



Ingleside Precinct – Draft Biodiversity Assessment Report

Prepared for
Department of Planning and Environment

October 2016



DOCUMENT TRACKING

Item	Detail
Project Name	Ingleside Draft Biodiversity Assessment Report
Project Number	13SYDPLA-0039
Project Manager	Steven Ward
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Reviewed by	Steven Ward, Mark Adams
Approved by	Mark Adams
Status	Final
Version Number	8
Last saved on	28 October 2016
Cover photo	Top Coastal Upland Damp Heath Swamp (EEC). Bottom left to right: <i>Xanthorrhoea arborea</i> , <i>Grevillea caleyi</i> (threatened flora species), <i>Scaevola ramosissima</i> and Needlebush - banksia wet heath community.

This report should be cited as 'Eco Logical Australia 2016. *Ingleside Biodiversity Certification: Draft Biodiversity Assessment Report*. Prepared for Department of Planning and Environment.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Department of Planning & Environment and Pittwater Council.

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3 Results

3.1 Literature review

The BCAA has been subject to a number of ecological assessments, including validation of vegetation and targeted surveys for threatened species. ELA conducted a review of available resources and database searches prior to field validations. Literature reviewed was either provided by Council, publicly available, or accessed from other sources. The results have been summarised in the table below.

Table 3: Summary of literature reviewed for the project (sorted by date)

Author	Literature Title	Date	General findings
Smith and Smith	Survey of the Duffys Forest Vegetation Community	2000	Smith and Smith were contracted to undertake detailed investigation of the floristic and abiotic characteristics of Duffys Forest and compare with similar adjoining vegetation types. A quantitative analysis tool on the identification of Duffys Forest was the outcome of this report. This methodology was used during field validations.
DEC	<i>Grevillea caleyi</i> Recovery Plan	2004	<i>Grevillea caleyi</i> occurs in a narrow distribution within the Pittwater and Warringah LGA (including Ingleside). And it is estimated that 85% of its habitat has been removed. Vegetation clearance, inappropriate fire, weed invasion and <i>Phytophthora cinnamomi</i> are major threats to this species. Other threats include urban runoff, predation of seeds, and rubbish.
DEC	Southern Brown Bandicoot Recovery Plan	2006	There are two known locations for <i>Isoodon obesulus</i> (Ku-ring-gai Chase National Park and Garigal National Park) within the BCAA. Management for this species includes appropriate fire regimes, predator controls (both domestic and introduced), reducing road mortality, and conserving habitat.
ELA	Ingleside Land Release – biodiversity	2008a	Initial biodiversity assessment of the Ingleside Land Release Area (note that the assessment boundary differs from the 2013 BCAA and the 2008 study did not have access to private lands). This report identified one EEC (Duffys Forest) and potential habitat for threatened species.
ELA	Revised corridors and Sandstone Rocky Heath DECC advice	2008b	Sandstone Rocky Heath vegetation community was identified by ELA as a regionally significant vegetation community as it provides habitat for threatened species, although it is well represented in the adjacent National Parks. Wildlife corridors were revised to include linkages with conservation areas.

Author	Literature Title	Date	General findings
Schnell, M	Feeder Creek Fishes of Narrabeen Lagoon	2009	This report details aquatic surveys within Narrabeen Lagoon catchment area and includes the lower section of Mullet Creek. Mullet Creek was identified as a large catchment with sedimentation issues. Any proposed development within the catchment may result in further water quality and stream health impacts.
ELA	Ingleside Land Release Area – integrated corridor layout	2010a	Update of potential wildlife corridors and protection of significant vegetation and habitats within the Ingleside Land Release Area (refer to section 4.1)
ELA	Ingleside Chase Reserve – Plan of Management (PoM)	2010b	Ingleside Chase Reserve borders the north-eastern boundary of the BCAA. It provides suitable habitat for threatened flora and fauna species. Development within the BCAA adjoining this Reserve should consider the priority actions and management recommendations for the Reserve.
DECCW	National Recovery Plan for Angus's Onion Orchid <i>Microtis angusii</i>	2010	<i>Microtis angusii</i> recovery plan Identifies the conservation requirements to protect this threatened species. The only known location for this species is at Ingleside.
Pittwater Council	Vegetation mapping and Corridor GIS layers	2011	Broad scale vegetation and corridor mapping provided by Pittwater Council in GIS format. No supporting report provided with the dataset. Mapping of potential corridors included intact and fragmented vegetation within private and public lands. Corridors linked internal fragmented habitats with conservation areas outside the BCAA.
ELA	Review of Provisionally listed EEC	2011	ELA conducted a technical report identifying the potential presence of Hanging Swamp (Coastal Upland Swamp) within the BCAA. The report was amended after the ELA 2008a survey following the nomination of this vegetation community as an EEC.
OEH	Updated CMA vegetation mapping	2013a	The extent of the Sydney Metropolitan CMA mapping was extended to the north to cover part of the Hawkesbury Nepean CMA. This vegetation map dataset covers the entire Ingleside Precinct, and provides a fine-scale (~1:4,000) composite vegetation map for the entire area. Part 2 of the technical report provides detailed community profiles for each vegetation type. The work also provides details on relationships to current and proposed Biometric vegetation types.

Author	Literature Title	Date	General findings
Law. B	A survey for Eastern Pygmy Possum (EPP) <i>Cercartetus nanus</i> on the Ingleside Escarpment, Pittwater	2013	Eastern Pygmy Possum were surveyed at five locations using nest boxes within or adjacent to the BCAA. The survey identified EPP at four of the sites. The highest level of activity was around the Powderworks Quarry. This site also had the only documented evidence of breeding activity.
Law. B	A Survey of Eastern Pygmy Possums <i>Cercartetus nanus</i> in Selected Reserves of Pittwater	2014	A systematic survey to identify presence of EPP in five major reserves within Pittwater, including Irrawong Reserve and sites along the Barrenjoey Peninsula. The results found no detection of EEP along the Barrenjoey Peninsula, despite presence of moderate quality habitat and appropriate food resources. A key finding of the report is the importance of remaining habitat on the Ingleside escarpment; these areas should be given a high priority for protection and restoration.
Ecosure and Niche 2015, SMEC 2015	GIS layers with threatened species records provided by Roads and Maritime Services	2015	Additional <i>Microtis angusii</i> records and draft reports provided by Roads and Maritime Services (Ecosure and Niche 2015). These records are along Mona Vale Road to the east of the previously known population. GIS records also provided for Eastern Pygmy Possum captures from trapping studies being conducted as part of the Mona Vale Road upgrade investigations (SMEC 2015).
Bangalay and East Coast Flora Survey	Pittwater Native Vegetation Management Plan	2012	This plan is an operational bushland management plan consistent with NSW legislation and Council's strategic planning policies. The plan comprises the following components: Management Plan, Native Vegetation Classification, pre 1750 Vegetation Mapping and Profiles and Vegetation Profiles. Detailed guidance is provided to address bushland management objectives such as restoration, monitoring and bushfire. An operational works schedule 2012-2017 is provided that addresses management actions.
Pittwater Council	Native Fauna Management Plan Pittwater LGA	2011	A plan developed for Council to meet the objectives of the Biodiversity Strategy under the Pittwater Strategic Plan 2020. The document provides an inventory of threatened and locally significant native fauna species found in the LGA, analyses threats to biodiversity and provides recommendations and management actions for maintaining and improving native fauna habitat. The report also provides recommendations for management of key sites, including the Ingleside land release area.

Author	Literature Title	Date	General findings
G. Bensen	Resource Selection Patterns in Microbats as a Response to Noise Pollution and Urban Development – Honours Thesis	2012	An <i>in situ</i> study undertaken at sites in Manly, Warringah and Pittwater on the effects of anthropogenic noise on resource selection in bats. The study found with the species selected, the presence of urban noise within the peri-urban landscapes did not strongly affect resource selection. The report also discussed implications for some species not deterred by urban noise e.g. physical hazards associated foraging adjacent to busy roads, disruption to sleep patterns etc.
Coastwide Marine Environmental Management and Ecological Services	Mullet Creek Restoration Project Reptile and Amphibian Surveys	2013	This study provided baseline data for diversity and abundance of herptofauna in upper Mullet Creek catchment. This survey design can be replicated and therefore used to compare diversity and abundance before, during and after the Mullet Creek Restoration Project has been implemented. The baseline results indicated diversity and abundance is low, potentially due to insufficient survey time and the small size and poor condition of habitat. However, the threatened Giant Burrowing Frog was detected at one site.
Ingleside Residents Landcare Group	Bird Survey Upper Mullet Creek Valley 2008-2010	2011	A summary of a two year bird survey undertaken in the upper Mullet Creek catchment using the 'Standardised Search Method' (Watson 2003). The survey collected data on bird species richness, presence of habitat and the role of the catchment in species survival. The results concluded that despite clearing and modification to natural areas, the catchment is important habitat for a range of different species, in particular remnant specialists known to be in decline.

3.2 Vegetation communities

The SMCMA (OEH 2013) vegetation mapping data layer, containing linework that was updated via GIS analysis and through ELA's use of recent aerial imagery, was utilised as a base map for the ecological field surveys. Within the BCAA, SMCMA (OEH 2013) mapped approximately 398 ha of vegetation comprising of 11 vegetation communities, and a mixture of weeds/exotics, urban native, plantation and other categories.

Although the SMCMA vegetation community mapping was relatively accurate, being a broad-scale map dataset there were areas of inaccuracies relating to an incorrect vegetation community classification or mapped extent. After field surveys were undertaken, the digital vegetation dataset derived from the desktop mapping exercise was updated, and classifications of vegetation communities amended where they were found to differ during validation. The boundaries of some vegetation community polygons were also realigned during these updates at a scale of 1:4,000. Approximately 19 ha or 4% of the ELA desktop refinement of SMCMA (OEH 2013) mapped vegetation was amended as a part of the ELA desktop

interpretation and field validation. Further refinement of vegetation mapping occurred as a result of further validation for Coastal Upland Swamp EEC (see **section 3.2.4** for details).

It is noted that the Ingleside Precinct boundary, the outer edge for the BCAA, was amended slightly during the course of the study. However, for the purposes of the biodiversity assessment report, the original boundary was retained. This does not affect impact calculations, because the outcomes in terms of development, conservation, or retained are applied based on the proposed future uses (**section 5**).

3.2.1 SMCMA (2013) Vegetation Communities

A detailed description of the 11 SMCMA vegetation communities is provided in **Section 3.2.3**. The field validation confirmed 10 SMCMA (OEH 2013) vegetation community types, as well as exotic vegetation, being present within the BCAA. The presence of an additional vegetation community identified in SMCMA (OEH 2013) mapping, Coastal Warm Temperate Rainforest, was not validated in the field because it was mapped on private land that could not be accessed.

Three vegetation communities validated in the BCAA conform to two EECs under the TSC Act (**Table 4**). Coastal Upland Swamps, which corresponds to two vegetation types within the BCAA, also conforms to the Endangered Ecological Community listing under the EPBC Act.

Table 4: Endangered Ecological Communities in the BCAA

SMCMA Vegetation Community	TSC Act Endangered Ecological Community	EPBC Act
Coastal Upland Wet Heath Swamp	<i>Coastal Upland Swamps in the Sydney Basin Bioregion</i>	<i>Coastal Upland Swamps in the Sydney Basin Bioregion</i>
Coastal Upland Damp Heath Swamp		
Sydney Ironstone Bloodwood-Silvertop Ash Forest	<i>Duffys Forest ecological community in the Sydney Basin Bioregion</i>	N/A

Duffys Forest Ecological Community

The most extensive of the inaccurate SMCMA (OEH 2013) vegetation classifications were areas classified as Sydney Ironstone Bloodwood-Silvertop Ash Forest (which corresponds to the endangered Duffys Forest Ecological Community, DFEC) mapped along the northern road verge of Mona Vale Road. A detailed floristic analysis and mapping of the Duffys Forest vegetation community has previously been undertaken for the NSW National Parks and Wildlife Service and Warringah Council (Smith and Smith 2000). The final determination for the endangered Duffys Forest Ecological Community (DFEC) was amended (OEH 2002) partly in response to the additional information provided by Smith and Smith (2000).

ELA reviewed the SMCMA (OEH 2013) mapping of DFEC against the “Duffys Forest index” for diagnostic species developed by Smith and Smith (2000) at a number of field sites to determine the presence of DFEC. The results of the field validation and application of the Duffys Forest index (provided in **Appendix B**) indicate that the distribution of DFEC within the BCAA is confined to the central southern section in the vicinity of the Baha’i Temple on Mona Vale Road; a significantly reduced distribution when compared to the SMCMA (OEH 2013) mapping. It is noted that the ELA mapping of DFEC for this assessment is more extensive than Smith and Smith (2000) as it extends further westwards and incorporates smaller patches mapped as being in weedy condition. BCAM requires all areas of remnant canopy vegetation to be identified as a vegetation type and assessed for site value regardless of vegetation condition. Therefore, it is likely that ELA have mapped fragmented canopy remnants as Duffys Forest vegetation which were

not mapped by Smith and Smith (2000). Furthermore these areas occur on private lands, where access was not available, and which have therefore not been validated in the field. As a consequence, a precautionary approach has been taken in the ELA vegetation mapping.

3.2.2 Biometric vegetation types

In accordance with BCAM, the SMCMA (OEH 2013) vegetation communities were matched with the equivalent biometric vegetation type. The report accompanying the SMCMA (OEH 2013) mapping vegetation had already identified a corresponding biometric vegetation type in the vegetation community descriptions. When the descriptions of the biometric vegetation types were checked against the field validation findings, it was determined that the SMCMA (OEH 2013) corresponding biometric vegetation types were the best fit; these are identified in **Table 5**.

The BCAA is located within both the Hawkesbury Nepean Catchment Management Area (HNCMA) and Sydney Metropolitan Catchment Management Area (SMCMA). However, until recently the boundary between the SMCMA and the HNCMA, and corresponding CMA sub-regions (Pittwater A and Pittwater B) bisected the BCAA. OEH instructed that HNCMA vegetation types should be utilised for the purposes for credit calculations where possible. For two vegetation communities, the relevant HNCMA communities cannot be selected in the current version of the Biodiversity Certification Calculator. Therefore, relevant SMCMA vegetation types have been identified and will be used for subsequent credit calculations.

One of the mapped SMCMA (OEH 2013) vegetation communities, HN648/ME58/1841, is not available for selection in the Biodiversity certification calculator as either HNCMA or SMCMA vegetation types. For this reason, after consultation with OEH HN606 will be utilised for subsequent credit calculations, using benchmarks for PCT 1841.

Table 5: Biometric vegetation type conversions

Vegetation SMCMA (OEH 2013)	Biometric Code	PCT Code	Biometric Vegetation Name	EEC (if relevant) and % Cleared in HNCMA
Coastal Enriched Sandstone Dry Forest	HN586	1181	Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest in sandstone gullies of western Sydney, Sydney Basin	Not an EEC, 20%
Coastal Enriched Sandstone Moist Forest	ME58 (also HN648)	1841	Bangalay - Smooth-barked Apple / She-oak open forest on sandy alluvium in coastal parts of the Sydney region	Not an EEC, 67%
	HN606	n/a	Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Note: Biometric vegetation type ME58, although identified in the SMCMA mapping and on the online Vegetation Information System (VIS), is not, as yet, available for use in the credit calculator. From consultation with OEH this vegetation type will be entered in the calculator as HN606, and benchmarks for PCT 1841 used.	Refer to ME58

Vegetation SMCMA (OEH 2013)	Biometric Code	PCT Code	Biometric Vegetation Name	EEC (if relevant) and % Cleared in HNCMA
Coastal Sandstone Gully Forest	ME012 (also HN651)	1250	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin	Not an EEC, 30%
Coastal Sandstone Heath-Mallee	HN541	882	Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin	Not an EEC, 10%
Coastal Sandstone Rock Plate Heath	HN540	881	Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin	Not an EEC, 5%
Coastal Sandstone Riparian Forest	HN607	1292	Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin	Not an EEC, 10%
Coastal Upland Damp Heath Swamp (note this is a "damp" subcommunity)	HN560	978	Needlebrush - banksia wet heath on sandstone plateaux of the Sydney Basin	Coastal Upland Swamps in the Sydney Basin Bioregion, 10%
Coastal Upland Wet Heath Swamp (note this is a "wet" subcommunity)	HN560	978	Needlebrush - banksia wet heath on sandstone plateaux of the Sydney Basin	Coastal Upland Swamps in the Sydney Basin Bioregion, 10%
Sydney North Exposed Sandstone Woodland	HN566	1083	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin	Not an EEC, 25%
Sydney Ironstone Bloodwood-Silvertop Ash Forest	HN567	1085	Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin	Duffys Forest Ecological Community, 50%
Coastal Warm Temperate Rainforest*	HN547	905	Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin and South East Corner	Not an EEC, 15%

PCT = Plant Community Type. The code number provided is that assigned in the online Vegetation Information System (VIS). The percent cleared is from VIS as at 20/2/2016.

* This vegetation type was found to be present, but was merged with Coastal Enriched Sandstone Moist Forest (ME58) due to the small area of the Coastal Warm Temperate Rainforest (<0.25ha).

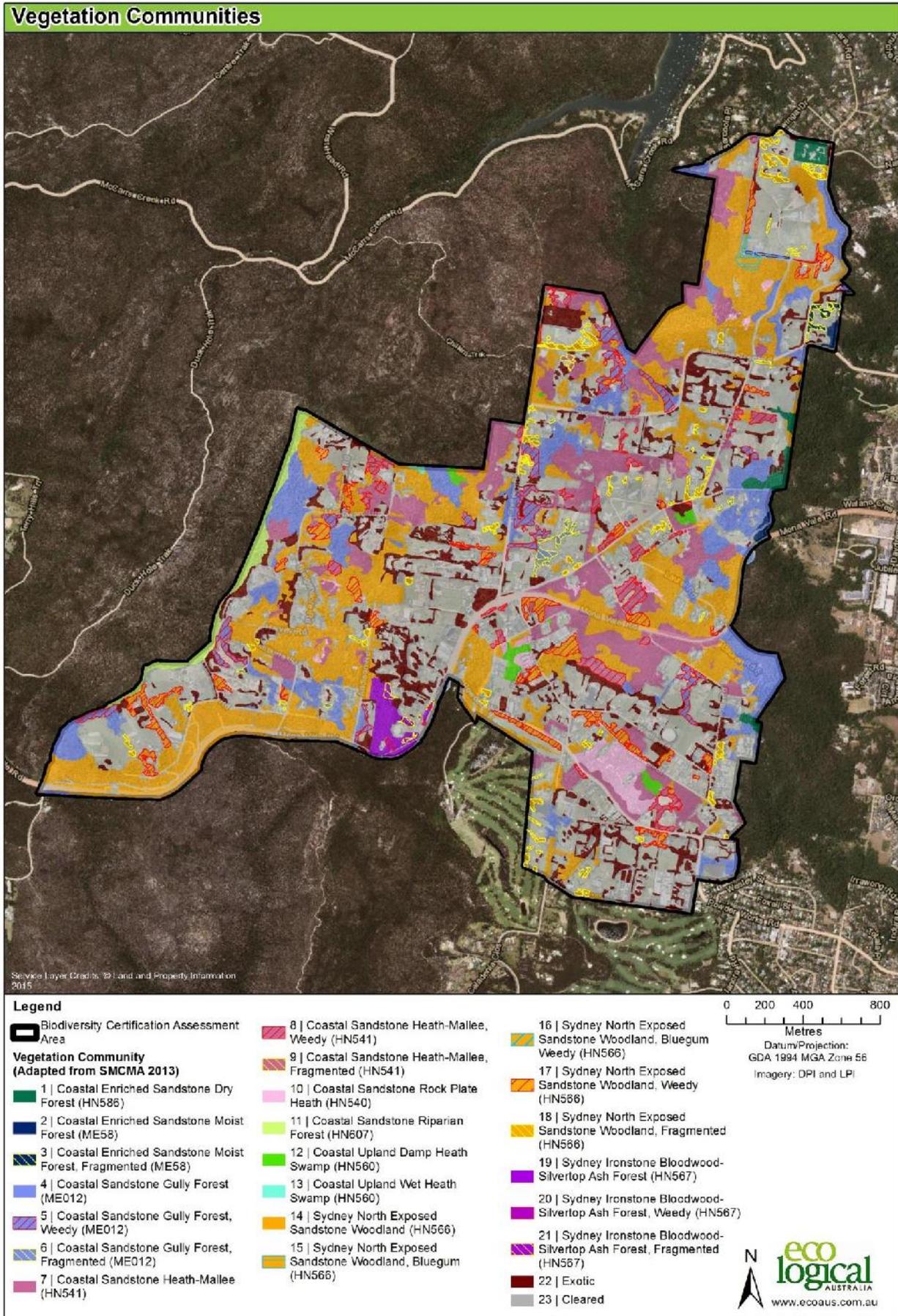


Figure 9: Vegetation communities

3.2.3 Vegetation community descriptions

Coastal Enriched Sandstone Dry Forest

This vegetation community is represented as small patches on private lands, which flow into adjacent conservation reserve along the eastern extent of the BCAA. There is high species diversity, with very low weed densities.

Biometric Vegetation Type	HN586 - Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest in sandstone gullies of western Sydney, Sydney Basin
Location	Located on private lands along the eastern boundary adjoining Katandra Bushland Sanctuary.
Description	<p>This vegetation type is a tall open forest generally located on upper slopes and dry gullies (OEH 2013). Vegetation is influenced by clay capping over sandstone soils. Vegetation is common on escarpments although it is poorly represented within the BCAA.</p> <p>This community comprises a significant buffer for an adjacent bushland reserve and potential wildlife corridor for threatened species.</p>
	
Canopy	This vegetation type has a canopy dominated by <i>Angophora costata</i> with <i>Syncarpia glomulifera</i> , <i>E. piperita</i> occurring less frequently.
Midstorey	Characterised by a tall midstorey of: <i>Allocasuarina torulosa</i> and <i>Notelaea longifolia</i> , <i>Elaeocarpus reticulatus</i> , <i>Glochidion ferdinandi</i> and <i>Ceratopetalum gummiferum</i>
Groundcovers	The groundcover of this vegetation type is characterised by a number of native species including: <i>Xanthorrhoea</i> sp., <i>Dianella caerulea</i> var. <i>producta</i> and <i>Entolasia marginata</i>
Weeds	None recorded.

Coastal Enriched Sandstone Moist Forest

This vegetation community is poorly represented within the BCAA. Limited access to validate the vegetation was available. Biometric plots and transects were conducted within the vegetation community outside the BCAA in the same vegetation type and condition (as per OEH 2015). Coastal Warm Temperate Rainforest (SR 567) was merged with this vegetation type due to the small size of the other vegetation zone (<0.25 ha).

This vegetation also includes remnant trees consistent with diagnostic species of the Coastal Enriched Sandstone Moist Forest vegetation community. These patches have been assigned a separate axillary code of “fragmented”.

Biometric Vegetation Type	ME58 Bangalay - Smooth-barked Apple / She-oak open forest on sandy alluvium in coastal parts of the Sydney region
Location	Two patches on private lands along the western boundary adjoining Katandra Bushland Sanctuary.
Description	This vegetation type is a tall open eucalypt forest occurring in sandstone gullies and sheltered slopes (OEH 2013). Vegetation is typically mesic and occurs between 20 and 120 metres above sea level. This community is poorly represented within the BCAA. It contains significant large trees and habitat for threatened species including amphibians.
	
Canopy	This vegetation type had a canopy dominated by <i>Angophora costata</i> and <i>Syncarpia glomulifera</i> , <i>E. piperita</i> occurring less frequently.
Midstorey	Characterised by mesic species: <i>Elaeocarpus reticulatus</i> , <i>Glochidion ferdinandi</i> and <i>Ceratopetalum gummiferum</i>
Groundcovers	The groundcover of this vegetation type represents a number of native ferns and vines including: <i>Pteridium esculentum</i> , <i>Stephania japonica</i> and <i>Eustrephus latifolius</i> .
Weeds	None recorded. Fragmented zone not accessible.

Coastal Sandstone Gully Forest

This vegetation community is confined to gullies along formed creek lines and sheltered lower slopes, and is extensive in the BCAA. The terrain rapidly fluctuates and contains large remnant trees. The vegetation classified as “good” condition is generally intact and in most situations forms a continuous corridor with adjacent conservation lands or other vegetation communities within the precinct boundary. Examples of good condition vegetation are located along the higher reaches of Wirreanda Creek, Cicada Glen Creek and the headwaters of a number of tributaries and creeks located beyond the confines of the BCAA. This vegetation community also exists as weedy and fragmented condition, and is adjacent to disturbed areas such as roads and as scattered remnant trees in urban landscaped gardens.

Biometric Vegetation Type	ME012 Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin
Location	Occurs at the headwaters of creek lines.
Description	This vegetation type located on sheltered gullies on infertile soils of the Hawkesbury sandstone. Vegetation consists of sclerophyll species mixing into gully streams often associated with a rocky terrain.
	
Canopy	This vegetation type had a canopy dominated by <i>Angophora costata</i> and, <i>Corymbia gummifera</i> , <i>E. piperita</i> . The presence of <i>E. piperita</i> distinguishes this community from adjacent vegetation. <i>E. punctata</i> and <i>E. sieberi</i> occur less frequently.
Midstorey	Characterised by tall shrub layer including: <i>Banksia serrata</i> , <i>Ceratopetalum gummiferum</i> , <i>Allocasuarina littoralis</i> or <i>Callicoma serratifolia</i> .
Groundcovers	The groundcover of this vegetation type are characterised by a number of native grasses and sedges including: variety of <i>Lomandra</i> sp., <i>Entolasia stricta</i> , <i>Xanthosia</i> sp., <i>Lepyrodia scariosa</i> and <i>Cyathochaeta diandra</i> .
Weeds	In weedy conditions vegetation includes: <i>Bidens pilosa</i> , <i>Ageratina adenophora</i> , <i>Lantana camara</i> , <i>Senna septemtrionalis</i> and garden escapees <i>Nephrolepis cordifolia</i> .

Coastal Sandstone Heath-Mallee

This community is widely distributed within the entire BCAA area. It includes large tracts of vegetation and small fragmented patches with the majority of the vegetation in good condition. There are three conditions mapped for this vegetation community i.e. good condition, weedy, and fragmented condition. Good condition Coastal Sandstone Heath-Mallee also varies in structure and species composition within the Precinct with examples of tree-less heath communities present in rocky outcrops. Where a canopy is present it is typically mallee or stunted. Weedy condition Coastal Sandstone Heath-Mallee is associated with clearing of vegetation for urban development and includes the outer edges of good condition vegetation. Fragmented vegetation includes remnant trees such as *Eucalyptus haemastoma* with exotic mid and ground layer. These are often featured in urban gardens.

Biometric Vegetation Type	HN541 Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin
Location	Widespread throughout the BCAA
Description	The vegetation is heath dominated by dense shrub layer. Vegetation is highly diverse with the shrub and ground layers.
	
Canopy	Canopy consists of mallee form trees or tall shrubs including: <i>Allocasuarina distyla</i> , <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> , and <i>Eucalyptus oblonga</i>
Midstorey	Highly diverse assemblage of shrubs: <i>Pultenaea tuberculata</i> , <i>Acacia suaveolens</i> , <i>Darwinia fascicularis</i> , <i>Kunzea ambigua</i> and variety of <i>Leptospermum</i> sp.
Groundcovers	The groundcover of this vegetation type is highly diverse assemblage of forbs and sedges and grasses: <i>Actinotus minor</i> , <i>Platysace linearifolia</i> , <i>Epacris longiflora</i> , <i>E. microphylla</i> , <i>Dampiera stricta</i> and <i>Anisopogon avenaceus</i>
Weeds	In weedy condition this vegetation community contained: <i>Hypochaeris radicata</i> , <i>Lantana camara</i> and <i>Cortaderia selloana</i> .

Coastal Sandstone Rock Plate Heath

There are several small patches of Coastal Sandstone Rock Plate Heath vegetation community scattered within the BCAA. These patches are typically surrounded by other heath vegetation forms in particular HN541 and HN566 and represent a floristically diverse assemblage of species in a small area. A large patch of intact located on the northern side of Powderworks Road is dominated by a dense midstorey of *Allocasuarina distyla*. This vegetation patch when surveyed in December 2013 had remained unburnt for an extended period. Despite the absence of fire, the vegetation within the ground layer remains diverse in this patch.

Biometric Vegetation Type	HN540 Hairpin Banksia - <i>Kunzea ambigua</i> - <i>Allocasuarina distyla</i> heath on coastal sandstone plateaux, Sydney Basin
Location	Located in the eastern extent of BCAA on higher elevations of shallow soils and exposed rocky outcrops surrounded by heath vegetation. Well represented north side of Powderworks Road.
Description	This vegetation type is a sparsely vegetated community on exposed rock plateaus. Shrub layer consists of small heathy patches where at times can form dense patches in long unburnt areas.
	
Canopy	Tree canopy is absent from this community
Midstorey	Shrubs include; <i>Kunzea ambigua</i> and <i>Allocasuarina distyla</i> , <i>Darwinia fascicularis</i> , <i>Epacris microphylla</i> and <i>E. longifolia</i>
Groundcovers	The groundcover of this vegetation type was characterised by a number of native sedges and herbs including <i>Caustis pentandra</i> , <i>Actinotus minor</i> and <i>Cyathochaeta diandra</i>
Weeds	None recorded.

Coastal Sandstone Riparian Forest

This vegetation community is mapped as a narrow band along the eastern boundary of BCAA. The vegetation corresponds with the riparian corridor along Wirreanda Creek and extends outside the BCAA into the adjacent Ku-ring-gai Chase National Park. There are no other examples of this vegetation community located within the BCAA. Vegetation was mapped as good condition, although some weedy patches were recorded behind the Wirreanda Nursery. There is potential that weeds may spread to adjacent bushland if left unchecked. When surveyed in December 2013, the vegetation had been subject to a recent burn (1 -2 years) which may consequently influence the floristic assemblage. Vegetation contains large remnant trees and potential habitat for threatened species.

Biometric Vegetation Type	HN607 Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin
Location	This vegetation community is represented along the eastern boundary of the BCAA boundary.
Description	This vegetation contains an open canopy of large remnant trees with a dense fern understorey and tall shrubs. It is typically associated with narrow gorges and minor creeks (OEH 2013). This community contains remnant trees and important habitat for threatened fauna species.
	
Canopy	This vegetation type had a canopy dominated by <i>Angophora costata</i> and <i>E. piperita</i> .
Midstorey	Characterised by dense mesic layer of: <i>Callicoma serratifolia</i> , <i>Ceratopetalum apetalum</i> and <i>C. gummiferum</i> .
Groundcovers	The groundcover of this vegetation type was characterised by a number of native ferns and vines including <i>Cyathea cooperi</i> , <i>Sticherus flabellatus</i> and <i>Smilax glycyphylla</i>
Weeds	Minor weed were recorded within this vegetation community: <i>Andropogon virginicus</i> and <i>Lantana camara</i>

Coastal Upland Damp Heath Swamp

This vegetation community conforms to the Coastal Upland Swamp community listed as an EEC under both the TSC Act and EPBC Act. This vegetation community is highly unique as it is one of two hanging or upland swamp communities recorded within the Sydney region (OEH 2013). The vegetation is located at high elevation up to 600 m above sea level. Water seepage is an important feature for this community as it is a groundwater dependent ecosystem (GDE). As such this community is often located at headwaters of creeks on impeded soils. There are several patches of this community scattered within the BCAA. A large patch is located between Manor Road and Powderworks Road, south of Mona Vale Road, and another large patch which extends outside of the Ingleside Precinct, within the north-western aspect of the BCAA in the grounds utilised by the Ingleside Scouts.

Biometric Vegetation Type	HN560 – Needlebush – banksia wet heath on sandstone plateaux of the Sydney Basin
Location	Located along the northern boundary of the Precinct and in small patches either side of Mona Vale Road.
Description	This vegetation type comprises of unique assemblage of sedges and scattered shrubs influenced by the moist seepage at higher elevations.
	
Canopy	Trees are absent from within the community, although mallee may fringe the edges
Midstorey	Characterised by sclerophyll species: <i>Banksia ericifolia</i> , <i>B. oblongifolia</i> , <i>Hakea teretifolia</i> and <i>Baeckea imbricata</i>
Groundcovers	The groundcover of this vegetation type was characterised by a number of sedges including: <i>Empodisma minus</i> , <i>Actinotus minor</i> , <i>Cyathochaeta diandra</i> and <i>Bauera rubioides</i> .
Weeds	None recorded.

Coastal Upland Wet Heath Swamp

This vegetation community conforms to the Coastal Upland Swamp community, listed as an EEC under both the TSC Act and EPBC Act. This community has a highly restricted distribution. This vegetation requires mean average rainfall greater than 1200 mm and where damp seepage is permanent (OEH 2013). It is also a GDE ecosystem and sensitive to changes in nutrient and hydrological flows.

Only one patch of this vegetation was represented within the BCAA. This patch is located within the Ingleside Scout Camp along the north-western boundary of the Precinct. The surrounding catchment flows into this patch of vegetation and into the adjacent Crystal Creek.

In accordance with the BCAM methodology, this community will be merged with Coastal Upland Damp Heath Swamp (HN560) for credit analysis purposes, as it is less than the minimum vegetation zone size of 0.25 ha.

Biometric Vegetation Type	HN560 - Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin
Location	One patch recorded within the Ingleside Scout Camp in upslope of Crystal Creek
Description	This vegetation type is treeless and forms a dense sedgeland with scattered heath species. Soils are regularly moist and peaty (OEH 2013). Vegetation is dominated by a variety of different sedges.
	
Canopy	Trees are absent from within the community.
Midstorey	Characterised by the presence of <i>Banksia robur</i> . Other shrubs include: <i>Banksia ericifolia</i> and <i>Hakea teretifolia</i> .
Groundcovers	The groundcover of this vegetation type was characterised by a number of native ferns and sedges including: <i>Empodisma minus</i> , <i>Gahnia</i> sp. and <i>Gleichenia dicarpa</i> .
Weeds	<i>Ageratina aethiopicus</i> and <i>Senna pendula</i> .

Coastal Warm Temperate Rainforest

The Coastal Warm Temperate Rainforest was previously mapped by SMCMA (OEH 2013) along the eastern boundary of the BCAA where it borders Ingleside Chase Reserve. The vegetation represented only a small portion (0.05 ha) within the BCAA. No access was available to validate this community.

An assessment of the vegetation type determined that the community represented similarities in structure, soils, topography as ME58 (refer to **Table 5**). In accordance with the BCAM methodology this community will be merged with ME58 for credit analysis purposes, as it is less than the minimum vegetation zone size of 0.25 ha.

Sydney North Exposed Sandstone Woodland

This community is the most extensive vegetation community within the BCAA. It forms low-open eucalypt woodland dominated by heath vegetation (OEH 2013). It is usually associated with shale influence on sandstone ridges in coastal Sydney regions (OEH 2013). Rocky outcrops may be exposed on upper slopes.

Weedy patches are located along road verges, urbanised areas and 'edge effect' habitats. Weedy patches contained a canopy of *Eucalyptus haemastoma* in a disturbed environment. A small patch of planted *Eucalyptus saligna* (Sydney Blue Gum) was located either side of Walter Road in the north of the BCAA. Although this species is native to Sydney region it is not indigenous to this vegetation community, and has been planted. Walter Road dissects the vegetation community. A small linear band of *E. saligna* remains on the northern side Walter Road and extends over private and public land along the road verge. This patch is in poor condition with only few native species present in each stratum. It has been assigned a 'bluegum weedy' axillary code. The remaining and more extensive patch of planted *E. saligna* remains on the southern side of Walter Road. Native shrubs and groundcover species are represented within this vegetation community and canopy dominated by *E. saligna*.

Biometric Vegetation Type	HN566 - Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin
Location	Widely distributed throughout the entire BCAA
Description	This vegetation type located on exposed slopes and scattered throughout the BCAA.
	
Canopy	This vegetation type had a canopy dominated by <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> and <i>Corymbia gummiifera</i> .
Midstorey	Characterised by a variety of species: <i>Leptospermum trinervium</i> , <i>Banksia ericifolia</i> , <i>B. serrata</i> , <i>Grevillea buxifolia</i> and <i>G. sericea</i> .
Groundcovers	The groundcover of this vegetation type was characterised by a number of species including: <i>Platysace linearifolia</i> , <i>Xanthosia tridentata</i> , <i>Lepidosperma laterale</i> , <i>Tetratheca ericifolia</i> and <i>Dampiera stricta</i> .
Weeds	<i>Asparagus aethiopicus</i> , <i>Rubus fruticosus</i> aggregate and <i>Hydrocotyle bonariensis</i> . <i>Eucalyptus saligna</i> is considered a non-indigenous species to the area and has been planted.

Sydney Ironstone Bloodwood-Silvertop Ash Forest

This vegetation community conforms to the Duffys Forest Ecological Community (DFEC) listed as an EEC under the TSC Act. Mapping of DFEC has been extensively undertaken within the LGA (Smith and Smith 2000). DFEC is a unique floristic arrangement of species along ridgetops and higher elevations. Geology plays a significant role in the assemblage of vegetation. DFEC is found on lateritic soils with shale influence overlaying Hawkesbury sandstone geology (NSW Scientific Committee 2011). It is represented in the Pittwater, Warringah, Ku-ring-gai, Hornsby and Manly LGAs. Vegetation within the BCAA is highly fragmented by urban development. However, in small pockets which remain within the BCAA the species diversity is high. This vegetation community provides suitable habitat for a threatened flora species, *Grevillea caleyi*.

Biometric Vegetation Type	HN567 Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin
Location	North side of Mona Vale Road
Description	This vegetation type forms an open forest or woodland located on shale lenses and lateritic soils in Hawkesbury Sandstone (OEH 2012).
	
Canopy	This vegetation type mix of <i>Eucalyptus</i> species including: <i>Eucalyptus sieberi</i> , <i>E. capitellata</i> and <i>Corymbia gummifera</i> .
Midstorey	Shrub layer is sparse. Species include: <i>Hakea sericea</i> , <i>Grevillea caleyi</i> and <i>Hibbertia bracteata</i>
Groundcovers	Groundcover species includes: <i>Lomandra</i> sp., <i>Entolasia stricta</i> , <i>Boronia ledifolia</i> and <i>Pteridium esculentum</i>
Weeds	Exotic species include: <i>Coreopsis lanceolata</i> , <i>Hypochaeris radicata</i> and garden escapee <i>Acacia elata</i>

3.2.4 Coastal Upland Swamps

Additional investigations of areas initially mapped as Coastal Sandstone Heath-Mallee (as discussed in **Section 2.1**), identified additional patches of Coastal Upland Damp Heath Swamp, which forms part of the Coastal Upland Swamps EEC, within the BCAA.

The reclassification of areas initially identified as Coastal Sandstone Heath-Mallee to Coastal Upland Damp Heath Swamp was based upon assessment of floristic composition and the interactions of landform and hydrology. Floristically, areas of Coastal Upland Damp Heath Swamp were distinguished from Coastal Sandstone Heath-Mallee by the absence or infrequent occurrence of species associated with woodlands, including *Banksia serrata*, *Allocasuarina distyla* and trees including *Eucalyptus* species and *Corymbia gummifera*. Coastal Upland Damp Heath Swamps generally had an increased cover of *Hakea teretifolia* and *Leptospermum squarrosum* within the shrub layer and a diverse array of sedges and rushes within the understorey, compared to Coastal Sandstone Heath-Mallee.

Coastal Upland Damp Heath Swamps are associated with increased moisture as a result of low surface gradients, where surface run-off is slow, or on steeper slopes where impermeable sandstone strata causes seepage of moisture where the impermeable sandstone outcrops, termed 'terminal steps'. Within areas of Coastal Sandstone Heath-Mallee, the landforms were such that surface flows were variable across the patch of vegetation, with changes in slope and aspect occurring over small areas. Surface flows quickly entered defined channels and no terminal steps with seepage were observed.

Three areas were reclassified from Coastal Sandstone Heath-Mallee to Coastal Upland Damp Heath Swamp as a result of the additional investigations, as shown in **Figure 10**, and which resulted in the total area of mapped Coastal Upland Swamp EEC within the Ingleside Precinct increasing from 1.60 ha to 3.33 ha. This include additional vegetation at the intersection of Manor Road and King Road, vegetation between McLean Street and Powder Works Road, and a small area north of Cicada Glen Road (**Figure 10**),

One area of potential Coastal Upland Swamp EEC within Ku-ring-gai Chase National Park was not inspected for targeted Coastal Upland Swamp mapping. However, whilst it is part of the BCAA, it will not be subjected to any change in land use or management as part of Biocertification application and will remain unchanged from its current state. One area of potential Coastal Upland Swamp EEC east of Chiltern Road was also not inspected due to site access not being available. This is proposed for development within the Draft Structure Plan (**section 5**), however it was considered a low potential of being the EEC based upon aerial photograph interpretation and consideration of the topography within this location.

3.2.5 Vegetation condition and vegetation zones

BCAM defines vegetation zones as relatively homogenous areas of the same vegetation type and similar condition. Vegetation in 'low' condition must always form a separate zone from vegetation in 'moderate to good' condition. Most vegetation zones in the BCAA met the definition of 'moderate to good' as defined by BCAM. The exception was zones that comprise of fragmented remnants of indigenous canopy trees within residential gardens, and semi-rural landscapes which have a site value score of ≤ 34 out of 100. Due to the range of vegetation condition characteristics in the 'moderate to good' definition, ancillary codes were used to further stratify the site's vegetation zones in moderate to good condition. A description is provided for each ancillary code in **Table 6**.

A final condition code of exotic which meets the BCAM definition of 'cleared land' was given to areas of dominated by weeds with no remnant canopy, no native mid-storey and negligible native ground cover. These areas generally comprised of dense thickets of lantana and blackberry.

Table 6: Condition Ancillary Code Description

Ancillary Code	BCAM Condition	Description
Good	Moderate – Good	Generally intact native vegetation where levels of weed presence are relatively minor. Disturbance is generally confined to tracks and vegetation patch edges and other small isolated areas of disturbance, such as past dumping or vegetation clearance. May include areas which have been recently burnt or under-scrubbed but still have high resilience and will recover to an intact condition.
Weedy	Moderate - Good	Native vegetation with reduced species diversity and moderate to heavy weed presence in the mid-storey and groundcover, e.g. lantana dominated mid-storey but generally intact indigenous canopy.
Blue Gum	Moderate - Good	Only occurs in one location and one vegetation type within the BCAA, <i>Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux</i> , where the indigenous canopy tree species have been largely replaced by non-indigenous <i>Eucalyptus saligna</i> (Blue Gum Trees). Only relatively minor presence of weeds as described in the good ancillary code above.
Blue Gum Weedy	Low	Only occurs in one location and one vegetation type within the BCAA, <i>Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux</i> , where the indigenous canopy tree species have been largely replaced by non-indigenous <i>Eucalyptus saligna</i> (Blue Gum Trees) but with moderate to heavy weed presence in the mid-storey as described in the weedy ancillary code above
Fragmented	Low or Moderate - Good	Indigenous canopy trees with no or negligible presence of native mid-storey and ground cover. May occur as remnant trees with exotic or non-indigenous garden plants or in fragmented weed dominated patches within a semi-rural landscape

The minimum size of a vegetation zone under BCAM is 0.25 ha. An area of vegetation that is less than 0.25 ha is included in the adjoining vegetation zone. Accordingly this assessment merged a small area of *Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin and South East Corner* HN547 (0.05 ha) into the adjacent vegetation zone ME58.

BCAM specifies a minimum number of plots and transects for each vegetation zone area. During the assessment there was no access to two zones located on private land to carry out a plot and transect survey. These zones were Coastal Enriched Sandstone Dry Forest (HN586) and Coastal Enriched Sandstone Moist Forest (ME58). Plot and transect data were collected from adjoining vegetation of the same biometric type and condition within Katandra Bushland Sanctuary, immediately outside the BCAA. There were a total of 20 vegetation zones in this BCA; these are detailed in **Table 7** along with the number of plots and transects required under BCAM and the number completed during the field survey. The location of each biometric plot is provided in **Figure 11**.

Table 7: Vegetation zones and number of transect/plots required under BCAM

Veg Zone ID	Vegetation Name	Biometric Code	Condition	Ancillary Condition Code	Area (ha)	Plots required	Plots conducted
1	Coastal Enriched Sandstone Dry Forest	HN586	Moderate - Good	Good	4.55	1	2*
2	Coastal Enriched Sandstone Moist Forest	ME58	Moderate - Good	Good	1.26	1	1*
3	Coastal Enriched Sandstone Moist Forest	ME58	Moderate - Good	Fragmented	0.93	1	0**
4	Coastal Sandstone Gully Forest	ME012	Moderate - Good	Good	51.47	4	4
5	Coastal Sandstone Gully Forest	ME012	Moderate - Good	Weedy	11.09	2	2
6	Coastal Sandstone Gully Forest	ME012	Low	Fragmented	1.55	1	1
7	Coastal Sandstone Heath-Mallee	HN541	Moderate - Good	Good	70.15	4	6
8	Coastal Sandstone Heath-Mallee	HN541	Moderate - Good	Weedy	10.07	2	2
9	Coastal Sandstone Heath-Mallee	HN541	Low	Fragmented	0.37	1	1
10	Coastal Sandstone Rock Plate Heath	HN540	Moderate - Good	Good	9.24	1	2
11	Coastal Sandstone Riparian Forest	HN607	Moderate - Good	Good	6.6	1	1
12	Coastal Upland Damp Heath Swamp / Coastal Upland Wet Heath Swamp	HN560	Moderate - Good	Good	3.33	1	2
13	Sydney North Exposed Sandstone Woodland	HN566	Moderate - Good	Good	148.6	5	6
14	Sydney North Exposed Sandstone Woodland	HN566	Moderate - Good	Bluegum	0.99	1	1
15	Sydney North Exposed Sandstone Woodland	HN566	Low	Bluegum Weedy	0.25	1	1
16	Sydney North Exposed Sandstone Woodland	HN566	Moderate - Good	Weedy	15.99	2	2
17	Sydney North Exposed Sandstone Woodland	HN566	Low	Fragmented	8.78	1	2
18	Sydney Ironstone Bloodwood-Silvertop Ash Forest	HN567	Moderate - Good	Good	4.76	1	1
19	Sydney Ironstone Bloodwood-Silvertop Ash Forest	HN567	Moderate - Good	Weedy	0.24	1	1***
20	Sydney Ironstone Bloodwood-Silvertop Ash Forest	HN567	Low	Fragmented	0.72	1	1
Total					350.94	33	39

* These plots were completed outside of the precinct in vegetation of the same type and similar condition.

** Vegetation zone 3 areas were located in private properties where access was not available, and hence this zone will be grouped with vegetation zone 2.

*** Due to the small size of this zone, and being less than the minimum zone size of 0.25 ha, it may be merged with another vegetation zone for future analysis.

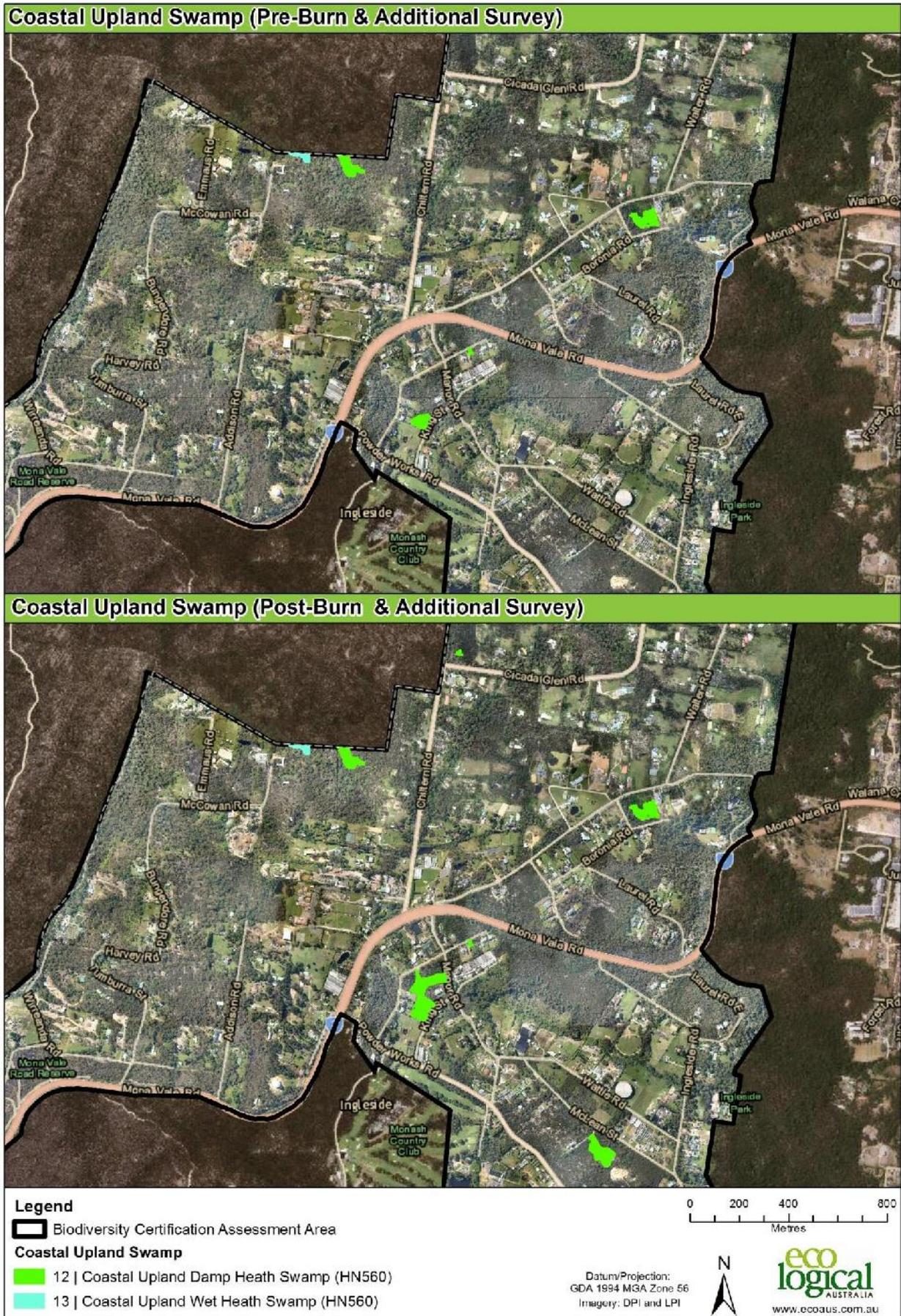


Figure 10: Coastal Upland Swamp

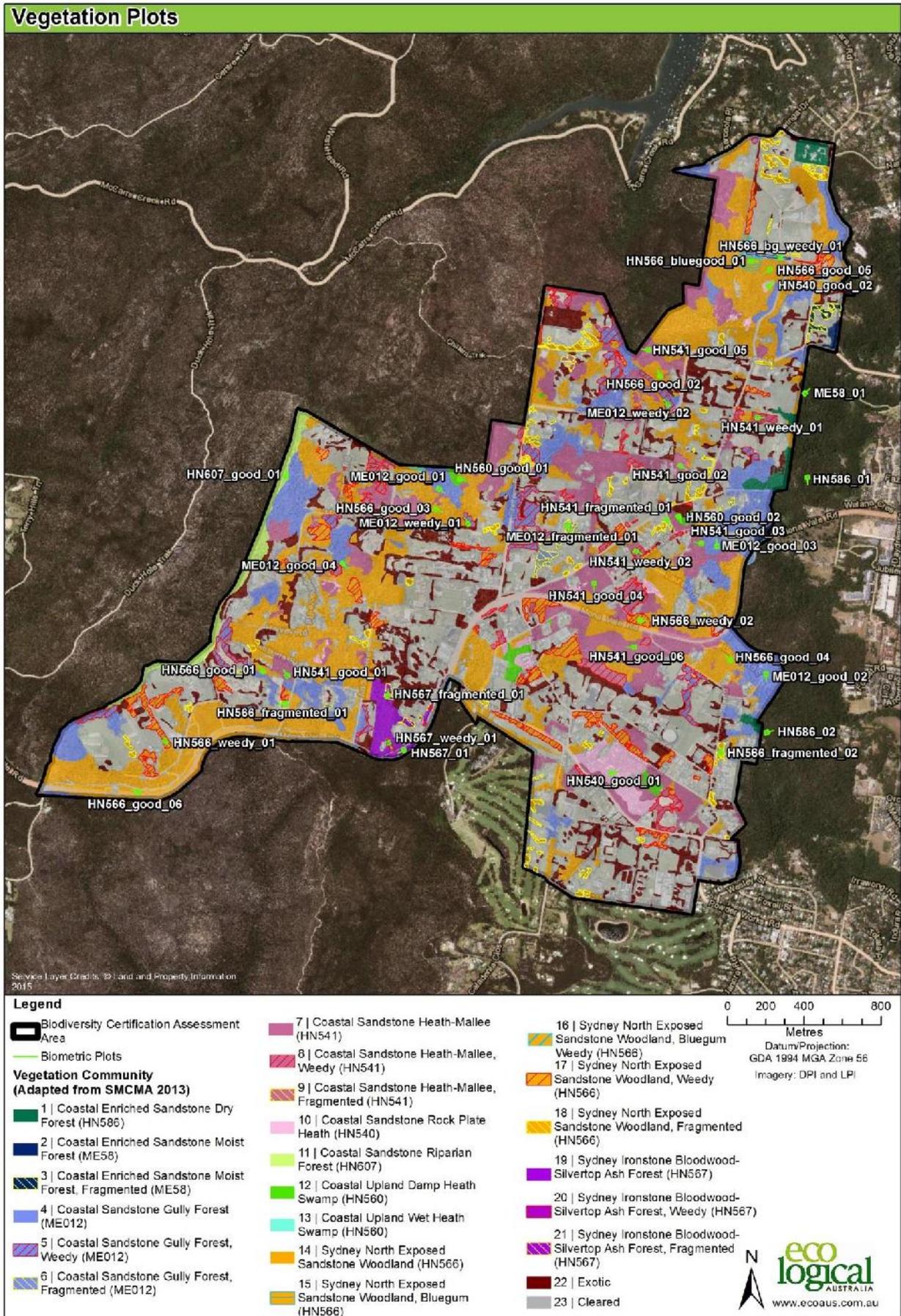


Figure 11: Biometric plots and vegetation communities

3.3 Threatened species

Under BCAM threatened fauna species are divided into those species that can be predicted by vegetation habitat surrogates (ecosystem credit species), and species that cannot reliably be predicted by habitat surrogates (species credit species). All threatened flora species are species credit species, and approximately half of all threatened fauna species are species credit species.

The assessment and measurement of ecosystem credit species and species credit species has been carried out in accordance with the steps outlined in sections 4.2 and 4.3 of BCAM (DECCW 2011), and the details are presented in **Appendix D**. A summary of the results with regards to relevant threatened species to be considered in the BCAA as either ecosystem credit species, or species credit species are provided in the sections below.

3.3.1 Ecosystem credit fauna species

The ecosystem credit species (all fauna species) which are predicted in the BCAA are summarised in **Table 8**. As identified in **Appendix D**, four ecosystem credit species (Eastern Free-tailed Bat, Barking Owl, Powerful Owl, Masked Owl) which may occur within the BCAA were not predicted, but have been included as they were considered to have a high likelihood of presence in the BCAA based on reliability, locality and age of records.

Table 8: Ecosystem credit species predicted using criteria

Group	Common name	Scientific Name	Status under TSC Act	Status under EPBC Act
Mammals (non-flying)	Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V	E
	Yellow-bellied Glider	<i>Petaurus australis</i>	V	-
	Squirrel Glider	<i>Petaurus norfolcensis</i>	V	-
Mammals (flying)	Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	-
	Little Bent-wing Bat	<i>Miniopterus australis</i>	V	-
	Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	-
	Eastern Free-tailed Bat (added)	<i>Mormopterus norfolkensis</i>	V	-
Birds (diurnal)	Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	V	-
	Little Eagle	<i>Hieraaetus morphnoides</i>	V	-
	Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-
	Swift Parrot	<i>Lathamus discolor</i>	E	CE, Ma
	Scarlet Robin	<i>Petroica boodang</i>	V	-
	Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	V	-
Nocturnal Birds	Barking Owl (added)	<i>Ninox connivens</i>	V	-
	Powerful Owl (added)	<i>Ninox strenua</i>	V	-
	Masked Owl (added)	<i>Tyto novaehollandiae</i>	V	-

CE = Critically Endangered species
E = Endangered species

V = Vulnerable species
Ma = Marine species

3.3.2 Species credit flora and fauna species

A total of 21 candidate species credit species were identified (**Appendix B**), of which 13 are flora species, and 8 are fauna species. These species and their “Tg” values which are “*the ability of a species to respond to improvement in site value or other habitat improvement through management actions undertaken at an offset site subject to a conservation measure*” (DECCW 2011) are summarised in **Table 9**. A low Tg value means that a species is anticipated to respond slowly to management actions, and a high number of credits are required (i.e. the lower the Tg value, the larger the offset that is required).

The Tg value will be relevant to credit calculations, to be performed when the Structure Plan is assessed. The credit calculations will be based on the number of individuals impacted for threatened flora species and the area of habitat for threatened fauna species.

The methodology also requires that species polygons are mapped for species credit species (for both flora and fauna species). These have been mapped, with some species grouped as they are linked to the same vegetation extent. **Appendix B** contains details of the approach used to identify and map the species polygons, and **Table 9** identifies the relevant figure for the species polygon for each species. It is noted that mapping of species polygons for potential habitat does not mean that the species does occur, this identifies potential habitat only.

Table 9: Final candidate species list for Ingleside BCAA species credit species

Species	Tg Score	Species polygon (Figure #)
Flora		
<i>Acacia terminalis</i> subsp. <i>terminalis</i>	0.6	Figure 12
<i>Callistemon linearifolius</i>	0.7	Figure 13
<i>Darwinia biflora</i>	0.5	Figure 14
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	0.6	Figure 15
<i>Eucalyptus camfieldii</i>	0.125	Figure 16
<i>Grevillea caleyi</i>	0.125	Figure 17
<i>Lasiopetalum joyceae</i>	0.5	Figure 18
<i>Leptospermum deanei</i>	0.75	Figure 19
<i>Melaleuca deanei</i>	0.125	Figure 12
<i>Microtis angusii</i>	0.375	Not included as this is a sensitive species and specific locations cannot be released
<i>Persoonia hirsuta</i>	0.125	Figure 20
<i>Pimelea curviflora</i> var. <i>curviflora</i>	0.125	Figure 16
<i>Tetradlea glandulosa</i>	0.625	Figure 12
Fauna Species		
<i>Heleioporus australiacus</i> (Giant Burrowing Frog)	0.75	Figure 21
<i>Pseudophryne australis</i> (Red-crowned Toadlet)	0.75	Figure 22

Species	Tg Score	Species polygon (Figure #)
<i>Phascolarctos cinereus</i> (Koala)	0.375	Figure 22
<i>Isoodon obesulus</i> (Southern Brown Bandicoot)	0.375 (red flag)	Figure 25
<i>Cercartetus nanus</i> (Eastern Pygmy Possum)	0.5	Figure 22
<i>Myotis macropus</i> (Southern Myotis) - breeding habitat (noted that this is a split species with foraging habitat captured under ecosystem credits Tg = 0.45)	0.125	Figure 24
<i>Anthochaera phrygia</i> (Regent Honeyeater)	0.125	Individuals would be vagrants migrating through the BCAA so species credits should not be required.
<i>Varanus rosenbergi</i> (Rosenberg's Goanna)	0.4	Figure 23

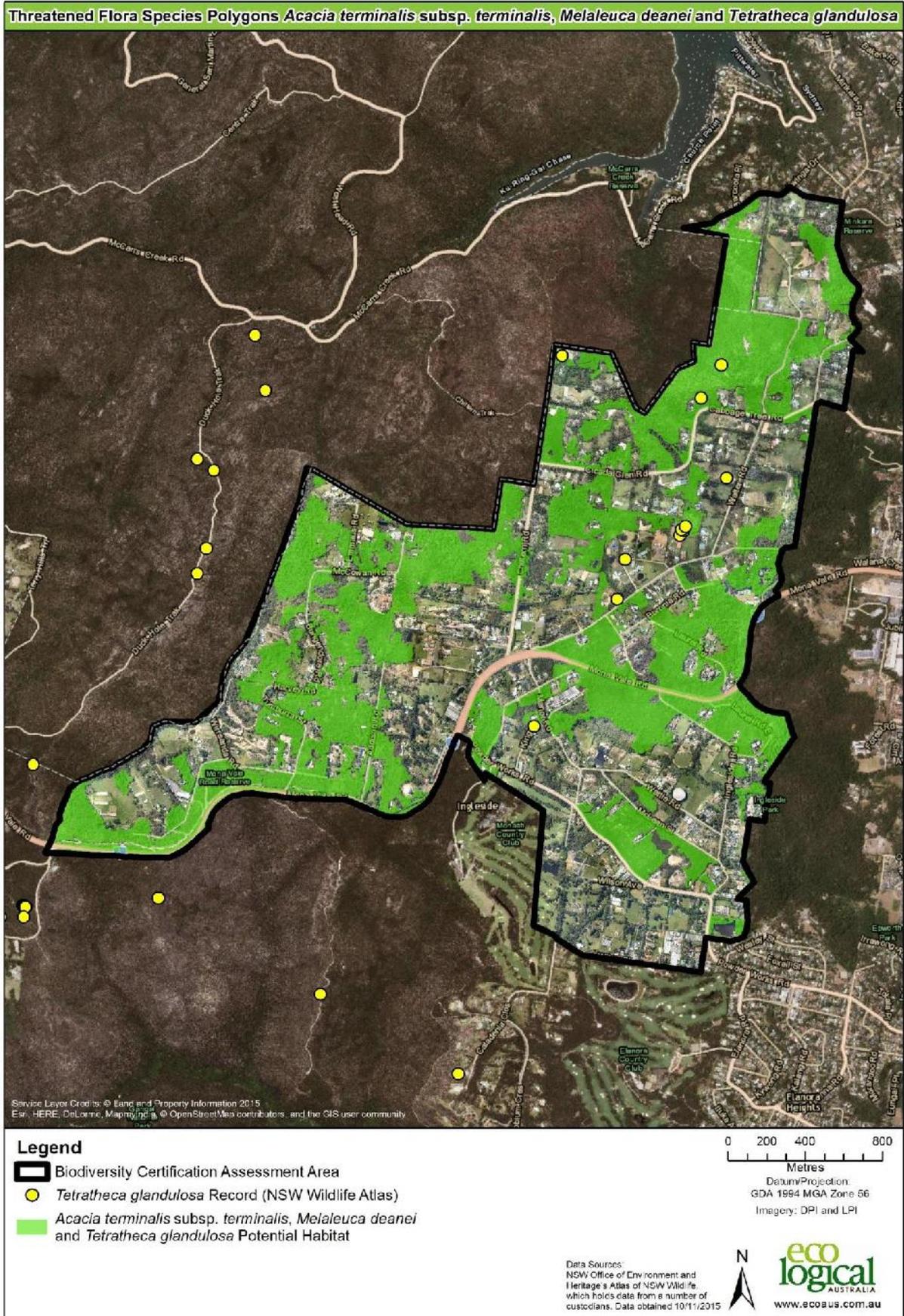


Figure 12: Threatened flora species polygons *Acacia terminalis* subsp. *terminalis*, *Melaleuca deanei* and *Tetratheca glandulosa*. No *Tetratheca glandulosa* were detected during survey for this species.

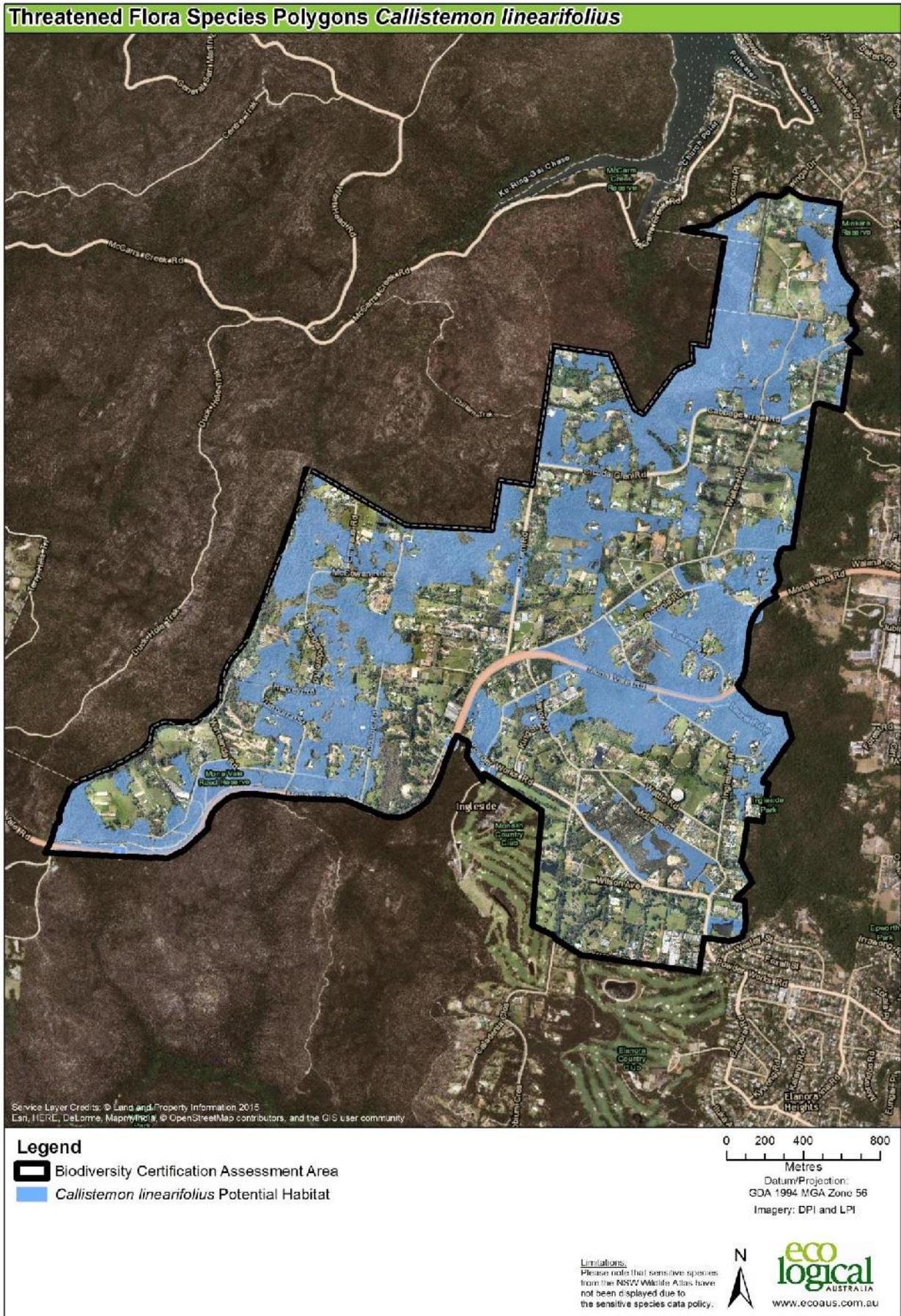


Figure 13: Threatened flora species polygons *Callistemon linearifolius*

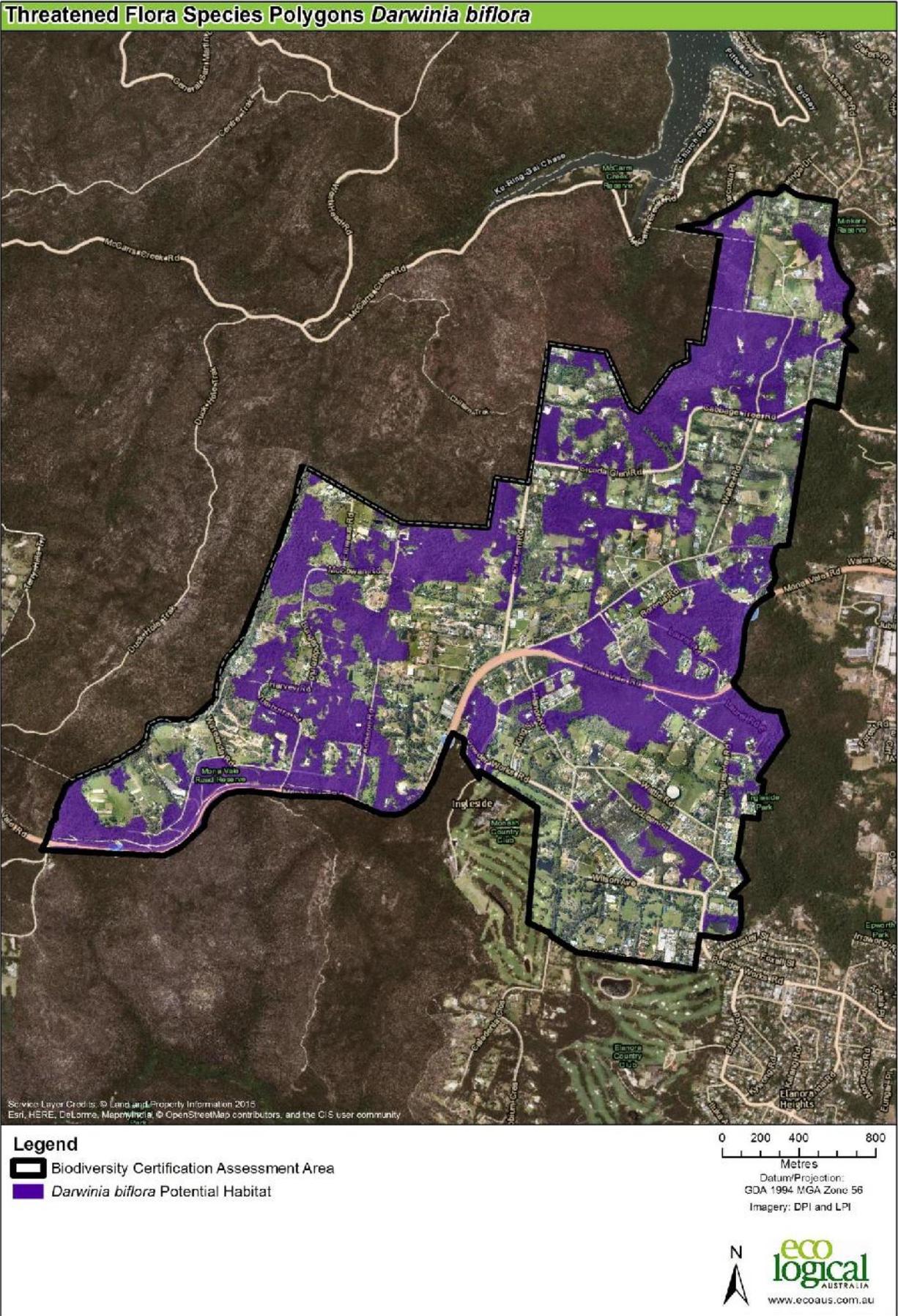


Figure 14: Threatened flora species polygons *Darwinia biflora*

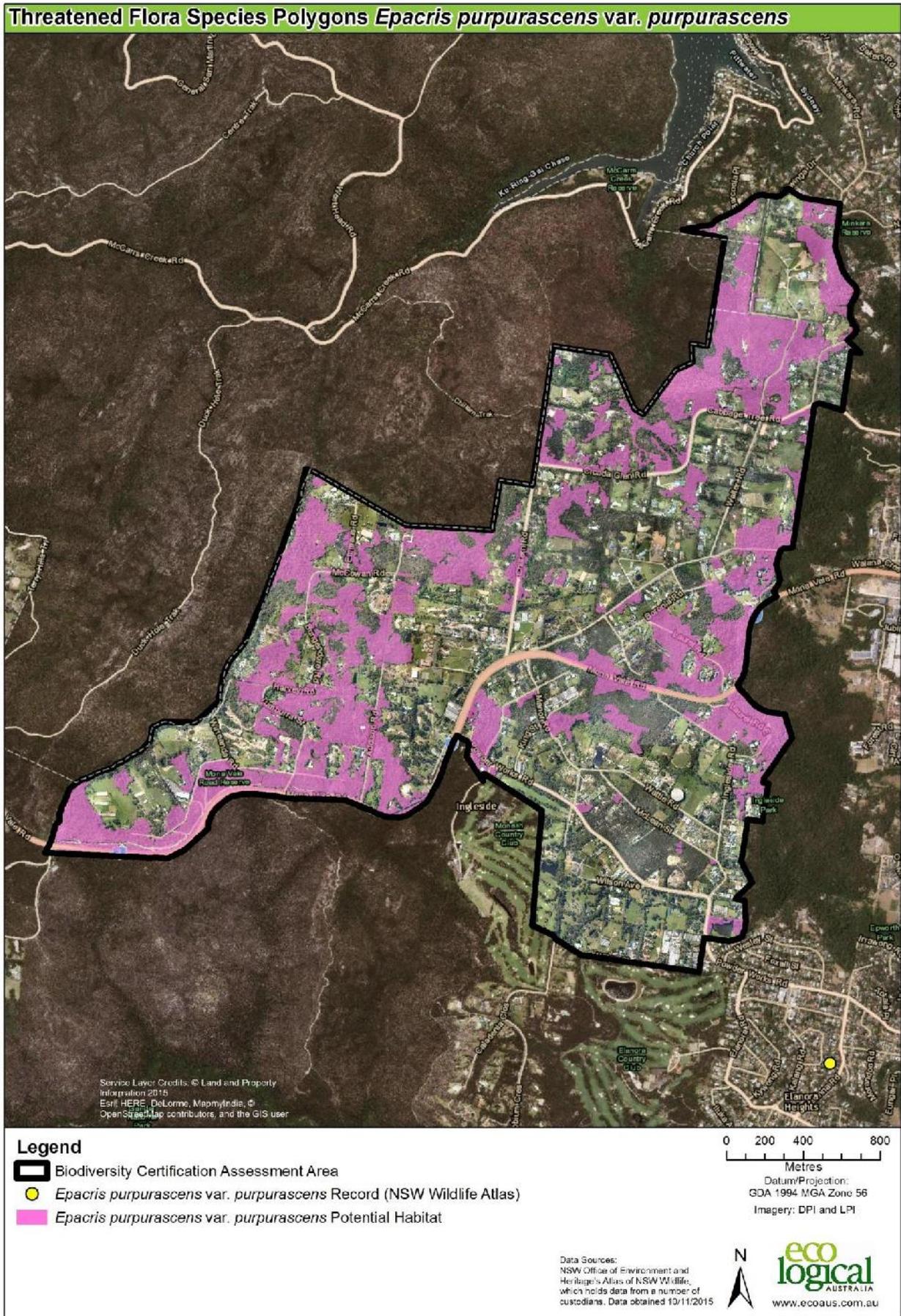


Figure 15: Threatened flora species polygons *Epacris purpurascens* var. *purpurascens*

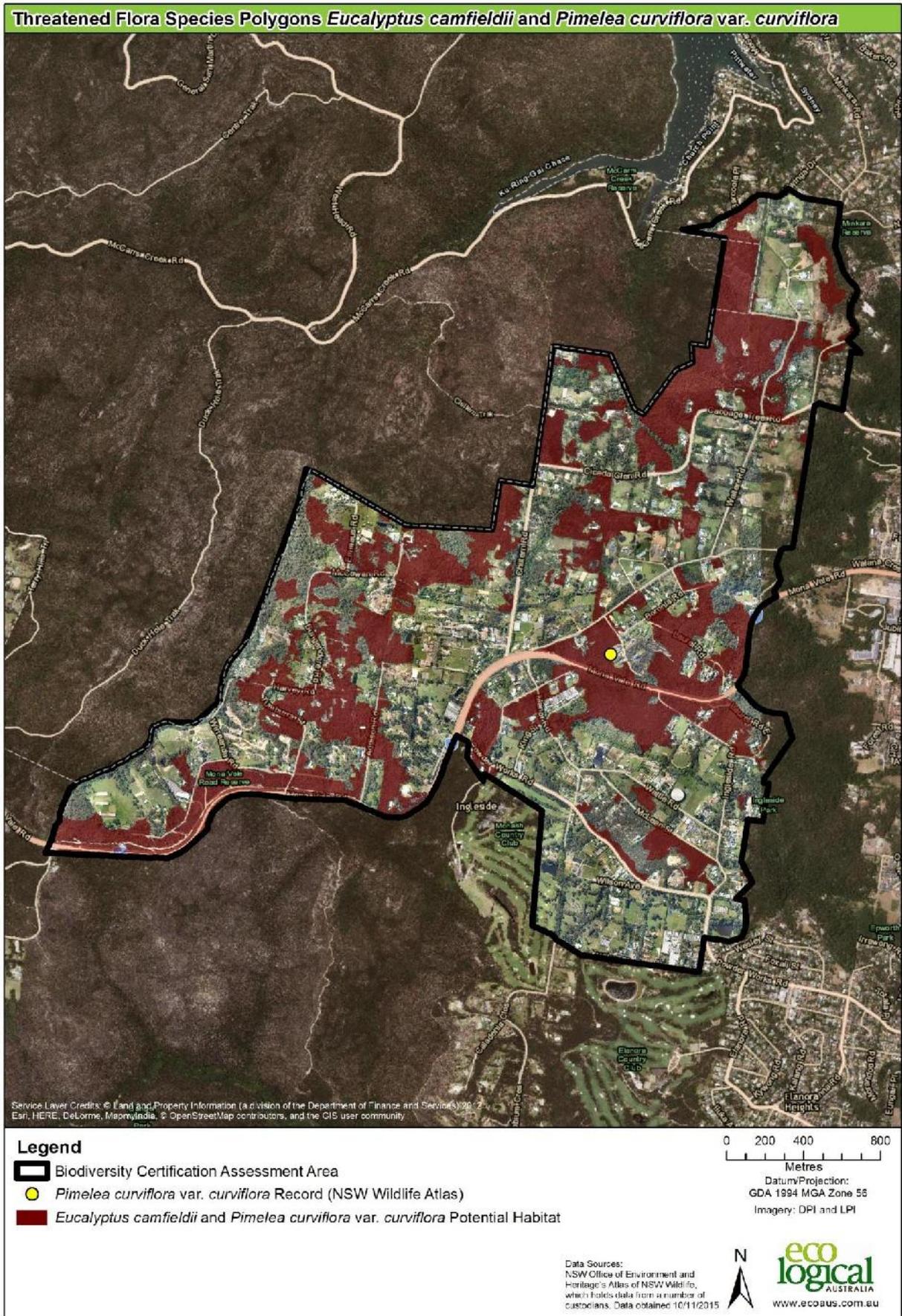


Figure 16: Threatened flora species polygons *Eucalyptus camfieldii* and *Pimelea curviflora* var. *curviflora*

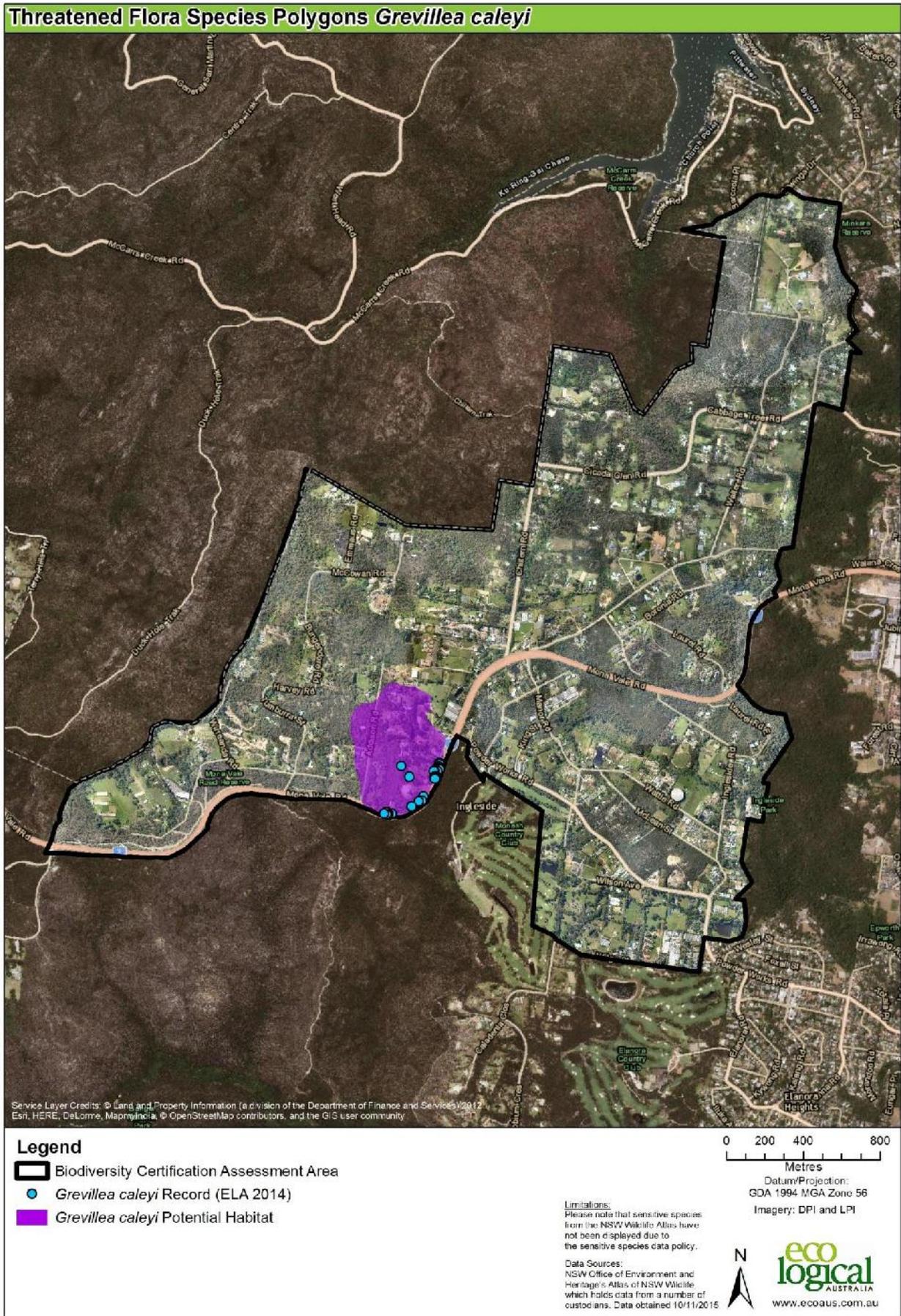


Figure 17: Threatened flora species polygons *Grevillea caleyi*

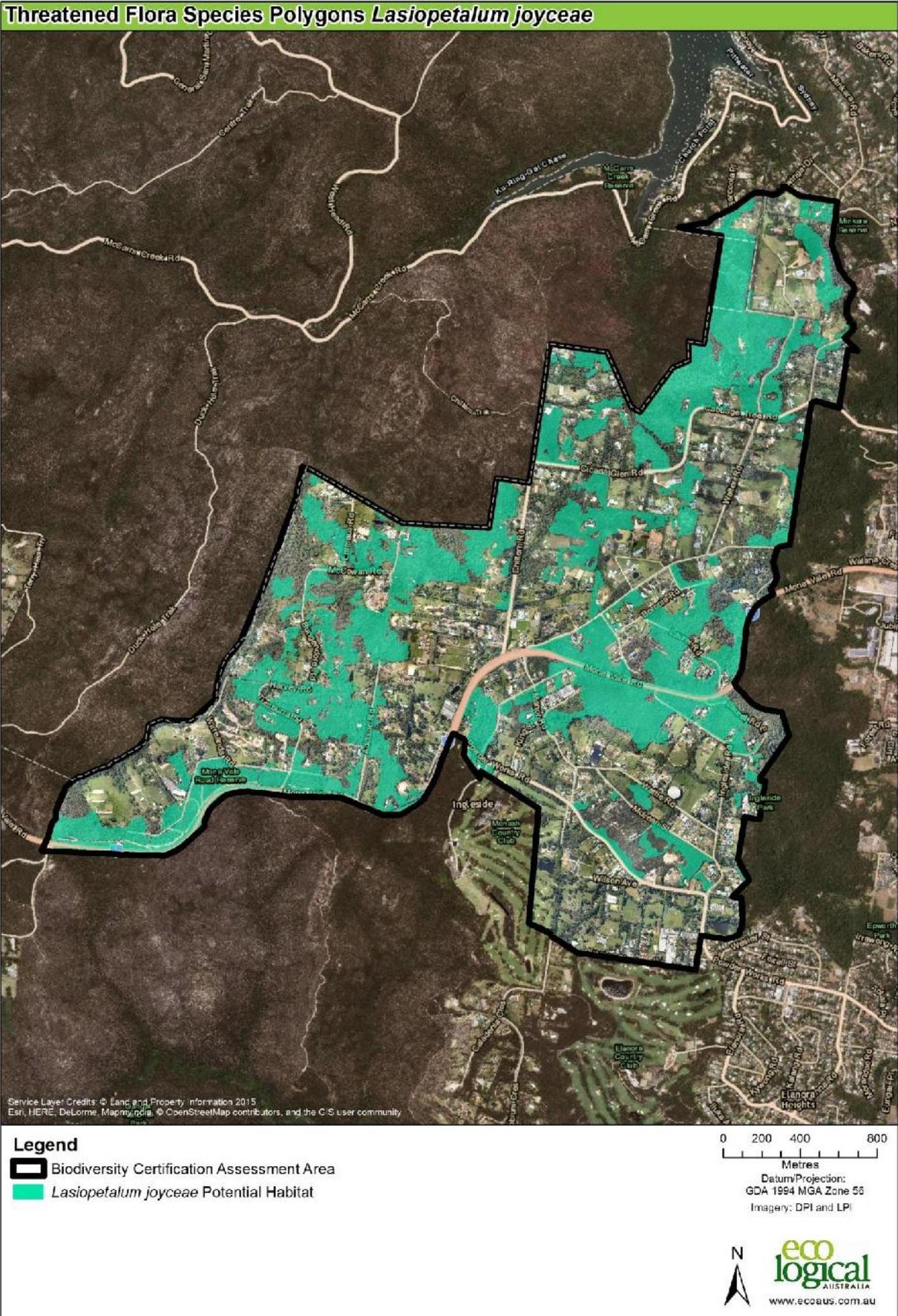


Figure 18: Threatened flora species polygons *Lasiopetalum joyceae*

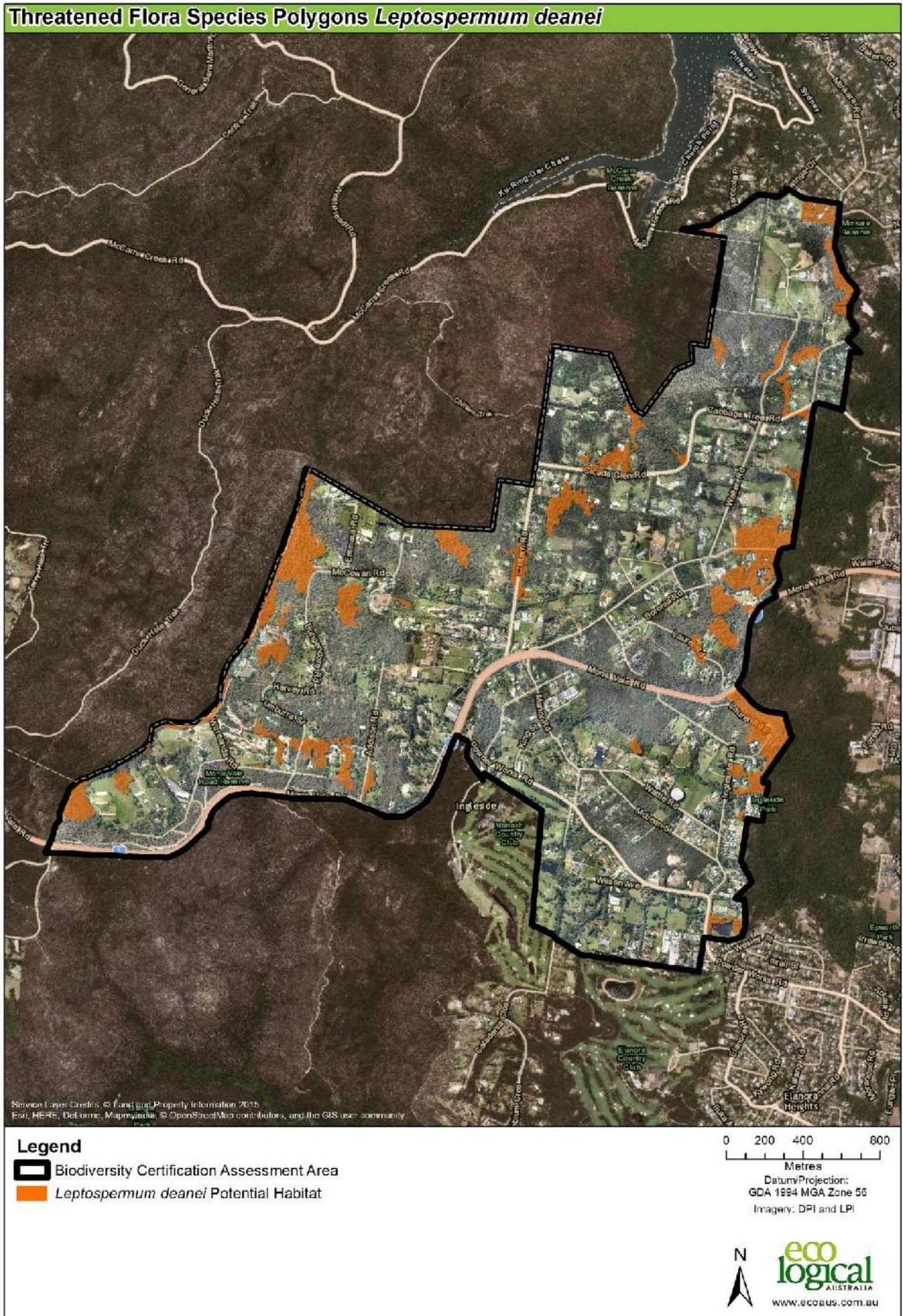


Figure 19: Threatened flora species polygons *Leptospermum deanei*

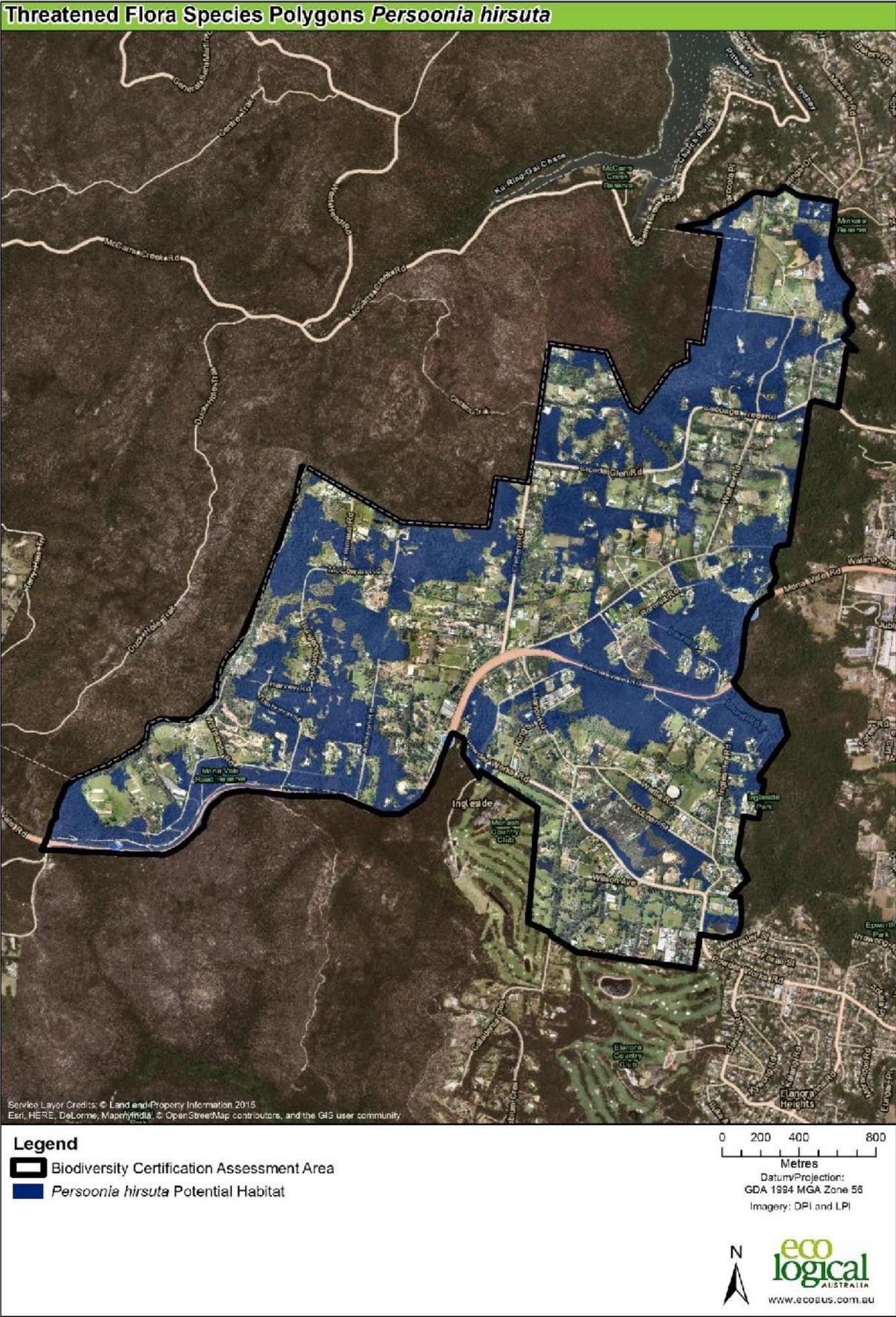


Figure 20: Threatened flora species polygons *Persoonia hirsuta*

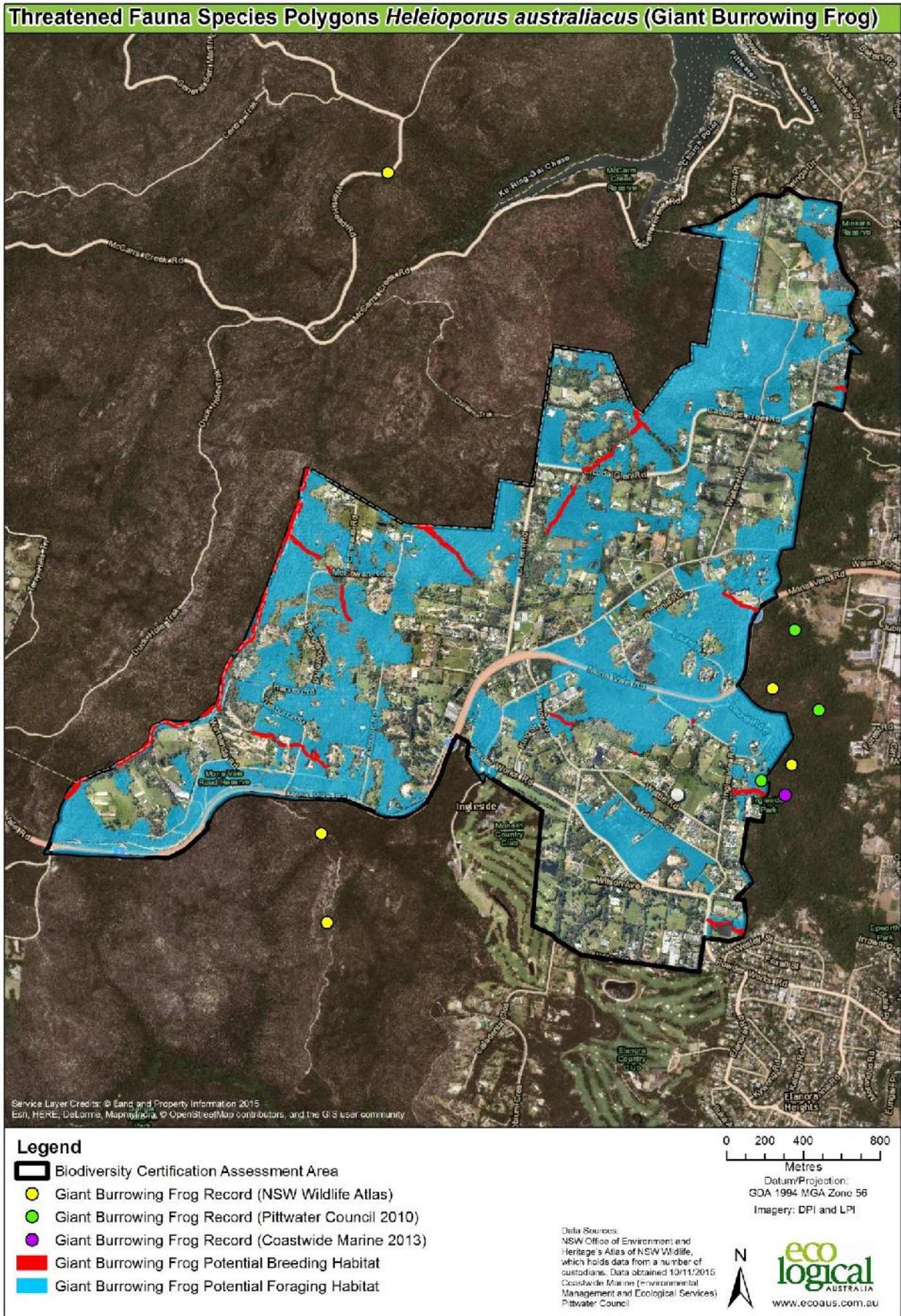


Figure 21: Threatened fauna species polygons *Heleioporus australiacus* (Giant Burrowing Frog)

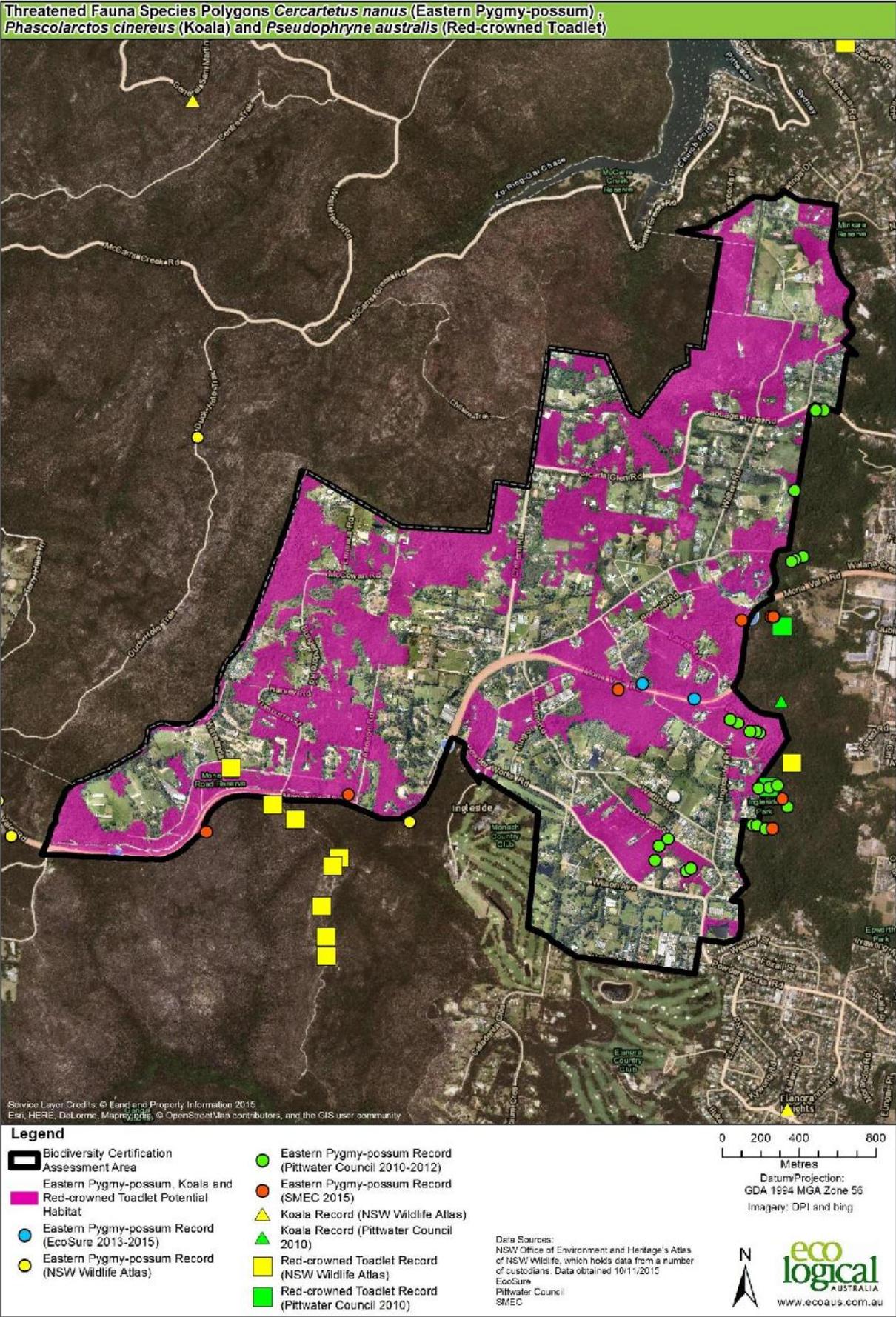


Figure 22: Threatened fauna species polygons Eastern Pygmy Possum, Koala, and Red-crowned Toadlet

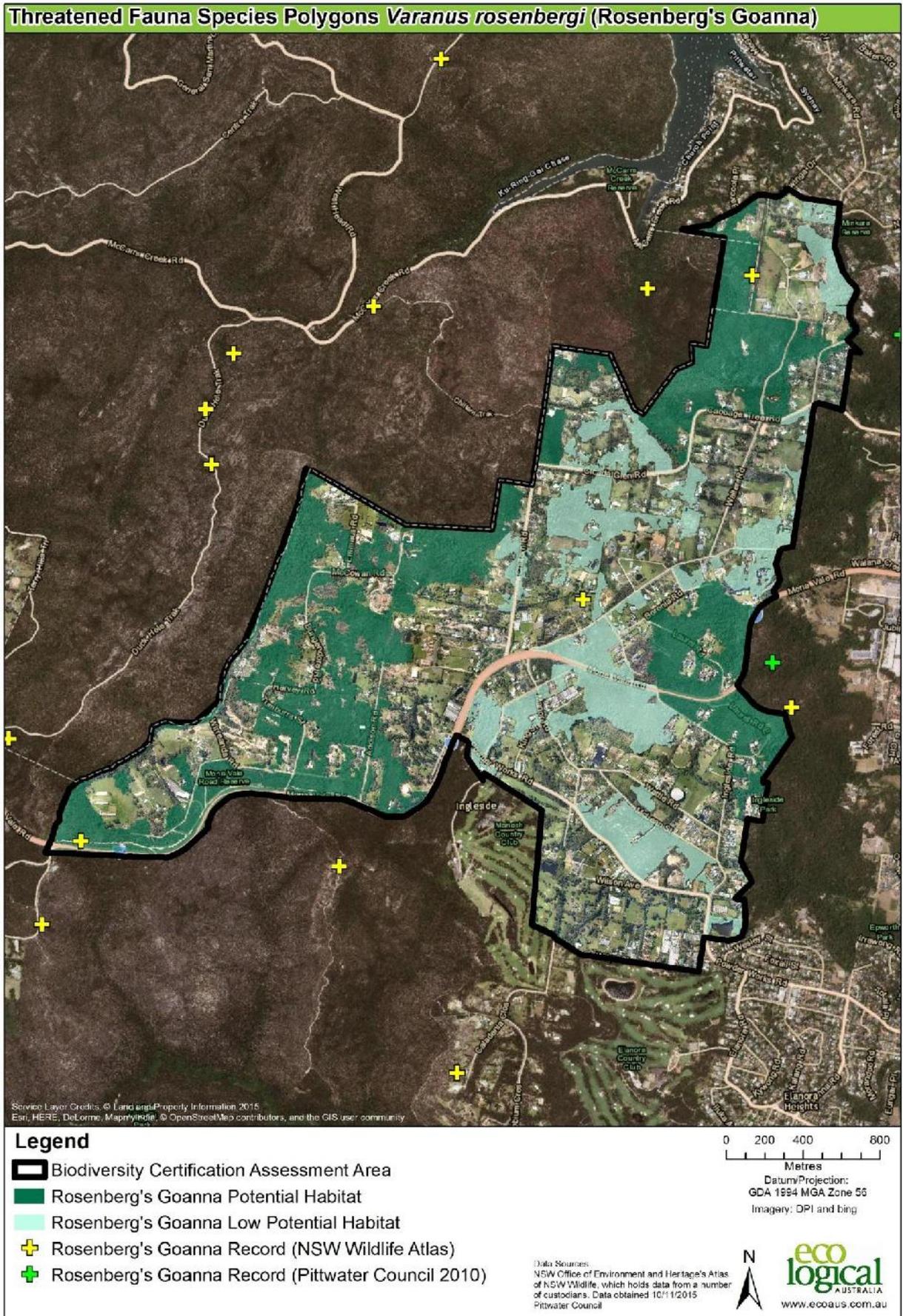


Figure 23: Threatened fauna species polygons Rosenberg's Goanna

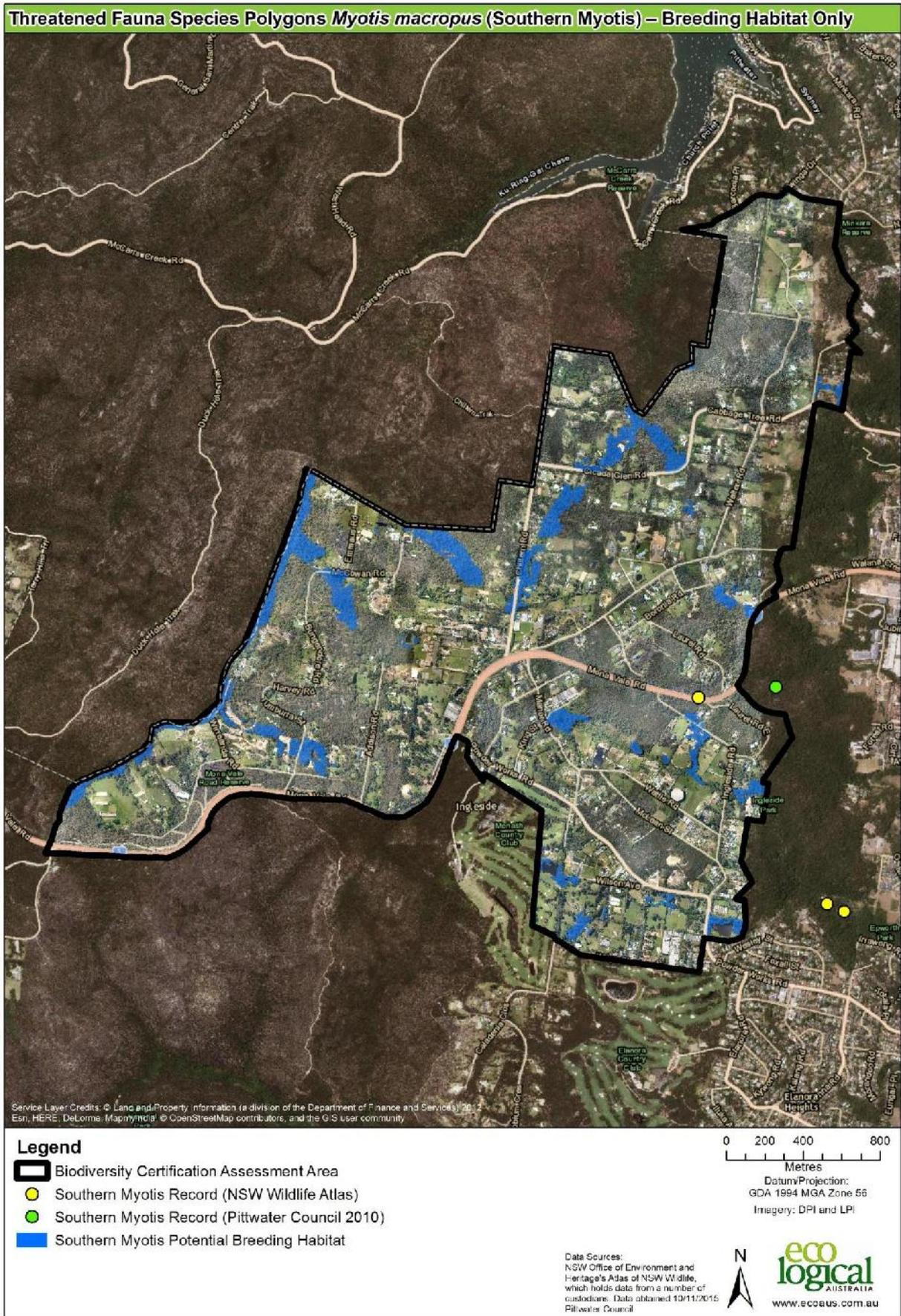


Figure 24: Threatened fauna species polygons *Myotis macropus* (Southern Myotis) – breeding habitat only

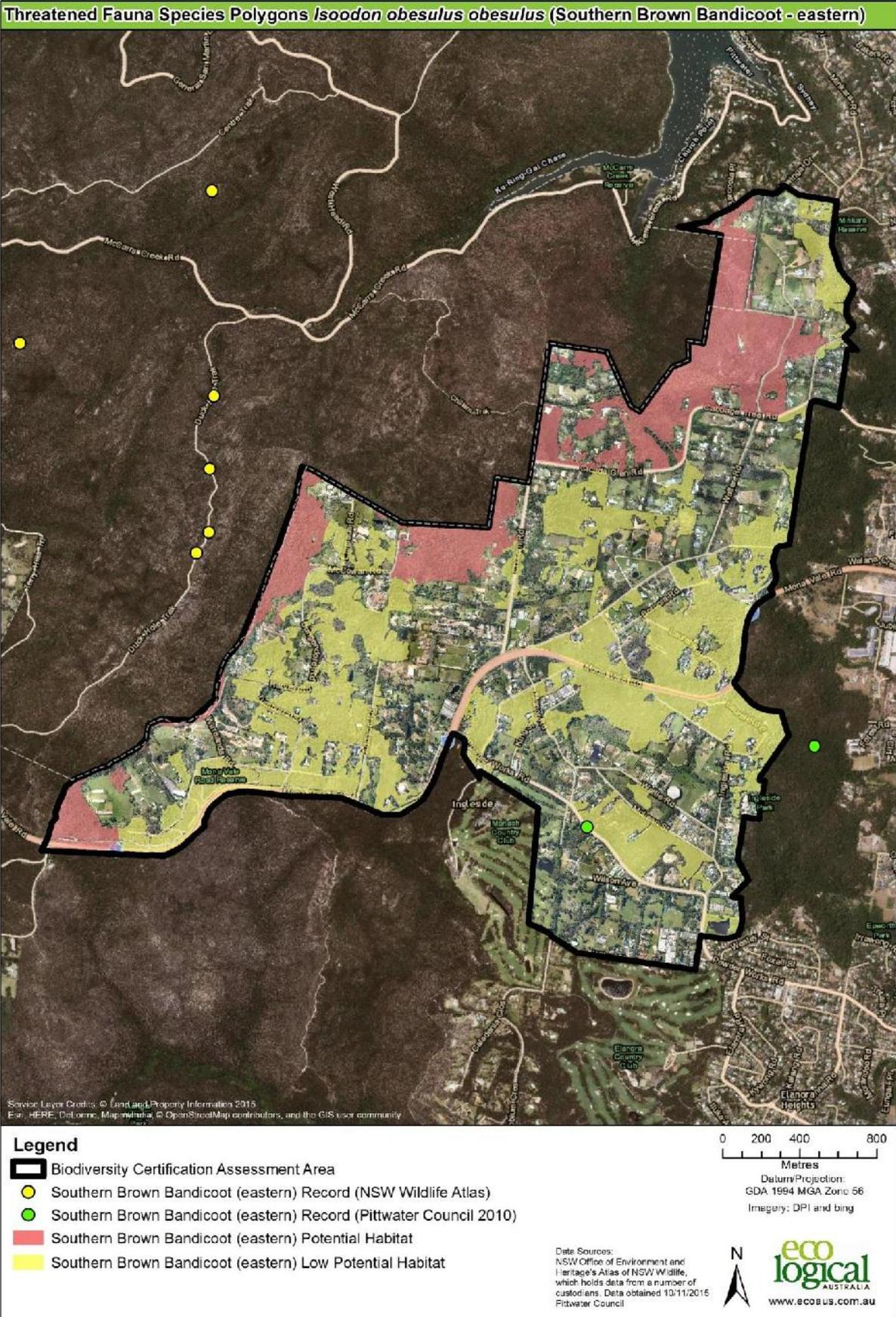


Figure 25: Threatened fauna species polygons Southern Brown Bandicoot

3.3.3 Threatened Flora Species Survey Results

No individuals were detected for *Acacia terminalis* subsp. *terminalis*, *Callistemon linearifolius*, *Darwinia biflora*, *Epacris purpurascens* var. *purpurascens*, *Eucalyptus camfieldii*, *Lasiopetalum joyceae*, *Leptospermum deanei*, *Melaleuca deanei*, *Persoonia hirsuta*, *Pimelea curviflora* var. *curviflora*, or *Tetratheca glandulosa*.

Grevillea caleyi was detected and counted in December 2013 as 39 live and four dead individuals, but as approximately 18% of potential habitat was accessible the confidence was rated as low.

A large number (8,500+) of *Microtis* individuals were detected within the Precinct. Although most individuals detected were suspected to not be *Microtis angusii*, based on published morphological characteristics, a total of 217 samples were genetically tested for species identification. Due to the sensitivity of specific locations for *Microtis angusii*, locations are not provided in this report.

Species identified from the field included *Microtis angusii*, *Microtis unifolia*, *Microtis parviflora* and *Microtis rara*. Where individuals could not be reliably assigned to a species in the field, due to lack of diagnostic morphological characteristics (e.g. inflorescent or leaves), they were identified as *Microtis* spp. All *Microtis* individuals were observed at sites associated with disturbance, with the vast majority recorded on road verges, particularly at the interface of slashed and non-slashed vegetation. Other sites' *Microtis* were recorded at included small drainage channels next to roads, mown lawns, amongst exotic grasses, recently burnt vegetation, mulch, and a single individual was recorded in a pot plant.

A total of approximately 8,500 *Microtis* individuals were counted and classified into species based on morphological characteristics. Leaf samples from individuals at each population were sent for genetic analysis. The samples sent for genetic analysis were used as the basis for determining population numbers, as *Microtis* species are found in clusters or colonies. Thus, all individuals from the population were assigned to the species confirmed through the genetic analysis sample. Four distinguishable species were confirmed from the genetic analysis. However, these differed from the field surveys. The notable difference being that no *Microtis unifolia* individuals were identified from the genetic testing (**Table 10**).

Individuals typically identified from the field surveys as *Microtis unifolia* were confirmed as *Microtis angusii* from the genetic analysis. This result suggests that *Microtis unifolia* and *Microtis angusii* identified from the field may actually be the same species from a genetic perspective, with a large amount of variation within the species for some morphological characteristics. Thus, *Microtis angusii* may be a relatively widespread species and the classification of the *Microtis* genus may need to be revised.

To inform whether *Microtis unifolia* and *Microtis angusii* are indeed the same species, samples of *Microtis* spp. (targeting *Microtis unifolia*) were collected from a number of locations outside of the precinct. These genetic results also supported the conclusion that the putative *M unifolia*, based on morphology, is actually *M. angusii*, because:

1. A sample from Belrose, south of the Ingleside Precinct, identified as *M unifolia*, based on morphology, came back as *M. angusii*,
2. One sample from Wentworth Falls tentatively identified as *M parviflora* (noting that this was collected very late in the flowering season), based on morphology, came back as *M. angusii*,
3. One sample from Blackheath came back as *M. angusii*, and,
4. Two samples from Cunnawarra National Park (near Armidale), identified as *M unifolia*, came back as *M. angusii*. It is noted that these were 'senso lato' which means that there was some minor variation from the reference *M. angusii* specimen, but this is not unusual given that this is 500km north of Ingleside.

M. angusii was previously thought to only occur in one location at Ingleside. Thus, the fact that *Microtis* spp. specimens from other sites are testing positive as *M. angusii* indicates that the species is actually much more abundant and widespread than previously thought. Further, the fact that *M. unifolia* and *M. angusii* are identifying as the same genetically, suggests that these are potentially part of a large morphological variation within the same species (i.e. that what is currently identified as *M. angusii* is a larger form of what is currently identified as *M. unifolia*).

Table 10: *Microtis* field survey and genetic analysis results

Species	<i>Microtis</i> populations estimated from field survey*	Samples confirmed from genetic analysis	Population count based on genetic results
<i>Microtis angusii</i>	139	101	4276
<i>Microtis unifolia</i>	4107	0	0
<i>Microtis parviflora</i>	1976 ¹	113	3659
<i>Microtis rara</i>	52	2	573
<i>Microtis</i> spp.	2240	N/A	N/A
<i>Microtis affiliate angusii</i>	0	1	6
Total	8514	217	8514

* Caution is required when interpreting population numbers identified from the field, as morphological characteristics required for identification between species may have been absent, or required high powered microscopes. The intention of the field survey was to collect samples for genetic identification. Thus, population numbers from the field survey is an estimate only.

3.4 Ecological connectivity and wildlife corridors

Ingleside Precinct is surrounded by large tracts of continuous vegetation. The most significant are conservation areas located along the western perimeter of the Precinct. Ku-ring-gai Chase National Park, located north of Mona Vale Road is over 154 km² in area, whilst Garigal National Park on the southern side of Mona Vale Road is 22 km² in area (**Figure 1**). Significant habitat for threatened flora and fauna species are represented within these National Parks. Connectivity between the two National Parks is currently fragmented by Mona Vale Road.

The BCAA incorporates a small portion of the adjoining conservation areas within the precinct boundary. The south-western corner is located on National Park tenure. It forms an important link between Ku-ring-gai Chase National Park and Garigal National Park. A band of Ku-ring-gai Chase National Park also occurs on the north-western perimeter of the Ingleside Precinct. The eastern boundary adjoins a series of three reserves (Minkara Reserve, Katandra Bushland Sanctuary, and Ingleside Chase Reserve).

Due to the current low density development within the Ingleside Precinct, connectivity within the landscape consists of intact patches of vegetation interspersed with cleared and scattered vegetation. Connectivity between the east and north, and east and western conservation areas, are currently present in a fragmented form. Clearing, fragmented vegetation, and roads have reduced the extent of vegetation connections in the BCAA.

3.4.1 Comparison of Pittwater Council and ELA Corridor Mapping

There have been several attempts to map potential wildlife corridors for conservation within the landscape. In 2011 Pittwater Council mapped large tracts of vegetation across the landscape as wildlife corridors. Prior to Pittwater Council, ELA worked in conjunction with Landcom (now UrbanGrowth NSW) to map potential wildlife corridors within Ingleside.

Pittwater Council

Pittwater Council produced broad scale wildlife corridor areas across the entire LGA, including the BCAA (Pittwater Council 2011, **Figure 26**). Pittwater Council supplied ELA a GIS layer of the corridors; however, no supporting documentation was available, and it is unclear whether any field validation was conducted, particularly over private lands.

The corridor mapping has utilised existing corridors which are represented as intact vegetation connected to conservation areas (Ku-ring-gai Chase National Park, Garigal National Park, Minkara Reserve, Katandra Bushland Sanctuary, and Ingleside Chase Reserve) outside the BCAA. By including large tracts of vegetation in the corridors, Pittwater Council has incorporated potential habitat and known habitat for threatened flora and fauna species. Each of the vegetation communities are represented in the corridors. Riparian buffers along Mullet Creek and other drainage lines are not mapped as part of the wildlife corridor.

The wildlife corridor mapping has identified fragmented vegetation and often privately owned lands adjoining Mona Vale Road, as well as between Cicada Glen Road in the north to Mona Vale Road in the south and Monash Golf Course, as part of the corridors. These areas are likely to provide limited current connectivity, and would require substantial restoration works to function effectively as linkages for a wide suite of fauna species.

ELA Corridors

ELA (2011) considered mapping of wildlife corridors within BCAA (**Figure 27**), and was based on field data from ELA (2008). The main objectives of the wildlife corridor mapping were to:

- Include the majority of the EECs within the corridor
- Achieve connectivity between five major conservation areas (Ku-ring-gai Chase National Park, Garigal National Park, Minkara Reserve, Katandra Bushland Sanctuary, and Ingleside Chase Reserve)
- Protect known or potential habitats for threatened species or regionally significant flora species habitat
- Retain examples of the native vegetation types which will be removed for development

The most significant link exists between Ku-ring-gai Chase National Park in the west and Garigal National Park in the south, and a second link joins to the north (also Ku-ring-gai Chase National Park) (**Figure 27**). Minor links exist between the east and west, particularly in a narrow link along Walter Road. There is potential that this link can extend to include National Park land located within the BCAA.

Connectivity between the north and south in ELA (2011) corridors would be maintained through a series of linear corridors and buffers which adjoin Katandra Bushland Sanctuary in the east. The ELA mapping included buffers to protect adjacent conservation areas such as National Parks and council reserves. Due to the access limitations and changes in listings, not all EECs were known within the BCAA and therefore some areas were not included within the wildlife corridors.

Comparison of Pittwater Council and ELA refined corridors

Pittwater Council corridor mapping is of large tracts of vegetation for corridors. On the other hand ELA identified a similar alignment of corridors in a reduced scale.

The greatest gap in the connectivity is maintaining north-south connectivity. This has been achieved in both datasets through a buffer along conservation areas outside the BCAA such as Katandra Bushland Sanctuary.

It should be noted that both sets of corridor mapping were prepared without field validation on privately owned lands (this is assumed for Pittwater Council). Similarly, both corridors were conducted prior to the listing of Coastal Upland Swamp as an EEC under the TSC Act. There are several patches of Coastal Upland Swamp which have not been included within the ELA corridor (King Street and Boronia Road) and one patch (King Street) was not included in the Pittwater Council corridors. The extent of Duffys Forest Ecological Community mapped by SMCMA (OEH 2013) is represented by both corridor sets.

Pittwater Council wildlife corridor and ELA have included an important link between Ku-ring-gai Chase National Park to the north-west and Garigal National Park to the south-east. The link borders Wirreanda Creek and captures a small extent of Coastal Sandstone Riparian Forest (HN607) for conservation within the corridor. This vegetation is not represented in other areas within the BCAA.

ELA updated the recommended wildlife corridor and buffers during the recent field validation. This is discussed in more detail in **section 4.2**.

3.4.2 Land mapped or defined as a state, regional or local biodiversity link

The connectivity value of the BCAA was determined in accordance with BCAM. No state or regional biodiversity links are present as defined by BCAM.

The BCAA includes areas defined as a local biodiversity link as:

- Riparian buffer 20m either side of a minor creek or 10m either side of a minor watercourse. It is noted that 'top of bank' mapping from ELA (2016) was used to calculate riparian buffer areas, and that this will differ slightly from 1:25,000 topographic centreline mapping.
- Areas of vegetation in moderate to good condition greater than 30m in width and with a patch size > 1ha separated by a distance of < 30m.

A minor creek is defined as a Strahler second order watercourse and a minor watercourse is defined as a Strahler first order watercourse. The local biodiversity links in the BCAA are presented in **Figure 28**.

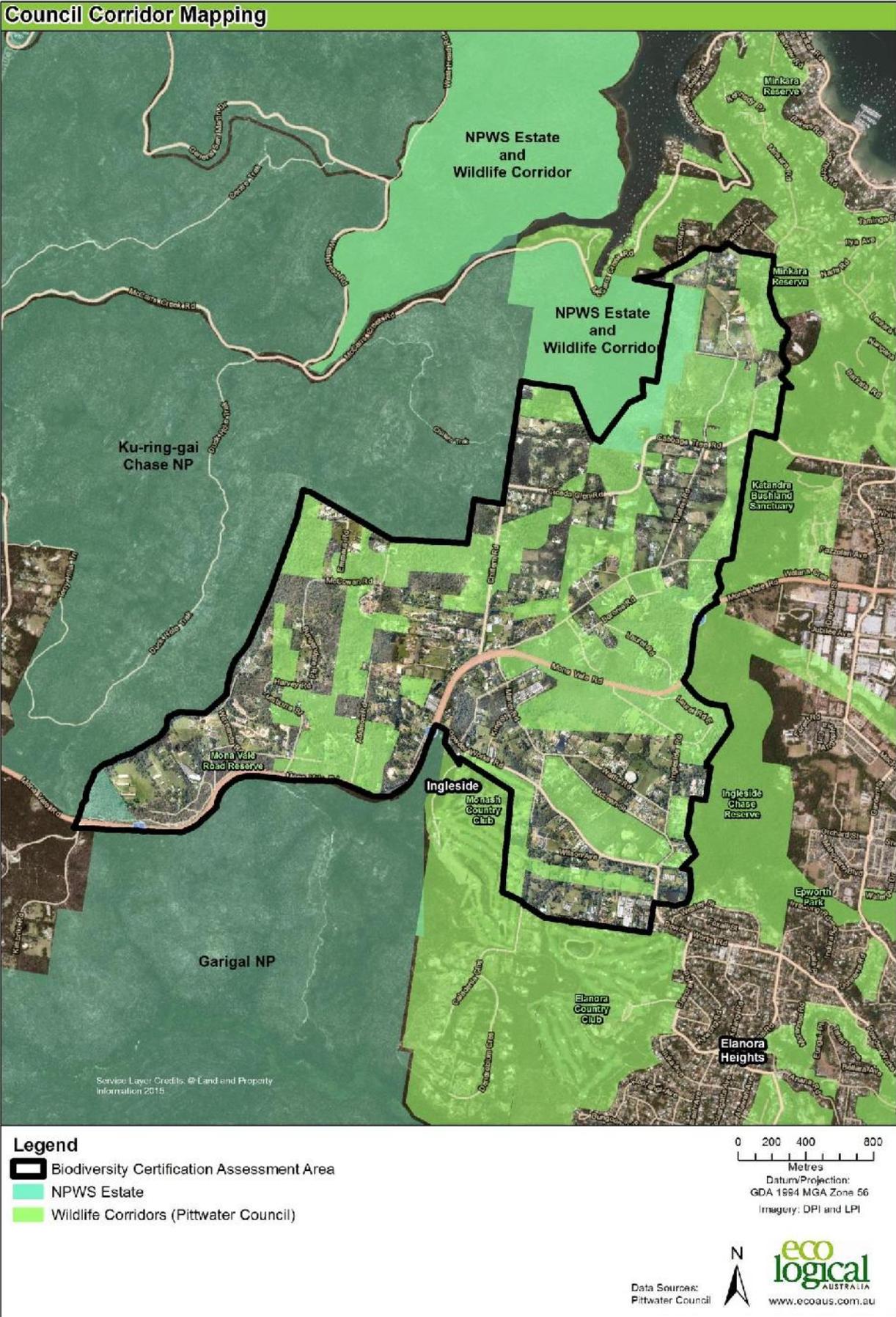


Figure 26: Pittwater Council wildlife corridors

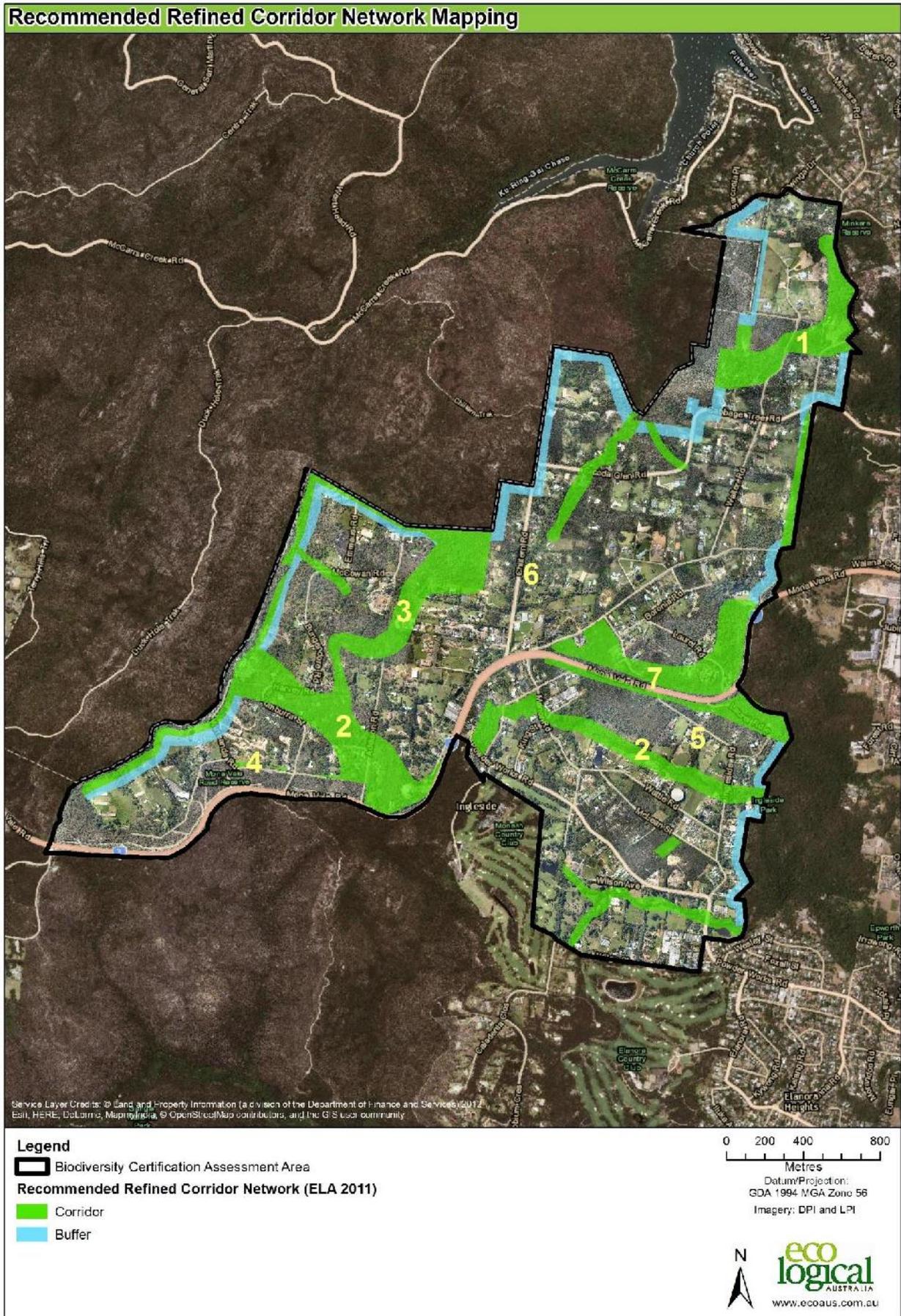


Figure 27: ELA recommended wildlife corridors (2011)

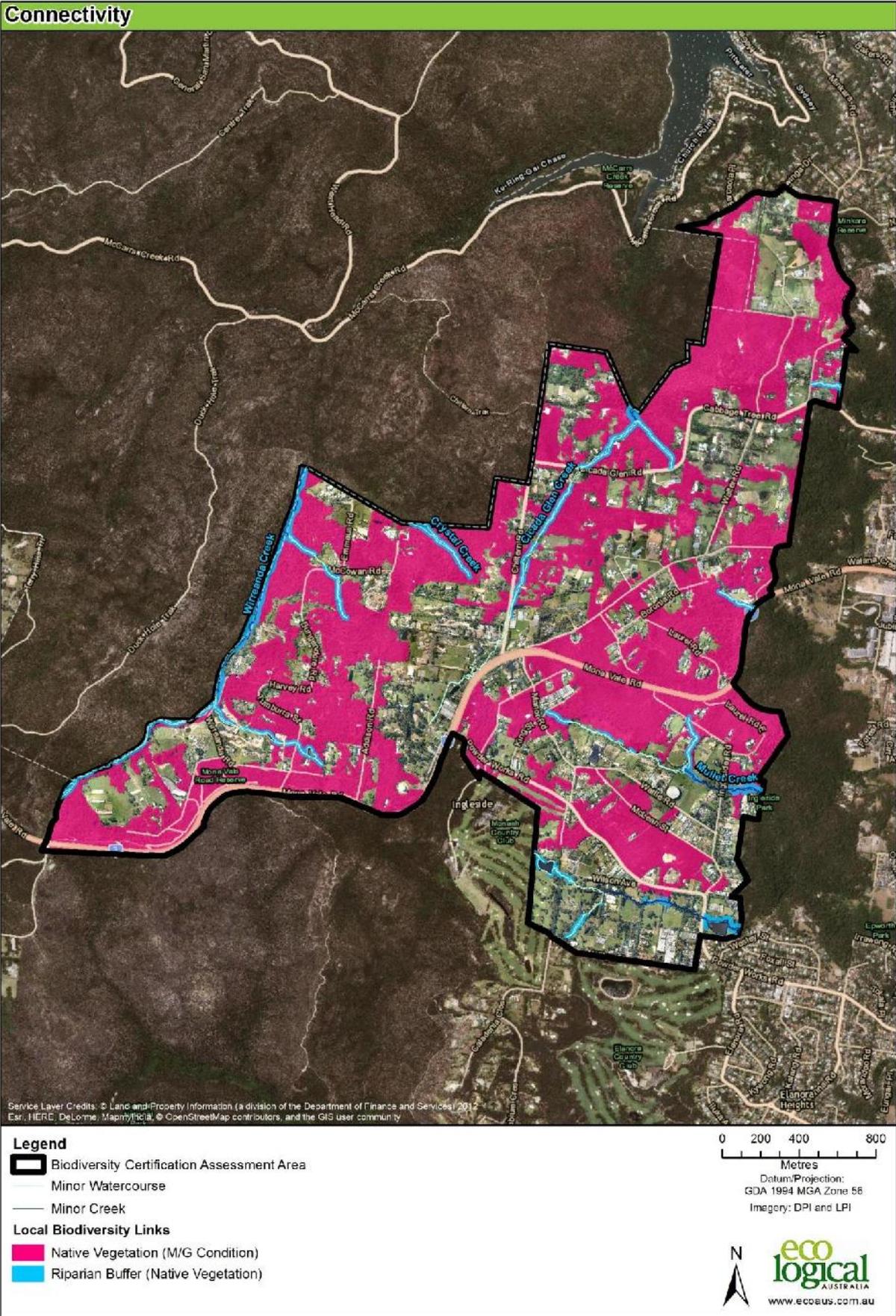


Figure 28: Map areas defined as BCAM biodiversity “local links”

3.5 Red flags

A red flag is an area regarded as having high biodiversity conservation values. Biodiversity certification may be conferred where the proposal will:

- Avoid direct impacts on red flag areas, or the Secretary is satisfied that the red flag variation criteria are satisfied (section 2.4 of BCAM, DECCW 2011).
- The direct impacts are offset in accordance with the rules and requirements set out in section 10 of the methodology (DECCW 2011).
- The Secretary is satisfied that any indirect impacts on biodiversity are appropriately minimised in accordance with section 6 of the methodology (DECCW 2011).

An area of land is regarded as a red flag are if it contains one or more of the following (summary of DECCW 2011):

- A critically endangered or endangered ecological community listed under the TSC Act or EPBC Act
- A vegetation type that is greater than 70% cleared as listed in the Vegetation Types Database
- Areas listed as a State Environmental Planning Policy (SEPP) 14 wetland.
- One of more threatened species in the Threatened Species Profile Database that cannot withstand further loss in the CMA
- Areas of vegetation recognised as having regional or state biodiversity conservation significance

These are discussed in **sections 3.5.1 - 3.5.3** below.

3.5.1 Red Flag Vegetation Types

Two vegetation types correspond to endangered ecological communities listed under the TSC occur in the BCAA. These are mapped in **Figure 28** and listed in **Table 11**. None of the vegetation types present are identified as >70% cleared (**Table 5**). There are no areas listed as SEPP 14 wetland.

Table 11: Red Flag Vegetation Types

Biometric Vegetation Type	SMCMA 2013 Vegetation Community	TSC Act Endangered Ecological Community	EPBC Act
HN560 - Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin	Coastal Upland Wet Heath Swamp	<i>Coastal Upland Swamps in the Sydney Basin Bioregion</i>	<i>Coastal Upland Swamps in the Sydney Basin Bioregion</i>
	Coastal Upland Damp Heath Swamp		
HN567 - Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin	Sydney Ironstone Bloodwood-Silvertop Ash Forest	<i>Duffys Forest ecological community in the Sydney Basin Bioregion</i>	N/A

3.5.2 Red Flag Threatened Species

Threatened species which are red flags are listed in **Table 12** below along with the number of individuals for threatened flora species which are considered a negligible loss within the CMA area. A loss of '0' means that the species cannot withstand the loss of any in the CMA and are red flagged; a number > '0' means that the species is able to withstand the loss of a number up to, and including, the number indicated. A loss of greater than the negligible number means a red flag is triggered.

Table 12: Red Flag Threatened Species

Scientific Name	Common Name	Negligible Loss per CMA area
Flora		
<i>Acacia terminalis</i> subsp. <i>terminalis</i>	Sunshine Wattle	2
<i>Callistemon linearifolius</i>	Netted Bottle Brush	5
<i>Darwinia biflora</i>	-	2
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	5
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	0
<i>Grevillea caleyi</i>	Caley's Grevillea	0
<i>Lasiopetalum joyceae</i>	-	5
<i>Leptospermum deanei</i>	Leptospermum deanei	0
<i>Melaleuca deanei</i>	Deane's Paperbark	0
<i>Microtis angusii</i>	-	150
<i>Persoonia hirsuta</i>	Hairy Geebung	0
<i>Pimelea curviflora</i> var.	-	0
<i>Tetratheca glandulosa</i>	Glandular Pink-bell	5
Fauna *		
<i>Isodon obesulus</i>	Southern Brown Bandicoot	0
<i>Phascolarctos cinereus</i>	Koala – Pittwater Endangered population**	0

* Other species credit fauna species are "n/a" for negligible loss which means that red flags are not triggered.

** It is noted that individuals within the BCAA would not be part of the Endangered Population, for which the intention was to list the population on the Barrenjoey peninsula, but which is now considered locally extinct.

3.5.3 Vegetation areas with regional or state biodiversity conservation significance

There are four areas of vegetation recognised as having regional or state biodiversity conservation significance in the BCAA. In accordance with the BCAM red-flag definitions, these areas are vegetation forming the 20m wide riparian buffers of a minor creek. The BCAM Appendix 1 definition of a minor creek includes: "any part of a stream that is not listed in the Major Rivers Database, is not an effluent or flood runner, and the topographic map in the PVP Developer shows that it has tributaries upstream of it..." (DECCW 2011). This assessment did not have access to the PVP Developer, however an OEH representative has advised that the map in the PVP Developer is 1:25,000 topographic maps. Accordingly, minor creeks as defined in Appendix 1 of BCAM are Strahler 2nd order watercourses.

Sections of the following creeks, which are downstream of the junction of two first order creeks, are minor creeks. The vegetation forming the 20m buffer on either side of these creeks is red-flagged (**Figure 30**):

- Wirreanda Creek
- Cicada Glen Creek
- Mullet Creek – portions of both the northern and southern tributaries in the south eastern section of the BCAA.

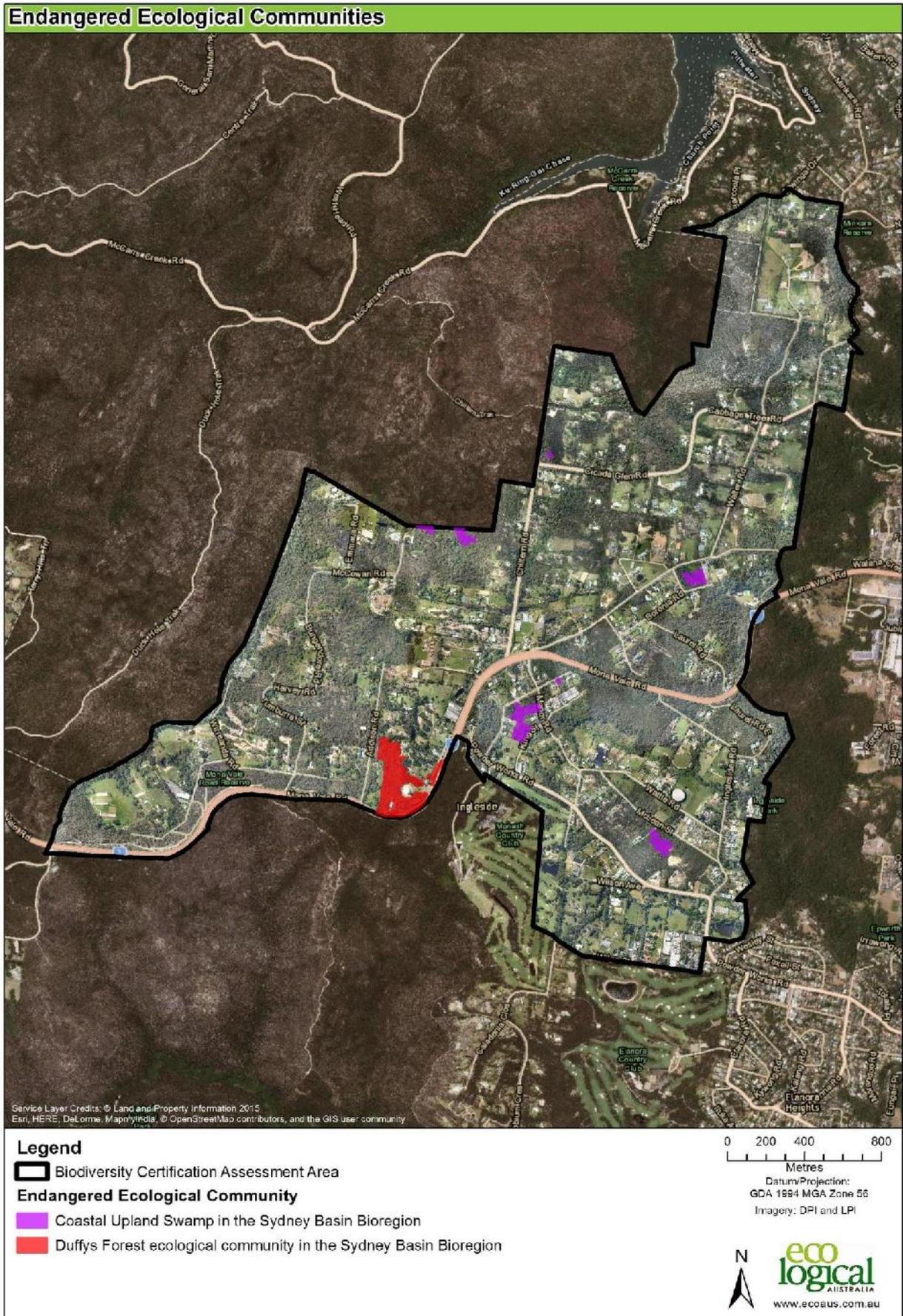


Figure 29: Location of EECs within the BCAA

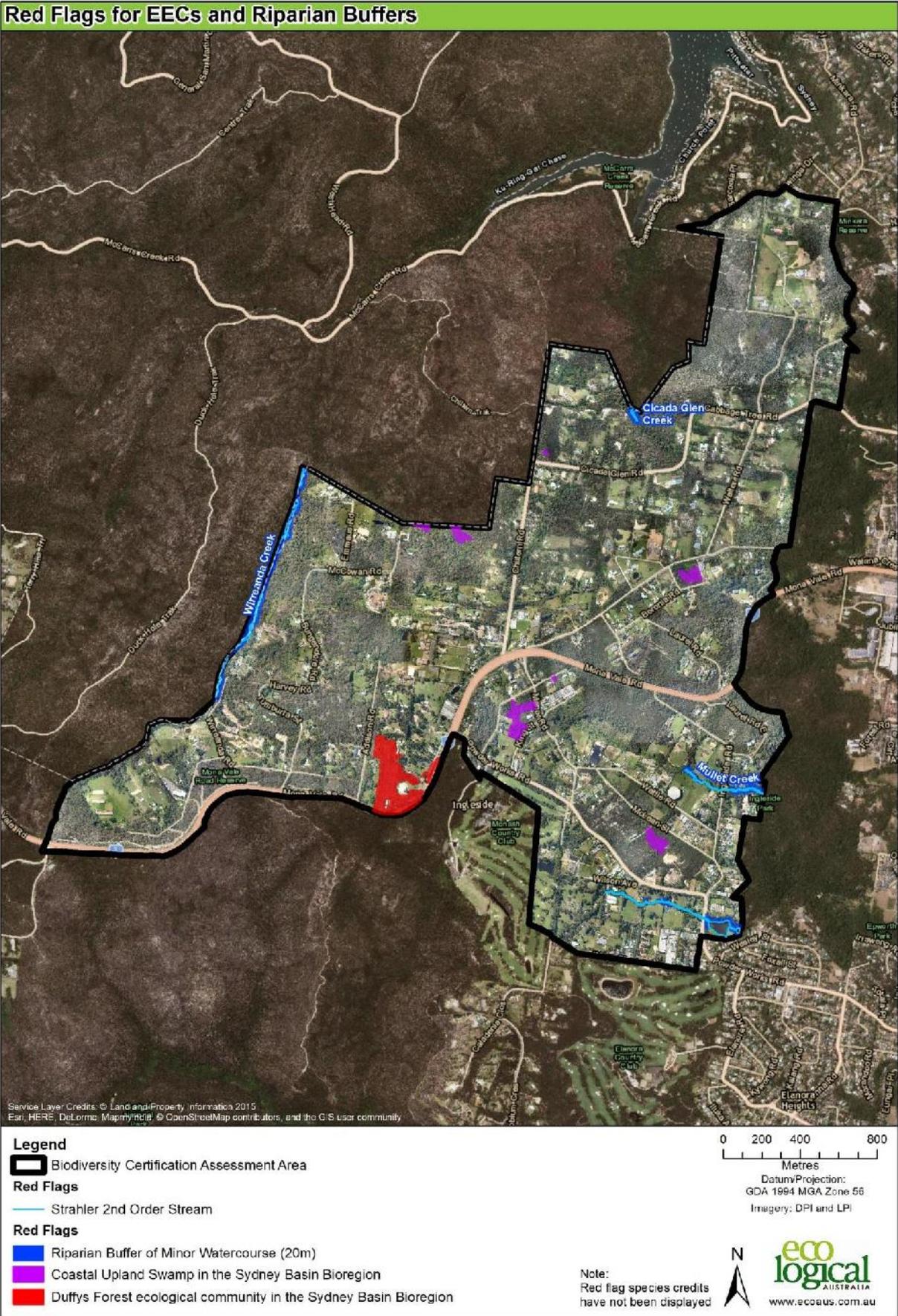


Figure 30: Vegetation and drainage line red flag areas

3.6 Property access and confidence levels

3.6.1 Property access

The BCAA incorporates semi-rural hobby farms, large estates, horticultural facilities, quarries and educational centres (Camp Kedron and Ingleside Scout Camp). A significant proportion of areas not surveyed are located on private lands where access was not permitted (**Figure 5**). Leased lands on crown property also contributed to areas where access was not gained, but was a small proportion of the total amount of crown lands.

Despite this, a total of 352.09 ha (consisting of 224.92 ha of native vegetation) was assessed using random meander, plots and transects during field surveys. This represents 49% of the total BCAA area. A large majority of the vegetation validated was represented along road verge vegetation. This contributed up to 82.98 ha of the assessable lands. Crown land also contributed a significant proportion of the lands accessed, while private lands were less frequently represented due to limited accessibility.

A further 227.89 ha (consisting of 76.12 ha of native vegetation) was validated from adjoining lands where the vegetation had a high visibility, which permitted identification of the canopy, shrub and ground cover species and equates to a moderate to high level of confidence (**Table 2**).

3.6.2 Confidence levels

An assessment of the confidence level of assessing vegetation type/condition and species habitats was conducted according to the BCAM guidelines. The OEH guideline for BCAM assessments where access is not available to lands within the BCAA (OEH 2015, Appendix F) states that:

“For each biodiversity value (vegetation type, fauna species credit species, flora species) the assessor should provide:

- (a) An assessment of the risk that the situation within the no access area will differ from the estimated condition, extent of habitat for fauna species, or the estimated number of individuals for flora species, and*
- (b) An assessment of the implications of the differences. For example whether it is likely that a vegetation community mapped as an Endangered Ecological Community could instead be a relatively abundant community type, whether the extent of estimated threatened fauna habitat could be more or less abundant and whether there is a risk that a key resource could potentially be present and impacted upon, and whether flora species may be more or less abundant than estimated.”*

The level of confidence is correlated to the limitations involved during the ecological assessment. Access is a key limiting factor in the ability to accurately identify vegetation zones, to gather plot/transect data, to identify and survey for threatened fauna habitat and to conduct threatened flora counts. The indicative level of confidence for vegetation zones (ecosystem credits), fauna species credit species, and threatened flora in areas of ‘no access’ was used as per the ‘Inaccessible land protocol’ for Biodiversity Certification assessments (Appendix F, OEH 2015). A key item to note is that a moderate level of confidence is likely to be the highest level achieved for a threatened flora species with ‘no access’ areas, because threatened flora can vary significantly in their abundance and density (i.e. plants may occur in very low numbers in one area, and very high numbers in another area). Vegetation communities and threatened fauna may represent a high level of confidence.

Other factors which may also influence the level of confidence include:

- Location of the no access areas in relation to lands which can be accessed

- The characteristics of the threatened species or vegetation for assessment, and the difficulty of assessing these remotely
- Whether or not the lands which cannot be accessed are likely to be similar in nature for vegetation condition, aspect, geology and other relevant attributes to the lands which can be accessed and surveyed
- The variation in density of threatened flora (i.e. whether the variation in density is relatively low, or extremely variable)
- The ecological needs of the individual threatened species

These factors considered in the assessment area are provided in **Figure 5** and **Appendix F**. The guideline ratings of 'low', 'moderate' or 'high' have been assigned according to the BCAM Inaccessible land protocol' (Appendix F, OEH 2015). However, these rankings may not represent the true level of confidence due to the factors listed above. ELA then completed a determination of the confidence levels and amended the ranking as required to reflect the true level of confidence of the data (as assessed by ELA). Potential ecological implications were also identified during this process. The results for each vegetation zone and threatened species are provided in **Appendix F**.

A variety of different assessment methods were used to validate vegetation within no-access areas. The recent SMCMA (OEH 2013) provided a base layer for field validation. Visibility of the vegetation structure, and an assessment of the vegetation within the surrounding landscape, assisted in the validation of vegetation in no-access lands. Topography and terrain also contributed to vegetation assessment. Riparian and sheltered gully vegetation types were easily distinguished from ridgetop and heathlands vegetation types.

Validation of threatened species habitats and records were also limited by no-access areas. A conservative approach was undertaken to map potential habitat for threatened species within the BCAA.

Confidence in the outcomes for the delineation of vegetation zones ranges from Moderate to High (refer to **Appendix F** for details). The vegetation has been assessed through ground-truthing, and where access is not available has been mapped via a combination of recent vegetation mapping dataset (OEH 2013), use of recent aerial imagery to delineate boundaries, and ground-truthing. The ground-truthing involved identification of the vegetation communities where access was available, plus visual inspections from roadsides or adjoining properties wherever possible. In some instances, plot/transect data has been gathered from sites outside of the BCAA so that this information will be available for analysis. In these instances, visual inspections identified that the vegetation in which the plot/transects were performed and the target vegetation were similar in nature. It is therefore considered that overall, there is a relatively high degree of confidence in the vegetation mapping. Some differences may potentially occur in the areas which could not be accessed, but overall these differences are likely to be large. There was one zone which could not be accessed to gather plot/transect data, and thus confidence for this zone will be low.

Confidence in the outcomes for the threatened flora was low to moderate (**Appendix F**). Species polygons were mapped, but it is very difficult to estimate population numbers without access to all habitat areas.

The confidence for the fauna species credit species polygons was moderate to high (**Appendix F**), as the habitat is associated with features that can be mapped, and is easier to predict in areas without access. The presence of these species was assumed, but this is not unreasonable given the large areas of contiguous habitat immediately adjacent to (and partially within) the BCAA. A conservative approach was taken to map the species polygons to capture all potential habitats. Accordingly, the implications of over-predicting this species is low for proposed development lands (as this would mean that additional credits were required), and moderate for proposed conservation lands (as credits would be created).