALUE (CONSIDER RETENTION)	PRIORITY AREA (CONSIDER FOR RESTORATION, REGENERATION, REVEGETATION)
278 Annangrove Road	2	879450	Potentially ^	Yes, but area is degraded	Yes, if area not developed
282 Annangrove Road	2	1032790	No	Yes	Yes
284 Annangrove Road	10	563695	Potentially ^	Yes, but area is degraded	Yes, if area not developed
286 Annangrove Road	2	838278	Potentially ^	Yes, but area is degraded	Yes, if area not developed
288 Annangrove Road	3	222080	Yes	No	No
20 Edwards Road	2	222080	Potentially ^	Yes, but area is degraded	Yes, if area not developed
31 Edwards Road	2	225401	No	Yes	Not currently high priority #
290-312 Annangrove Road	26	834050	Parts	Yes	Yes
290-312 Annangrove Road	12	835727	Parts	Yes	Yes

STREET ADDRESS	LOT	DP	SUITABLE FOR DEVELOPMENT	AREA OF BIODIVERSITY VALUE (CONSIDER RETENTION)	PRIORITY AREA (CONSIDER FOR RESTORATION, REGENERATION, REVEGETATION)
314 Annangrove Road *	27	834050	Yes	No	No
316 Annangrove Road *	28	834050	Yes	No	No
318 Annangrove Road	29	834050	Yes	No	No
320 Annangrove Road	30	834050	Yes	No	No
322 Annangrove Road		78246	Yes	No	No
324 Annangrove Road	32	834050	Potentially ^	Yes, but area is degraded	Yes, if area not developed
326 Annangrove Road	33	834050	Potentially ^	Yes, but area is degraded	Yes, if area not developed
328 Annangrove Road	34	834050	Potentially ^	Yes, but area is degraded	Yes, if area not developed
330 Annangrove Road	12	833069	Potentially ^	Yes, but area is degraded	Yes, if area not developed
332-334 Annangrove Road	13	833069	Yes	No	No
NA (part of drainage corridor)	1	1032790	Parts	Parts	Yes
NA	1	133473	No	Yes	Not currently high priority #
NA (part of drainage corridor)	1	835727	No	Yes	Yes
NA (part of drainage corridor)	1	879450	No	Yes	Yes
NA (part of drainage corridor)	14	833069	No	Yes	Not currently high priority #
NA (part of drainage corridor)	15	833069	No	Yes	Not currently high priority #
NA (part of drainage corridor)	17	834050	No	Yes	Not currently high priority #
NA (part of drainage corridor)	18	834050	No	Yes	Yes
NA (part of drainage corridor)	19	834050	No	Yes	Yes
NA (part of drainage corridor)	20	834050	No	Yes	Yes
NA (part of drainage corridor)	21	834050	No	Yes	Yes
NA (part of drainage corridor)	22	834050	No	Yes	Yes
NA (part of drainage corridor)	23	834050	No	Yes	Yes
NA (part of drainage corridor)	24	834050	No	Yes	Yes
NA (part of drainage corridor)	25	834050	No	Yes	Yes

* vegetation on these lots was observed during the site inspection as cleared, despite available aerial imagery
^ if offsets are committed to and meet the improve or maintain test
# weed density is currently low, but needs to be maintained to this low level

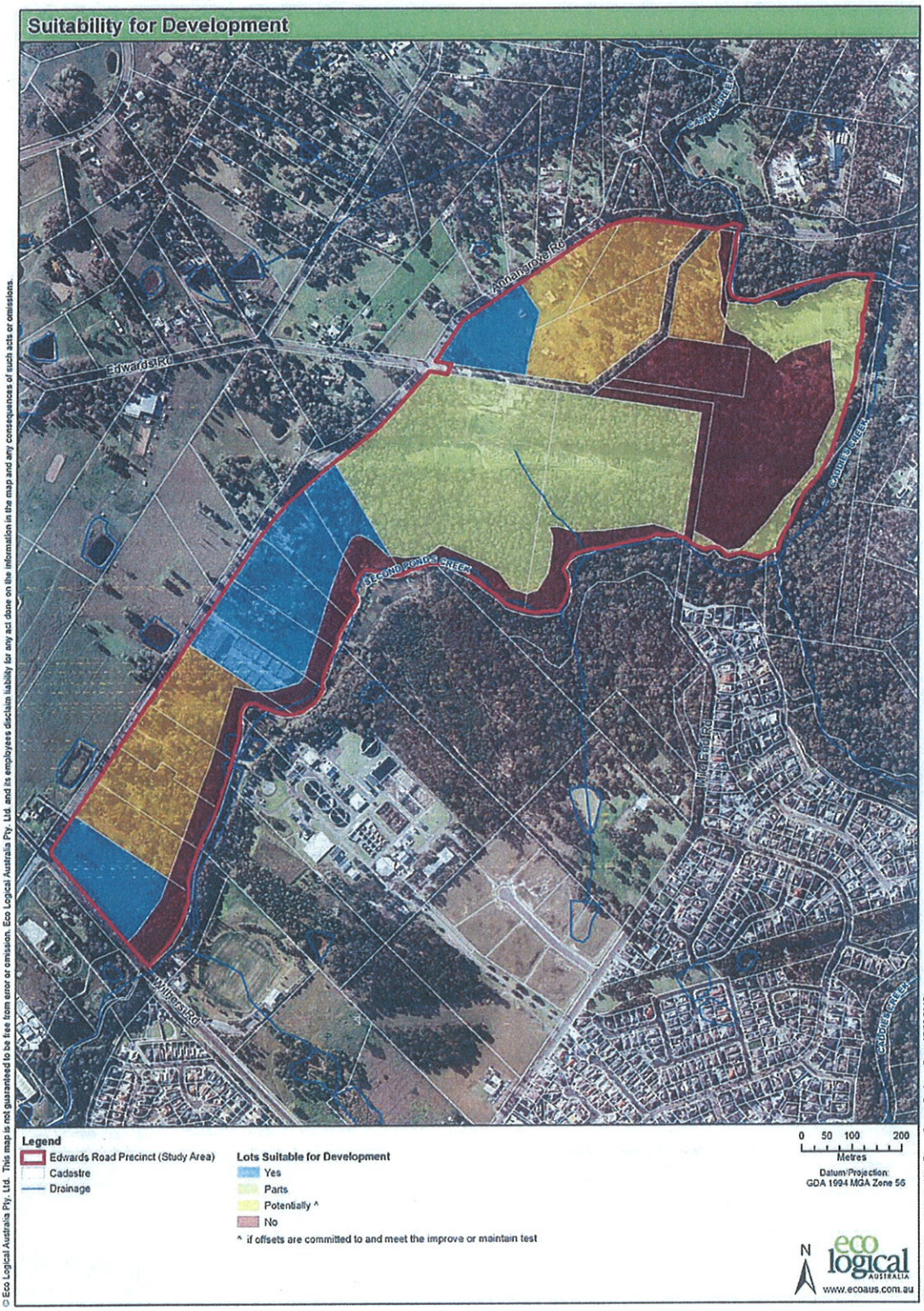

Figure 17: Areas suitable for development

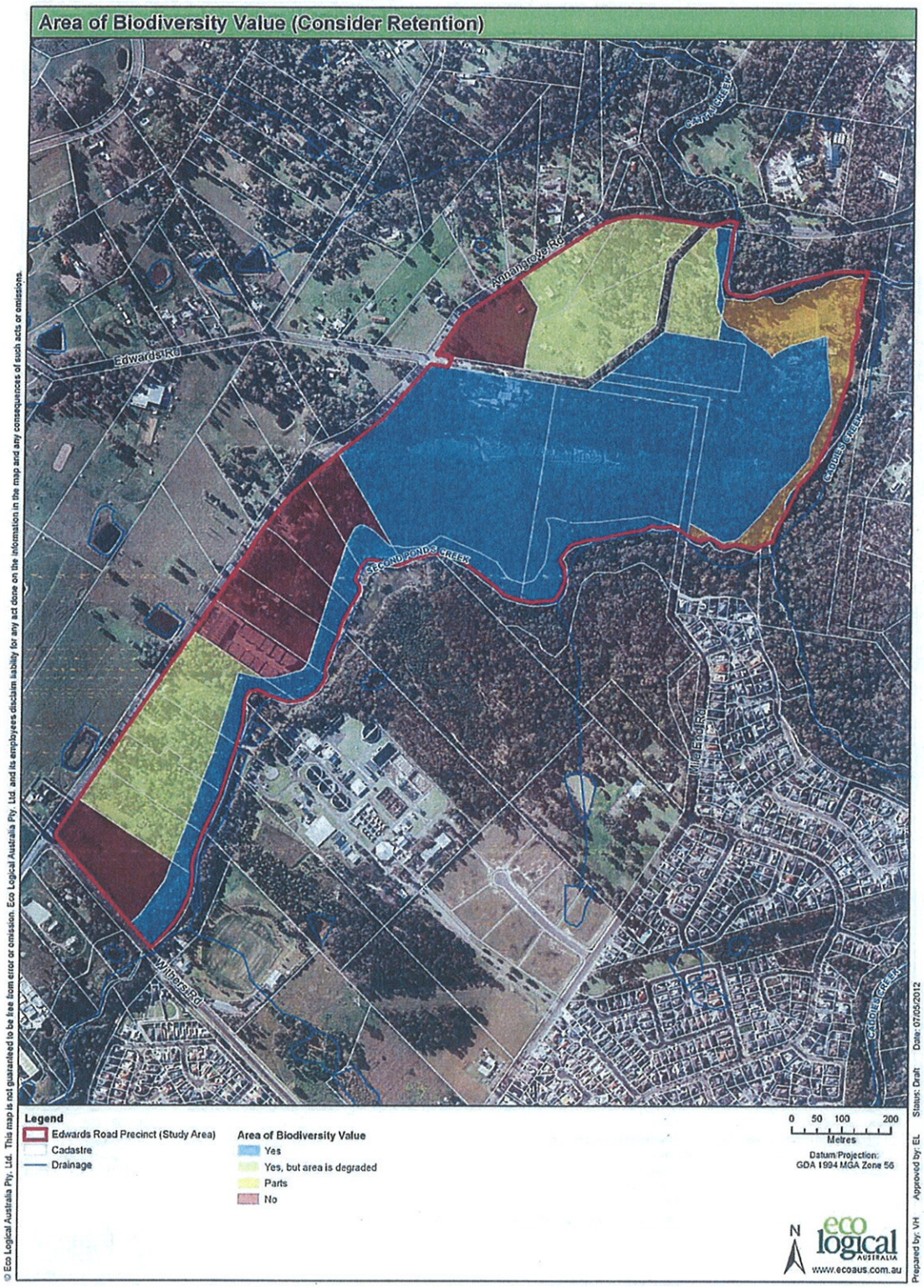

Figure 18: Areas of biodiversity value to be considered for retention

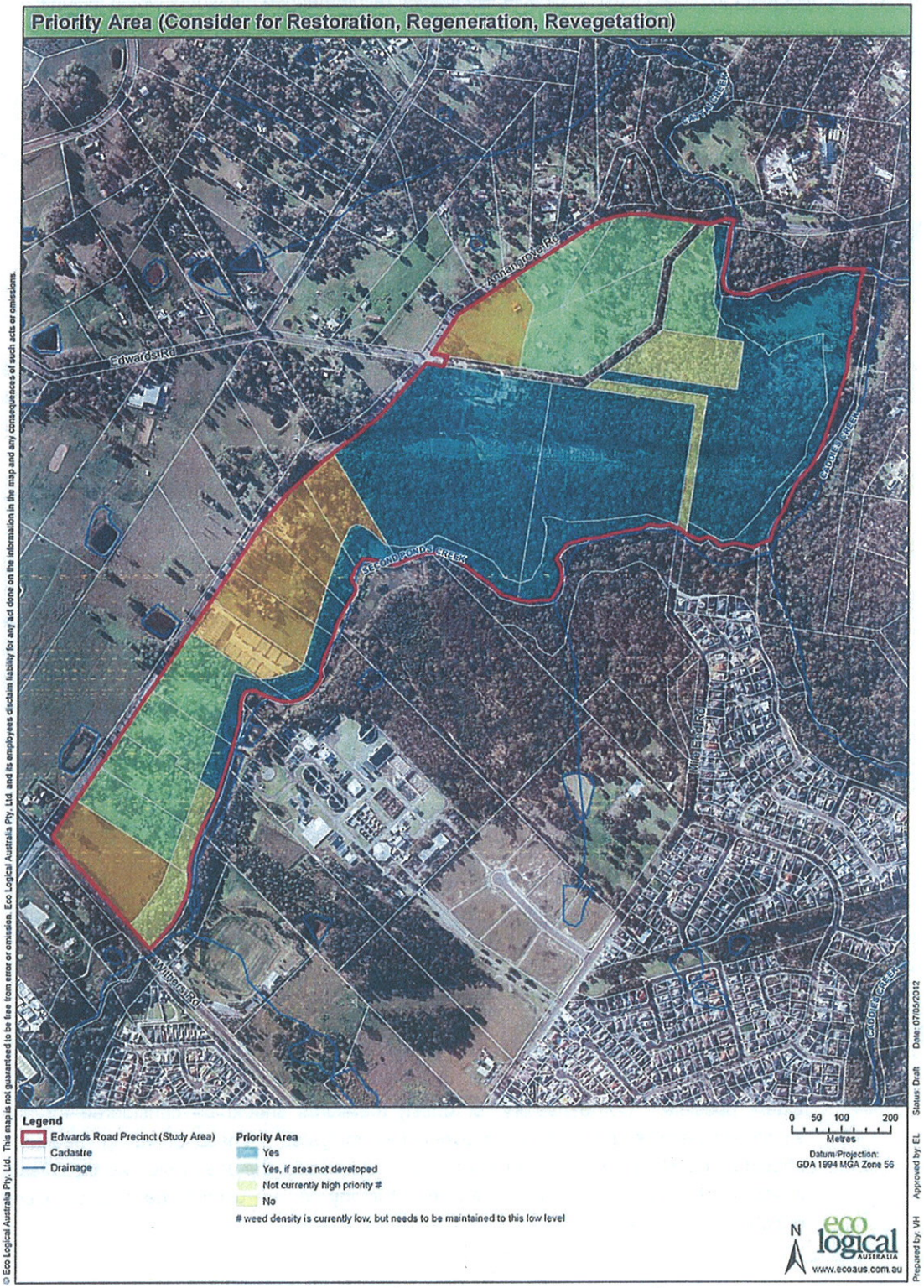

Figure 19: Priority areas for restoration, regeneration or revegetation

In terms of measures to protect existing biodiversity values, recommended measures would include:

Avoidance measures

- Avoid any additional clearing of native vegetation (see **Figure 8** for areas of native vegetation), and
- Limit the impacts of any additional disturbances to the study area and the extent of existing disturbances e.g. paintball activities.

Ameliorative measures

- Manage any pre- and post-development activities through a Conservation Area Management Plan (CAMP) that aims to ensure that the ecological values of the study area are maintained through:
  - Weed control: the density of weeds should be reduced and weeds should be controlled to prevent the spread of weeds within and between native vegetation communities (see **Figure 9** for the levels of weed invasion in vegetation communities)
  - Controls on access and allowable activities: the collection of fire wood and bush rock should be prohibited, and rubbish dumping prevented
  - An adaptive management approach that will respond to any post-development ecological changes. The adaptive management approach places an emphasis on encouraging natural resilience and integrating natural processes to retain the ecological values of the site. In this manner, actions to maintain the condition and integrity of the ecological values of the study area, such as weed control, minimising vegetation disturbance and reducing stormwater and sediment run off, are priorities for on-ground works;
  - The establishment of a framework for ongoing site management
  - Recommendations for ongoing monitoring such that required changes to the management approach can be identified
  - The establishment of areas that will amongst other matters cover:
    - Erosion and sediment management pre- during and post-construction;
    - Construction fencing pre- and during construction to ensure that construction related impacts are contained within the construction areas

Compensatory strategies

- Any development should avoid, minimise and ameliorate any impacts to the maximum extent possible. Compensatory (or offset) measures should be considered for any significant impacts that cannot be avoided or mitigated. These offsetting measures should be developed in accordance with the "Principles for the use of Biodiversity Offsets in NSW"; the Biobanking Assessment methodology can be used to develop proposed offsetting measures.

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Appendix A: Likelihood of Occurrence Table

Searches of the Atlas of NSW Wildlife and EPBC Protected Matters search tool were performed for the study area in January 2012, buffered for 10 km around -33.6584 150.9153, -33.6584 150.9334, -33.6717 150.9334, -33.6717 150.9153, and-33.6584 150.9153. Marine species (including whales, seabirds, turtles and seals) have been removed from the list as these species were not considered relevant to the current proposal.

The likelihood of occurrence was considered for all listed species, and is provided for each species under the 'likely' column. The terms for likelihood of occurrence are defined below:

Y	yes: the species was observed on the site during previous or current surveys or has been previously observed (NSW Atlas data)
L	likely: a medium to high probability that a species uses the site
P	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
U	unlikely: a very low to low probability that a species uses the site
N	no: habitat on site and in the vicinity is unsuitable for the species.

Those species considered as potentially, likely or known to occur (likelihood of potential, likely or yes) are considered subject species for this project and are highlighted in blue.

TSC Status	Listing under the NSW Threatened Species Conservation Act 1995
EPBC Status	Listing under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999
CE	Critically Endangered
E	Endangered
E2	Endangered Population
V	Vulnerable
M	Migratory