Ingleside Precinct – Draft Biodiversity Assessment Report

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Cover photo	Top Coastal Upland Damp Heath Swamp (EEC). Bottom left to right: *Xanthorrhoea arborea*, *Grevillea caleyi* (threatened flora species), *Scaevola ramosissima* and Needlebush - banksia wet heath community.

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Abbreviations

Abbreviation	Description
ARA	Adjacent Remnant Area
APZ	Asset Protection Zone
BCAA	Biodiversity Certification Assessment Area
BCAM	Biodiversity Certification Assessment Methodology
BCAR	Biodiversity Certification Assessment Report
BCS	Biodiversity Certification Strategy
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DFEC	Duffys Forest Ecological Community
DoE	Commonwealth Department of the Environment (formally SEWPaC)
DP&E	NSW Department of Planning and Environment (formerly NSW Department of Planning)
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now the Department of the Environment)
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPP	Eastern Pygmy Possum
GBF	Giant Burrowing Frog
GDE	Groundwater Dependent Ecosystem
HBT	Hollow-bearing Trees
HNCMA	Hawkesbury Nepean Catchment Management Area
IoM	Improve or Maintain
LGA	Local Government Area
NPWS	NSW National Parks and Wildlife Service (now part of OEH)
OEH	NSW Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PCT	Plant Community Type
RCT	Red-crowned Toadlet
SIC	State Infrastructure levy
SEPP	State Environmental Planning Policy
SMCMA	Sydney Metropolitan Catchment Management Area (now merged with the HNCMA)
TBSA	Threatened Biodiversity Survey and Assessment guidelines

Abbreviation	Description
TS	Threatened Species
TSC Act	NSW *Threatened Species Conservation Act 1995*
TSPD	Threatened Species Profile Database
VIS	Vegetation Information System

Definitions

DEFINITION	DESCRIPTION
Area of High Biodiversity Conservation Value	As described under Section 2.3 of the BCAM. Areas include critically endangered and endangered ecological communities (EEC) not in low condition, threatened species that cannot withstand further loss, areas of vegetation that have regional or state conservation significance, and state and regional biodiversity corridors. Also termed Red Flag Areas.
Biodiversity Certification Assessment Area	As described in the BCAM, it includes land where certification is proposed to be conferred and any surrounding or adjacent land. Surrounding and adjacent land may be proposed for biodiversity conservation, or neither certification or development (Retained Land). In this report it refers to the Ingleside Precinct.
Biometric Vegetation Type	A plant community classification system used in BioMetric Tools, including the BioBanking Tool, Biodiversity Certification Tool and Property Vegetation Planning Tool. Plant Community Type (PCT) is now also used for vegetation type identification, and these are also identified in this report.
Conservation Area	Land within the Biodiversity Certification Assessment Area that is proposed for conservation measures.
Conservation Measures	The range of measures identified in Section 126L of the TSC Act.
Candidate species credit species	A species which is a 'candidate' for assessment as a species credit species. If habitat is not present, the species can be shown not to be present, or an expert report is prepared which identifies that the species is unlikely to occur, then credits will not be required for that species. An expert report can also be prepared to identify the presence and extent of habitat for fauna, or number of individuals for flora.
Development Area	Land within the Biodiversity Certification area that is proposed for certification.
Ecosystems Credit	As described under the BCAM, the class of credit for biodiversity certification that are generated for conservation measures or required for the land proposed for certification. Ecosystem credits are also generated for some threatened species that are assumed to be present based on the location of the site and the vegetation types present.
Expert Report	A report prepared by 'a person who has the relevant experience and/or qualifications to provide expert opinion in relation to the biodiversity values to which an expert report relates'. These reports are prepared to identify whether a threatened species is present, and the extent of habitat for fauna, or number of individuals for flora.
Low Biometric Condition	As described in Section 2.3 of the BCAM. To meet the 'low condition' threshold a number of criteria described in the method must be met, including <50% of the lower benchmark value of over storey precent cover for the relevant vegetation type or native vegetation with a site value score of less than 34 (Site value score is described in Section 3.6.2 of the BCAM).
Managed and Funded Conservation Measure	As described under Section 8.1.1 of the BCAM. Examples include entering into a Biodiversity Banking Agreement with respect to the land under Part 7A of the TSC Act and the reservation of land under the NPW Act.
Managed Conservation Measure	As described under Section 8.1.2 of the BCAM. Examples include entering into a conservation agreement under Division 12, Part 4 of the NPW Act and entering into a planning agreement under the EP&A Act that makes provision for development contributions to be used for, or applied towards, the conservation or enhancement of the natural environment.

DEFINITION	DESCRIPTION
Moderate-Good Biometric Condition	As described in Section 2.3 of the BCAM. Any vegetation that is not in 'low condition' is in 'moderate to good' condition.
Planning Instrument Conservation Measure	As described under 8.1.3 of the BCAM. Application of this measure requires a number of conditions to be me that are described under the relevant Section of the method.
Plant Community Type (PCT)	A plant community classification system used for vegetation identification. At this stage Biometric Vegetation Type is used in the Biodiversity Certification Tool for credit calculations, but associated Plant Community Type (PCT) are also identified in this report.
Red Flags	As described in Section 2.3 of the BCAM. See 'Areas of High Biodiversity Conservation Value' above.
Retained Land	Land within the Biodiversity Certification Assessment Area that is not land proposed for biodiversity certification or subject to proposed conservation measures.
Species credit	As described in the BCAM, the class of credits for biodiversity certification that are generated for a conservation measure or are required for the land proposed for certification.
Species credit species	A threatened species which requires (on generates) credits specifically for that species, as specified by the BCAM methodology. It is a species which is not included as part of ecosystem credits.

Executive summary

Eco Logical Australia Pty Ltd (ELA) was engaged by Department of Planning and Environment (DP&E) to assess ecological impacts of the proposed land use changes for the Ingleside Precinct. The Ingleside Precinct encompasses an area of approximately 700 hectares on the Northern Beaches of Sydney, in the west of the former Pittwater Local Government Area (now part of the Northern Beaches Local Government Area). The two key objectives of this report are to identify the biodiversity values of the Ingleside Precinct and provide strategic conservation management recommendations. The ecological values identified in this report have also informed the development of the Draft Structure Plan.

DP&E intends to seek Biodiversity Certification for the rezoning of the Ingleside Precinct in the future under the NSW *Threatened Species Conservation Act 1995* (TSC Act). For this reason the Biodiversity Certification Assessment Methodology (BCAM) has been used to assess the ecological outcomes of the proposed Draft Structure Plan (referred to in this report as the Biodiversity Certification Assessment Area or BCAA).

The assessment has been undertaken using field and desktop methods. In preparing the report, existing information in previous flora and fauna reports, databases and vegetation mapping products has been utilised where possible. Additional vegetation survey, collection of biometric transects/plot data, and targeted surveys for threatened species have been undertaken by ELA for this project in lands that were accessible.

Ten biometric vegetation types and approximately 351 ha of native vegetation have been identified in the BCAA. The remaining 365 ha were classified as either “exotic” which comprised non-native planted vegetation and/or weed species, or previously cleared. A large proportion (300 ha or 85%) of the native vegetation was assessed as being in good condition, with weed invasion mainly confined to tracks, edges and small isolated areas of disturbance. However, a number of areas of native vegetation had reduced plant species diversity and moderate to heavy weed presence in the mid-storey and groundcover strata. The poorer condition vegetation communities occurred along watercourses and some minor drainage lines in disturbed catchments, roadsides and adjacent to land-uses involving heavy earthworks and landfill. The highly invasive aquatic weed *Ludwigia peruviana* (Peruvian Primrose) was detected along Wirreanda and Cicada Glen Creeks.

Two Endangered Ecological Communities (EECs) are located within the BCAA. Duffy’s Forest Ecological Community and Coastal Upland Swamp are both listed as EECs under the TSC Act, with Coastal Upland Swamp also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In accordance with BCAM a total of 16 threatened fauna species, including Glossy-Black Cockatoo, Spotted-tail Quoll, Powerful Owl, Gang-gang Cockatoo, and other species, are predicted to be present on site by habitat surrogates. This means that these species are assessed together with native vegetation, collectively under ‘ecosystem credits’.

The remaining eight threatened fauna species and 13 threatened flora species are candidate ‘species credit species’ and the likely habitat for these species has been mapped as ‘species polygons’ using past records, known population locations, existing information on the species’ habitat requirements supplemented by field survey.

Grevillea caleyi was detected in proximity to the Baha’i temple near the intersection of Mona Vale Road and Addison Road, with 39 live individuals counted. None of these individuals are within areas proposed

for urban land use. A fire in this area within the last few years appears to have stimulated the germination of *Grevillea caleyi* seedlings.

Prior to this study *Microtis angusii* (Angus's Onion Orchid), which is listed as Endangered under both the TSC Act and EPBC Act, was known to occur in the southwestern corner of the Ingleside Precinct in proximity to Mona Vale Road. This was the only known location for this threatened species, but additional recent records have been provided by Roads and Maritime Services, with locations identified in proximity to Mona Vale Road extending as far east as Ingleside Road. An intensive field survey was undertaken within the precinct and a total of approximately 8,500 individuals from the Microtis genus were counted during the field survey. Individuals were classified into species in the field based on morphological characteristics, and included *Microtis angusii*. However, because the threatened species *Microtis angusii* is difficult to differentiate from other species within the genus, genetic testing subsequent to the field survey was utilised. The genetic testing gave the result that individuals identified from the field surveys as *Microtis unifolia* (a common and widespread species) were actually identified as *Microtis angusii* based on the genetic analysis.

Additional samples of *Microtis* from outside the Ingleside Precinct, collected from Belrose, Blackheath (Blue Mountains), Wentworth Falls (Blue Mountains), and Cunnawarra National Park (Armidale), were also genetically tested and came back as matching *Microtis angusii.* This result suggests that *Microtis unifolia* and *Microtis angusii* may actually be the same species from a genetic perspective, just with a large amount of morphological variation. Thus, *Microtis angusii* is now believed to be a relatively widespread species. The classification of the Microtis genus, and the listing of *Microtis angusii* as threatened, may therefore need to be revised. A total of 4,276 *Microtis angusii* individuals were identified within the precinct.

A further 10 threatened plant species were considered as potentially occurring and species polygons (areas where the species may occur) have been mapped, but individuals were not detected during surveys in the appropriate time of year.

Two threatened frogs, Giant Burrowing Frog and Red-crowned Toadlet, are considered likely to occur due to the presence of suitable habitat and recent records in the Katandra Bushland Sanctuary and Ingleside Chase Reserve to the east. Eastern Pygmy Possum is known to occur with known records in habitat to the north of Powderworks Road (within management zone 7). The Koala, Rosenberg's Goanna, and Southern Brown Bandicoot are considered as potentially occurring, particularly in areas of habitat within or well connected to Ku-ring-gai National Park. Breeding habitat for Southern Myotis may potentially occur in proximity to drainage lines, and the species has been recorded in the Ingleside Chase Reserve to the east (their foraging habitat is captured under ecosystem credits). Potential foraging habitat for Regent Honeyeater is present, however, this would be for infrequent vagrant individuals with the site unlikely to be of significance as a foraging resource whilst migrating.

The following general management recommendations have been made:

- Protect and manage areas of 'high' ecological constraint (**Table 13**).
- Retain the majority of areas of 'moderate' ecological constraint (**Table 13**). The long-term management of smaller areas of 'moderate' constraint should be considered, and if these patches are not retained their loss should be offset through rehabilitation or restoration to consolidate remnants and link priority areas.
- Provision of a vegetation buffer along conservation areas such as National Park and Council reserves to retain wildlife corridors and protect conservation areas. Buffer areas would also assist

in bushfire management, both ecologically and by reducing the level of bushfire risk for development. Seek to manage invasive weed species in these buffer areas.

- Asset protection zones should not be located in areas set aside for conservation (either wildlife corridors or in National Parks or Council reserves).
- Investigate the possibility of "ecological burns" in a matrix of unburnt and burnt design to provide foraging habitat for threatened fauna species, such as the Eastern Pygmy Possum. The aim of these would be to remove weed growth and rejuvenate native shrub growth in heath, woodland and riparian habitats. Management post fire would also be required.
- Undertake best practice soil erosion control during construction, and maintain as required, to prevent sediment flow into watercourses and into management units.
- Maintain corridor link between Garigal and Ku-ring-gai Chase National Park. Continue liaison with RMS on Mona Vale Road upgrade and ecological crossings to retain wildlife links and reduce fauna mortality.

Specific conservation management strategies and options were provided for each management unit. These have been considered in the preparation of the Draft Structure Plan but should also be considered during subsequent more detailed planning.

Ecological connectivity through the site attempts to link large areas of habitats outside the BCAA. The corridor mapping considered the biodiversity links mapped in accordance with BCAM, Pittwater Council Corridor (2011) corridor mapping, and ELA Refined Corridor Mapping (2008). It is understood that fauna crossings will be included in the pending Mona Vale Road upgrade.

The Draft Structure Plan has been assessed for its ecological impacts and the broad outcomes are:

- Just over 30% of lands within the Ingleside Precinct are proposed to be converted to Environmental Conservation or Environmental Management. This is in addition to lands currently conserved within National Parks.
- The vast majority (96%) of the 9.05 ha of EECs present are being retained.
- Of the 291.87 ha of native vegetation which is not listed as threatened and is in ‘good’ condition:
    - 48% will be conserved,
    - 29% retained (no change in status),
    - 22% being impacted by development landuse,
    - 1% is within water management landuse.
- For threatened flora, no *Grevillea caleyi* are within development areas. For *Microtis angusii* (Angus Onion Orchid) 69% of *Microtis angusii* individuals are in conservation areas, 9% are within development areas, and land use for the remainder will not change.
- As the majority of good condition native vegetation on site is being conserved or retained, similarly the majority of habitat for threatened fauna species credit species is also being conserved or retained.
- It is anticipated that red flag variations will be required for the minor impacts on Coastal Upland Swamp EEC (due to impact on 0.35 ha and all areas triggering a red flag), *Microtis angusii* (as 373 individuals within the development land use is more than the 150 ‘negligible loss’ per CMA area permitted before a red flag is triggered), and Southern Brown Bandicoot habitat (as any impact on habitat triggers a red flag).

These outcomes for biodiversity values in terms of ecosystem and threatened species credits will be quantified when Biodiversity Certification is sought, which is anticipated to occur in conjunction with the rezoning.

Pittwater and Northern Beaches Councils

In May 2016 Pittwater Council was merged into a new body, the Northern Beaches Council. As this report was commenced prior to these changes, it makes reference to the former council. The plans and strategies of the former council continue to apply to the former local government area until the new council prepares its own plans and strategies.

1 Introduction

1.1 Project Background

The Ingleside Precinct (referred to in this report as the Biodiversity Certification Assessment Area or BCAA) is located in the Northern Beaches Local Government Area (LGA) (**Figure 1**). The majority of the Precinct is zoned Rural Landscape under Pittwater Local Environment Plan (LEP) 2014. Ownership is a mix of public and private ownership, with approximately one third in state government ownership.

The Minister for Planning and Pittwater Council have agreed to undertake a Precinct Planning Process for the BCAA. This process is to identify development potential and to establish development controls. The Department of Planning and Environment (DP&E) intend to ultimately seek Biodiversity Certification of development land within the BCAA in accordance with Part 7AA of the NSW *Threatened Species Conservation Act 1995* (TSC Act).

1.2 Biodiversity Certification Process

The Biodiversity Certification Assessment Methodology (BCAM) (DECCW 2011) was developed by the NSW Office of Environment and Heritage (OEH) and was gazetted by the NSW government in February 2011. The methodology may be applied to land for which biocertification is sought, and conferred by the Minister for the Environment if the proposed conservation measures result in an overall improvement or maintenance in biodiversity values. This is referred to under the methodology as satisfying the 'improve or maintain test' (IoM test).

To obtain Biodiversity Certification (or 'biocertification') the 'planning authority' (i.e. Council or DP&E) must submit a biodiversity certification application and Biodiversity Certification Strategy (BCS); both of which are required to be publicly exhibited. The ecological values are to be assessed in accordance with the gazetted methodology (BCAM). It is anticipated that the data gathered and presented in this report will be used in a future BCAM assessment. This future assessment will quantify the impact on biodiversity values from the proposed rezoning, in addition to any gains from conservation measures in accordance with the BCAM methodology.

For the purposes of the TSC Act, biodiversity values include (but are not limited to) threatened species, threatened populations and threatened ecological communities (EECs), and their habitats. Biodiversity values listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are also assessed, though Biodiversity Certification does not, at the time of writing this report, grant Commonwealth EPBC Act approval. The definition of biodiversity values does not include fish or marine vegetation within the meaning of Part 7A of the NSW *Fisheries Management Act 1994*, unless that fish or marine vegetation has been the subject of an order under section 5A of the TSC Act.

If the Minister confers biocertification on land, under Part 7AA of the TSC Act, a consent/approval authority does not have to take biodiversity issues into consideration when assessing future development applications, i.e. for the purpose of s.5A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), the development or activity is not subject to an Assessment of Significance for threatened species, populations or ecological communities.

1.3 Conditions of Biodiversity Certification

Under the BCAM, the impact of development and conservation measures on biodiversity values is quantified using biodiversity credits, which are defined by each of the vegetation types (ecosystem credits)

and threatened species present (either via ecosystem credits for threatened fauna species or via species credits). In this regard, the methodology determines the number of credits that are '*required*' to offset the adverse impacts of development on biodiversity values, and, the number of credits that can be '*generated'* by undertaking recognised conservation measures as outlined in s126L of the TSC Act that will improve biodiversity values within the BCAA. Where the number of credits that are created is equal to, or exceeds the number and type of credits required, the '*improve or maintain'* test described under the methodology is considered to be satisfied, provided 'Red Flags' have been avoided, or a Red Flag Variation has been approved by the Secretary of OEH.

Red Flags are areas of high biodiversity conservation value, and include vegetation types that are >70% cleared, Endangered Ecological Communities (EECs) or Critically Endangered Ecological Communities (CEECs) listed under the TSC Act and/or EPBC Act, certain threatened species (where the loss is greater than a threshold level), and areas that are recognised as biodiversity corridors of state or regional significance. This report identifies Red Flags present within the site (**Section 3.5**).

Further details on Biodiversity Certification can be found on the Office of Environment and Heritage website at: http://www.environment.nsw.gov.au/biocertification/index.htm.

1.4 Scope of Report

Eco Logical Australia has been engaged by DP&E to apply the BCAM to assess the proposed Ingleside Precinct rezoning, hereafter the Biodiversity Certification Assessment Area (the BCAA). This document presents the results of field survey data and information on biodiversity values, as well as the amount of native vegetation present within zones proposed in the Draft Structure Plan.

Subsequent to this Draft Biodiversity Assessment Report, it is anticipated that a formal Biodiversity Assessment Report and a Biodiversity Certification Strategy (not yet prepared) will be exhibited as part of the Ingleside precinct planning process. The future formal Biodiversity Assessment Report will include calculation of the impacts and gains according to the Biodiversity Certification methodology. The Biodiversity Certification Strategy will set out the conservation actions proposed and will be prepared to accompany the formal rezoning application. This document thus primarily identifies the biodiversity values present within the precinct, and also provides indicative details of biodiversity outcomes, noting that full credit calculations will be provided in the future documentation.

ELA has also been engaged to undertake a Riparian Corridor Assessment (ELA 2016c) and Bushfire Assessment (ELA 2016a), the results of which are presented in separate documents. A separate report was also prepared for the results of investigations on *Microtis angusii* (Angus's Onion Orchid) (ELA 2016b). As this plant is classified as a category 2 sensitive species under the NSW Sensitive Species Data Policy, observation locations cannot be released due to the potential risk of disturbance. However, the results are summarised in this report.

Further details on the NSW Sensitive Species Data Policy can be found on the Office of Environment and Heritage website at:

http://www.environment.nsw.gov.au/policiesandguidelines/SensitiveSpeciesPolicy.htm

1.5 Study area description

The Ingleside Precinct is approximately 700 hectares (ha) in size (see **Figure 1**). The Ingleside Precinct is bounded by major roads, conservation areas and other lands. Mona Vale Road bisects the Ingleside

Precinct and also forms part of the south-western boundary. Other major roads which intersect the Ingleside Precinct include: Powderworks Road, Lane Cove Road and Chiltern Road.

Currently the Ingleside Precinct consists of low density rural dwellings interspersed with open grazing land and dense native vegetation patches. Agricultural and horticultural industries feature within the landscape. These include quarries, nurseries and golf courses (Monash and Elanora Country Club) located along the southern boundary.

Significant conservation lands are immediately adjacent to the Ingleside Precinct, these include: Ku-ring-gai Chase National Park to the north and northwest, Garigal National Park to the south, Katandra Bushland Sanctuary to the east and Ingleside Chase Reserve to the east (**Figure 1**).

The vegetation types within the Ingleside Precinct (referred to in this report as the Biodiversity Certification Assessment Area – BCAA) are strongly influenced by the topography. Heath vegetation is associated with shallow soils and rocky outcrops and generally occurs at higher elevations within the Precinct. At times the terrain rapidly falls away and steep moist gullies are located along the eastern and western boundaries of the precinct (e.g. Wirreanda Creek and Cicada Glen Creek, **Figure 2**).

A large proportion of the Ingleside plateau is cleared semi-rural land with remnants of coastal heath/scrub. These remnants are characterised by a high diversity of flowering shrubs dominated by proteaceous species (ICF and AM 1994). There are also extensive stands of natural and secondary regrowth bushland containing flora and fauna habitats, particularly along the ridgelines and creek lines (Pittwater Council 2008).

Most of the vegetation across the site was burnt during the large January 1994 bushfires (Ingleside Landcare 2006). Since this time there has been other smaller fire activity throughout the precinct. Vegetation within the western and northern boundaries, and central portions of the precinct, has experienced fires in recent years, and fire areas within the Duffys Forest vegetation community was observed to have stimulated the germination of *Grevillea caleyi* seedlings.

Weed invasion is quite heavy in areas where native vegetation has been cleared or disturbed, including along roadsides and most of the watercourses. There is also evidence of weed invasion caused by dumping and escapees from private gardens. Major weeds include Pampas Grass (*Cortaderia selloana*), Crofton Weed (*Ageratina adenophora*), Lantana (*Lantana camara*) and West Australian Wattle (*Acacia saligna*) (Ingleside Landcare 2006).

The site occurs on Hawkesbury Sandstone with minor shale and laminite lenses. Five different soil landscape types occur across the site (Chapman and Murphy 1989, **Figure 3**). These are described briefly below:

- Oxford Falls soil landscape consists of hanging valleys on Hawkesbury Sandstone with low eucalypt woodland, scrub, heathland and sedgeland. Soils include moderately deep to deep earthy sands, yellow earths and siliceous sands on slopes; deep leached sands, podzols and grey earths on valley floors.
- Hawkesbury soil landscape features rugged, rolling to very steep hills on Hawkesbury Sandstone with >50% rock outcrops. Vegetation is mostly uncleared eucalypt open-woodland and tall open-forest. Soils are shallow lithosols/siliceous sands associated with rock outcrops; earthy sands, yellow earths and some yellow podzolic soils on inside of benches; localised yellow and red podzolic soils associated with shale lenses; siliceous sands and secondary yellow earths along drainage lines.

- Lambert soil landscape features undulating to rolling hills on Hawkesbury Sandstone, occurring on exposed plateau surfaces, convex ridges and coastal headlands of the Hornsby Plateau. Vegetation consists of open and closed-heathland, scrub and occasional low eucalypt open-woodland. Soils include shallow earthy sands and yellow earths, shallow siliceous sands/lithosols; shallow to moderately deep leached sands, grey earths and gleyed podzolic soils in poorly drained areas; localised yellow podzolic soils associated with shale lenses.
- Somersby soil landscape is characterised by gentle undulations to rolling rises on deeply weathered Hawkesbury Sandstone plateau. Vegetation is extensively cleared, low eucalypt open-woodland and scrubland. Soils include red and yellow earths overlying laterite gravels and clays on crests and upper slopes; yellow earths and earthy sands on mid slopes; grey earths, leached sands and siliceous sands on lower slopes and drainage lines, gleyed podzolic soils in low lying poorly drained areas.
- Gymea soil landscape features undulating to rolling rises and low hills on Hawkesbury Sandstone with extensively cleared open-forest and eucalypt woodland. Soils are shallow to moderately deep yellow earths and earthy sands on crests and inside of benches; shallow siliceous sands on leading edges of benches; localised gleyed podzolic soils and yellow podzolic soils on shale lenses; shallow to moderately deep siliceous sands and leached sands along drainage lines.

The soils of the Ingleside area are prone to erosion and landslip (Pittwater Council, 2008). Sources of erosion include unstabilised driveways and tracks on steep slopes, removal of vegetation and dumping of landfill (Ingleside Landcare, 2006).

1.6 Project objectives

The objectives of this report are to:

- Identify biodiversity values within the Ingleside Precinct
- Define ecological constraints and opportunities in the Ingleside Precinct to inform the Draft Structure Plan
- Provide broad conservation management recommendations for ongoing environmental management; and
- Quantify native vegetation and ecological values present within proposed landuse zones.

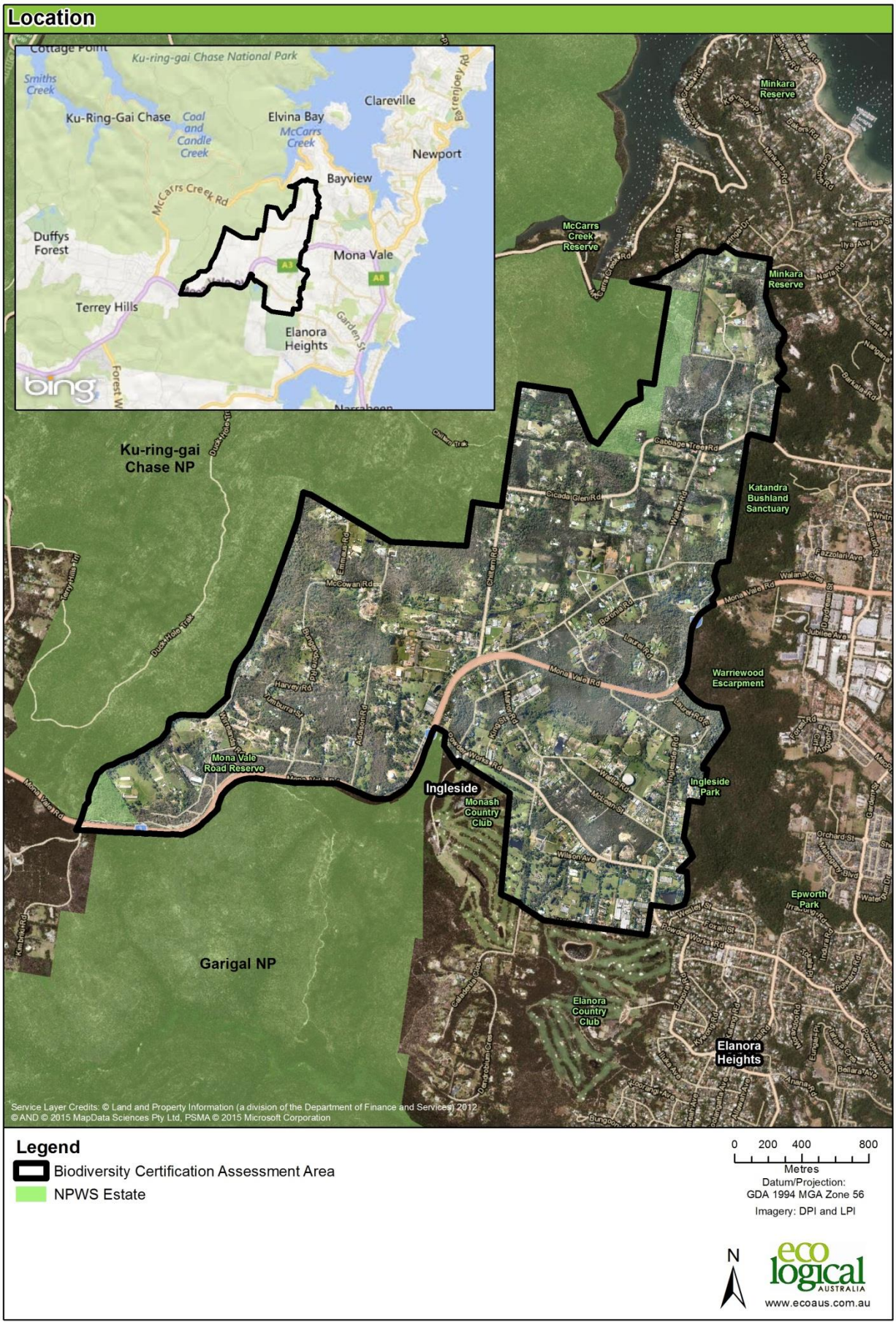

Figure 1: Ingleside Precinct (BCAA) locality map

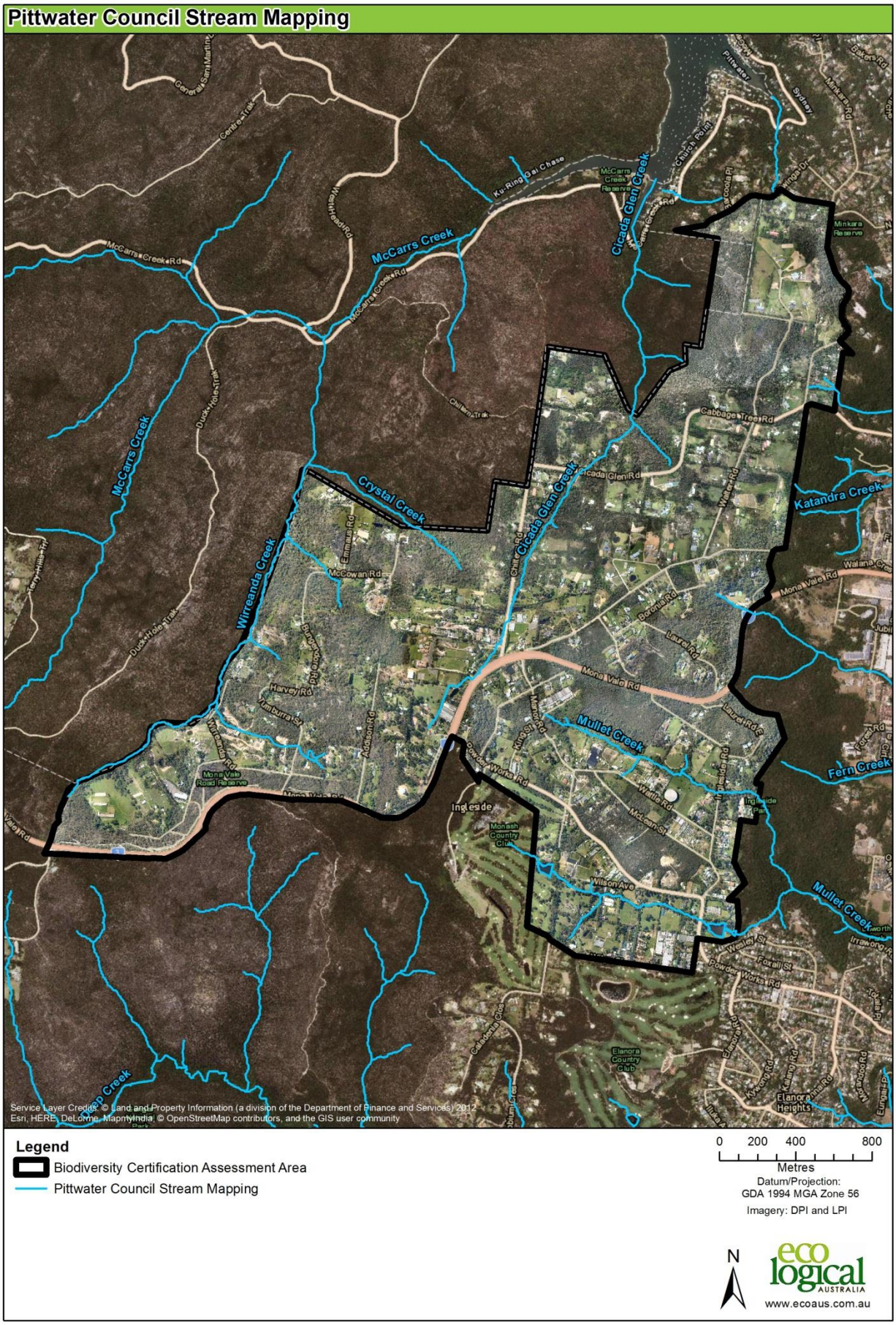

Figure 2: Drainage lines

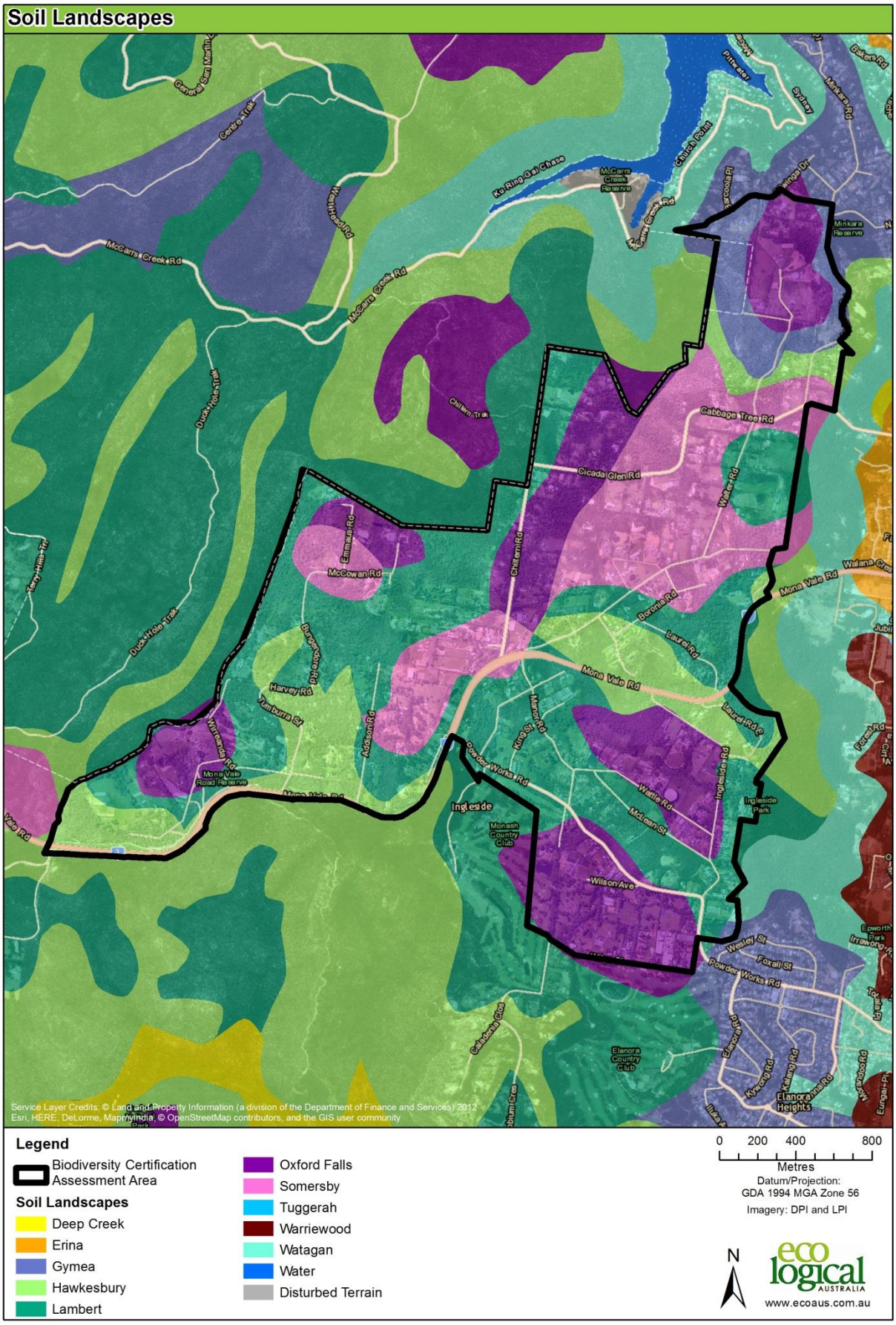

Figure 3: Soil landscape

2 Methods

The BCAM methodology was used to identify biodiversity values (vegetation type and condition, identifying vegetation zones and assessment of site value using plot and transect surveys), and to undertake assessment of ecosystem credit species and species credit species known or likely to occur in the BCAA.

DP&E provided a GIS layer of property access and land tenue (refer to **section 3.6.1** for details of property access). This information was used to guide field work. ELA obtained permission from land holders before field surveys.

Top of Bank (ToB) mapping has been undertaken by ELA within the BCAA and the methods and results are available in the separate Riparian Assessment report (ELA 2016c). Reference should be made to this report for riparian buffers and stream health, however, this report utilises the results of that assessment.

2.1 Vegetation mapping and condition assessment

A desktop review of previous vegetation mapping datasets was conducted in October/November 2013 prior to field validation. Comparison of three vegetation mapping datasets (ELA 2008, Pittwater Council 2011, and OEH 2013) was undertaken.

ELA (2008) vegetation mapping was a combination of desktop datasets, and two days of field validation by two ELA botanists on public lands only. It included a broad condition category assessment, and the vegetation types were correlated to biometric vegetation types.

Vegetation mapping and corridor mapping produced for Pittwater Council (2011) was provided in GIS format and had finer scale mapping, with some limited ground-truthing of private property. The Pittwater Council mapping identified much of the vegetation within the Ingleside Precinct as altered/disturbed. The mapping did not provide a correlation to biometric vegetation types, and did not include a condition category assessment. 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.

The latest vegetation mapping for Sydney Metropolitan Catchment Management Authority (SMCMA, OEH 2013) had detailed mapping incorporating small scale changes in the landscape and vegetation type. Within the BCAA the OEH (2013) mapped approximately 398 ha of vegetation comprising of eleven vegetation communities, and a mixture of weeds/exotics, urban native, plantation and other categories. This mapping also provided corresponding biometric vegetation types. Consequently, the SMCMA mapping by OEH (2013a) was used as a base layer.

Prior to field validation, ELA carried out desktop aerial photograph interpretation of all the digital vegetation datasets using high resolution aerial photography at a scale of 1:5,000 (provided by Council). Some areas of mapped vegetation patches were reclassified based on aerial interpretation, and new areas were assigned a preliminary identification of “potential remnant”, “unknown” or “exotic/native plantings”, which resulted in another approximately 5.5 ha of mapped vegetation. These additional categories were then classified as either a biometric vegetation type or as exotic during field validation. The exotic classification included native non-indigenous plantings within private gardens and other landscaped areas.

A range of condition states for vegetation were encountered during the field survey conducted from Dec 2013 to February 2014. Vegetation condition and zones were determined in accordance with BCAM methodology and biometric vegetation types (DECC 2008b). BCAM defines vegetation zones as relatively homogenous areas of the same vegetation type and similar condition. The results and terminology used for the various condition states are discussed in **section 3.2.4**.

A final condition code of exotic which meets the BCAM definition of 'cleared land' was given to areas 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.

Following agency consultation further investigations were undertaken in March and April 2016 which targeted areas potentially supporting the Coastal Upland Swamp EEC. The time since fire is a particularly important factor to identify and delineate the occurrence of Coastal Upland Swamp EEC. This is because with increased time since fire, Coastal Upland Swamps commonly form dense thickets dominated by obligate seeders (species which are killed by fire). In this state dense thickets of shrubs can form. These shrubs, such as *Banksia ericifolia*, which is found in the Coastal Upland Swamp EEC at Ingleside, are part of the community. However, this species also occurs, and is dominant in, adjoining Coastal Sandstone Heath-Mallee (HN541) and Coastal Sandstone Rock Plate Heath (HN540) vegetation. In addition, when Coastal Upland Swamp EEC occurs in a dense shrub thicket state, the sedge and smaller shrub layers, which are indicative of the Coastal Upland Swamp EEC, become less diverse and much sparser in cover. Thus, identification of the location and extent of Coastal Upland Swamp EEC is difficult if it is a long time since fire.

Some areas were identified by Pittwater Council for further investigation, for sites containing potential Coastal Upland Swamp EEC. These sites were revisited in March 2016 (**Figure 4**). At the time of the initial field validation of vegetation types (December 2013/January 2014), most of the vegetation within the BCAA showed no evidence of having been burnt since the bushfires in January 1994. When further investigations were undertaken in March 2016 on the Council identified sites, there had been some recent bushfires (<1 year prior) which allowed additional areas of Coastal Upland Swamp EEC to be identified.

Subsequent to this fieldwork, the occurrence of Coastal Upland Swamps across the Precinct was reviewed. Locations where Coastal Upland Swamps could potentially occur were determined through a combination of aerial photograph interpretation, consideration of the topography, and the extent of field validation which had already been undertaken within specific locations. This work was undertaken by ecologist Brian Towle, who has extensive experience in the identification of Upland Swamps. Areas which were considered to potentially support Coastal Upland Swamps were mapped (**Figure 4**). Each polygon was also assigned a confidence level which represented the overall likelihood of Coastal Upland Swamp occurring (Very likely, Uncertain, and Unlikely) based upon aerial photo interpretation, topography and level of survey already conducted within the area.

The areas of identified potential Coastal Upland Swamps were then validated through a targeted field survey by ecologist Brian Towle. Two areas identified as potentially supporting Coastal Upland Swamp were not inspected: an area located within private property to the east of Chiltern Avenue (rated as unlikely), for which access was not available, and an area within Ku-ring-gai Chase National Park (rated as uncertain).

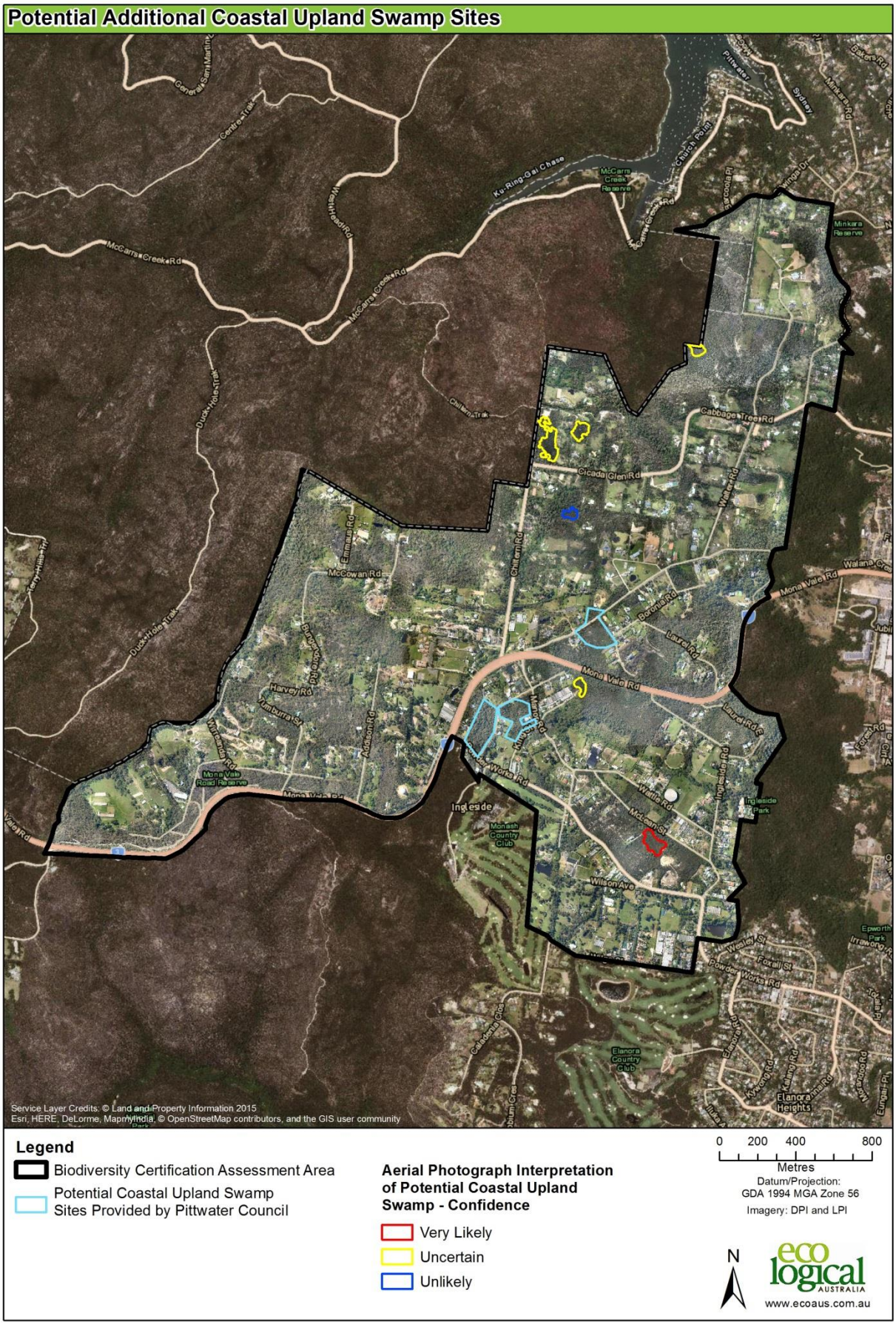

Figure 4: Potential Coastal Upland Swamp sites.

2.2 Threatened species

Searches of BioNet / Atlas of NSW Wildlife and the EPBC Protected Matters Search Tool (OEH 2015b) for threatened flora and fauna which have either been previously recorded within the region or are likely to occur due to the presence of suitable habitat were undertaken in November 2015. A 5km search radius around the BCAA was undertaken. The threatened species profile database which supports the BCAM and Biobanking Assessment Tool v1.08, and which contains the most up to date information on threatened species, was also accessed to identify which fauna species are dealt with as species credits, and for which species habitat would need to be mapped. Species from these searches were combined to produce a list of threatened fauna and flora species that may occur within the study site. **Appendix A** of this report lists the threatened flora and fauna species identified by the database searches as potentially occurring within a 5 km radius of the BCAA. The potential occurrence of threatened species was also assessed using the BCAM methodology, and these details are supplied in **Appendix D**.

Targeted surveys were conducted for locations of previous recorded threatened flora species using the random meander technique was utilised in suitable habitat within land with permitted access. The species *Grevillea caleyi* was detected and a count of individuals was performed, though not all habitat could be accessed.

Targeted surveys within the suitable survey period for *Microtis angusii* and *Tetratheca glandulosa* were conducted in late September and early October in 2015. *Microtis angusii* is known to flower between August and October, and was confirmed to be flowering based on inspections of known sites both within and outside the precinct. *Tetratheca glandulosa* is known to flower between July and November. Thus, the survey period coincided with the peak flowering period for both species. The threatened species surveys concentrated efforts in areas identified as higher potential habitat for *Microtis angusii*. However, surveys were also conducted in areas of lower potential habitat for this species. These areas of lower potential habitat coincided with intact native vegetation and represented potential for *Tetratheca glandulosa* habitat.

It is noted that some survey effort targeting *Microtis angusii* occurred outside of the Ingleside Precinct, due to new information on this species and seeking to ascertain if the species occurred across a wider distribution than previously known. Similarly, survey effort targeting *Tetratheca glandulosa* occurred outside of the Ingleside Precinct in areas identified as potential offset sites.

Microtis angusii is hard to differentiate from other *Microtis* species based on morphological characteristics. Genetic testing to differentiate *Microtis* species has been developed by the Royal Botanic Gardens. Thus, small leaf samples were taken from *Microtis* specimens and analysed to determine whether they were *Microtis angusii*.

All accessed vegetation zones were assessed for potential habitat for the candidate threatened fauna species. Potential habitat features were recorded, such as the presence of termite mounds, dams, hollow-bearing trees (HBT's), and presence of abundant foraging resources for Eastern Pygmy Possum (EPP). Field assessments were also conducted along drainage lines and adjacent sandstone and ridgetop vegetation to validate habitat presence for Giant Burrowing Frog (GBF, *Heleioporus australiacus*) Red-crowned Toadlet (RCT, *Pseudophryne australis*), and Southern Myotis (*Myotis macropus*).

Species polygons were created for threatened flora and fauna candidate species (excluding threatened fauna species that are part of ecosystem credits). This was done using past records, known population locations, existing information on the species' habitat requirements, targeted survey for threated flora species, and habitat field survey for fauna species as per **Appendix B**.

The field survey effort for undertaking both the vegetation validation and condition assessment and the threatened species habitat assessment are detailed in Table 1.

Table 1: Field Survey Tasks and Survey Effort

Date	Total Person Hours	Tasks
2/12/2013	20	• Vegetation type validation • Condition assessment • Collection of transect and plot data • Targeted flora survey • Fauna habitat assessment
4/12/2013	20	
5/12/2013	20	
6/12/2013	20	
10/12/2013	20	
11/12/2013	20	
12/12/2013	20	
13/12/2013	20	
7/01/2014	20	• Collection of transect and plot data • Targeted threatened flora survey • Fauna habitat assessment along watercourses for Red-crowned Toadlet, Giant Burrowing Frog and Southern Myotis • Fauna habitat assessment for Eastern Pygmy Possum of both trapped and non-trapped areas
8/01/2014	20	
9/01/2014	20	
15/01/2014	20	• Targeted threatened flora survey • Counts for *Grevillea caleyi* • Validation of the Duffys Forest Endangered ecological Community • Collection of transect and plot data
16/01/2014	24	
17/01/2014	24	
11/02/2014	20	• Vegetation type validation • Condition assessment • Collection of transect and plot data
12/02/2014	20	
21/09/2015	40	• Targeted survey for threatened plants, particularly *Tetratheca glandulosa* and *Microtis angusii*
22/09/2015	32	
23/09/2015	24	
24/09/2015	32	
25/09/2015	32	
28/09/2015	32	
29/09/2015	32	
30/09/2015	32	
1/10/2015	24	
2/10/2015	10	
6/10/2015	10	
7/10/2015	10	
8/03/2016	7	• Validation of Coastal Upland Swamp EEC
6/04/2016	7	
Total	652 hours	

2.3 Red flags

Red flags were identified in accordance with BCAM. Red flags areas contain high biodiversity conservation values. These include vegetation types, certain threatened species and their habitat features (i.e. dams) and riparian buffers. Further discussion is provided in **section 3.5**.

2.4 Ecological connectivity

Biodiversity links were mapped in accordance with BCAM. In addition, ecological corridors identified by Pittwater Council (2011), and by ELA (2008 and revised in the ELA 2011 report) were reviewed and compared. Recommendations based on this review are made with regards to retaining ecological connectivity. In light of the current surveys ELA has developed a new wildlife corridor map which includes previously inaccessible areas (**section 3.4)**.

2.5 Property access and confidence levels

In situations where access was not provided to private properties or commercial lands, an assessment of the confidence level was prepared for vegetation communities and threatened species. Confidence ratings were determined according to the OEH 'Inaccessible land protocol' (Appendix F of OEH 2015), and results are presented in **section 3.6** and **Appendix F**.

Four key terms were used to describe how vegetation was validated and these are described in **Table 2**, with their extent mapped in **Figure 5.** Survey for threatened flora was performed as a separate event and thus there were some changes in lands which could be accessed as shown in **Figure 6**.

Table 2: Summary of the access and no-access lands

Term	Criteria
Accessible	According to the DP&E mapping provided accessible lands include: • Private land holders as per agreement • Council lands • NSW Department of Primary Industry (except when land was apparently leased i.e. where infrastructure was present) • National Park (Ku-ring-gai Chase and Garigal) • NSW Department of Planning and Environment (except when land was apparently leased i.e. where infrastructure was present) • Road verge vegetation Validation of the vegetation was undertaken using random meander, plots, and transects of the vegetation patch. Confidence rating for vegetation mapping in these areas was high.
No Access: high visibility	Areas where access was not provided, i.e. private properties which did not provide access or no contact details provided, leased crown lands. Despite the lack of access, vegetation was visible from adjoining lands or road side access. This includes identification of vegetation within the canopy, shrub and ground layer. High visibility assessment includes identification of the flora species to determine the vegetation type, zone and condition. Vegetation types were also assessed using SMCMA base mapping, an assessment of the vegetation within the adjoining land, drainage and topography. Confidence rating for vegetation mapping in these areas was moderate to high.

Term	Criteria
No Access: low visibility	Areas where access was not provided, however, some of the vegetation was visible from adjoining lands or road side. Vegetation types were identified using diagnostic canopy species. Previous vegetation mapping by SMCMA (OEH 2013), adjoining lands and the topography were used to support validation of the vegetation. The condition was assessed according to the level of fragmentation, presence of weeds (if visible) and level of disturbance. Confidence rating for vegetation mapping in these areas was low due to the lack of visibility.
No access	Lands where access was not provided AND no visibility to determine the vegetation condition. Validation of the vegetation was conducted using aerial interpretation (desktop review), or could not be conducted. Confidence rating for vegetation mapping in these areas was low.

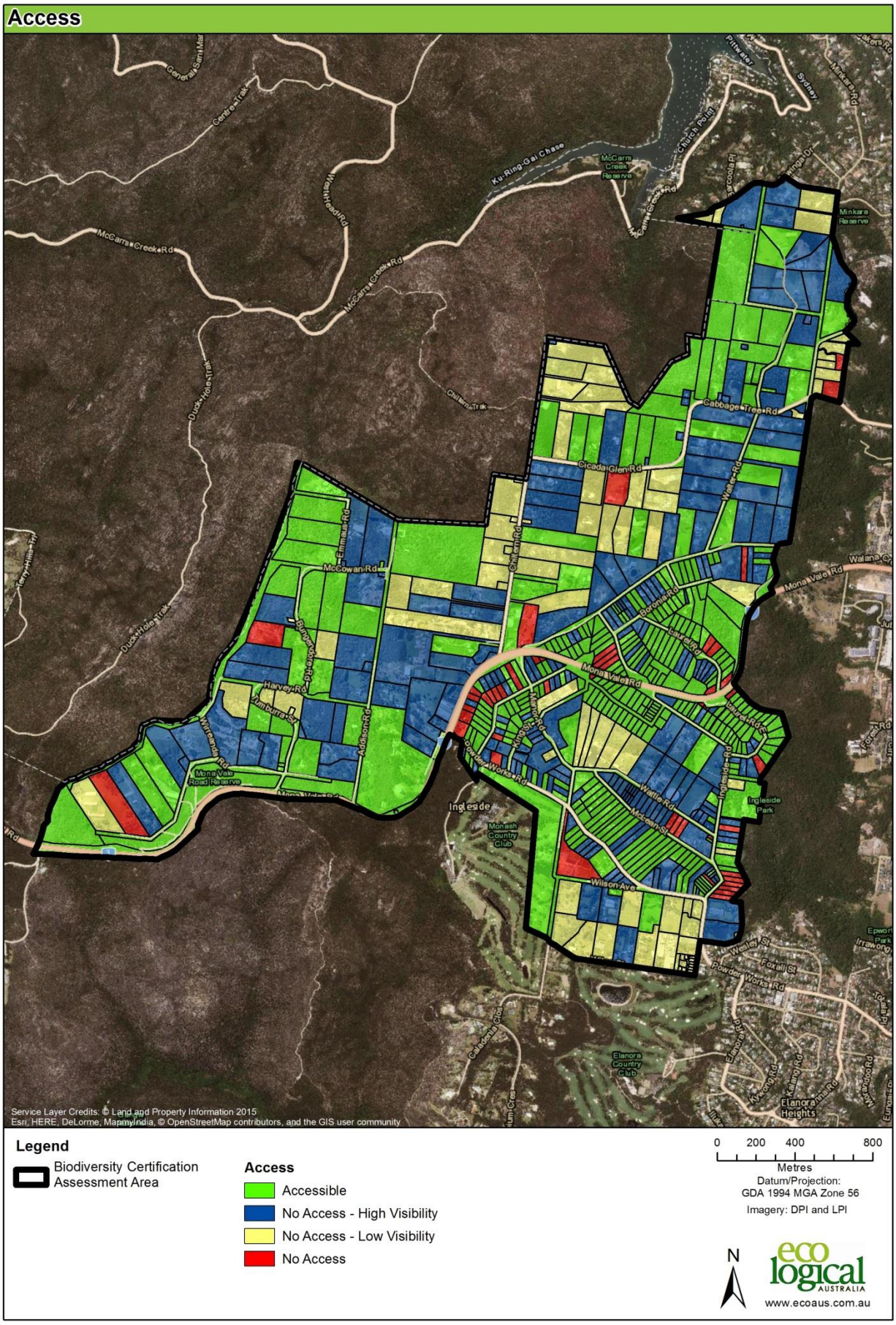

Figure 5: Property access for vegetation survey.

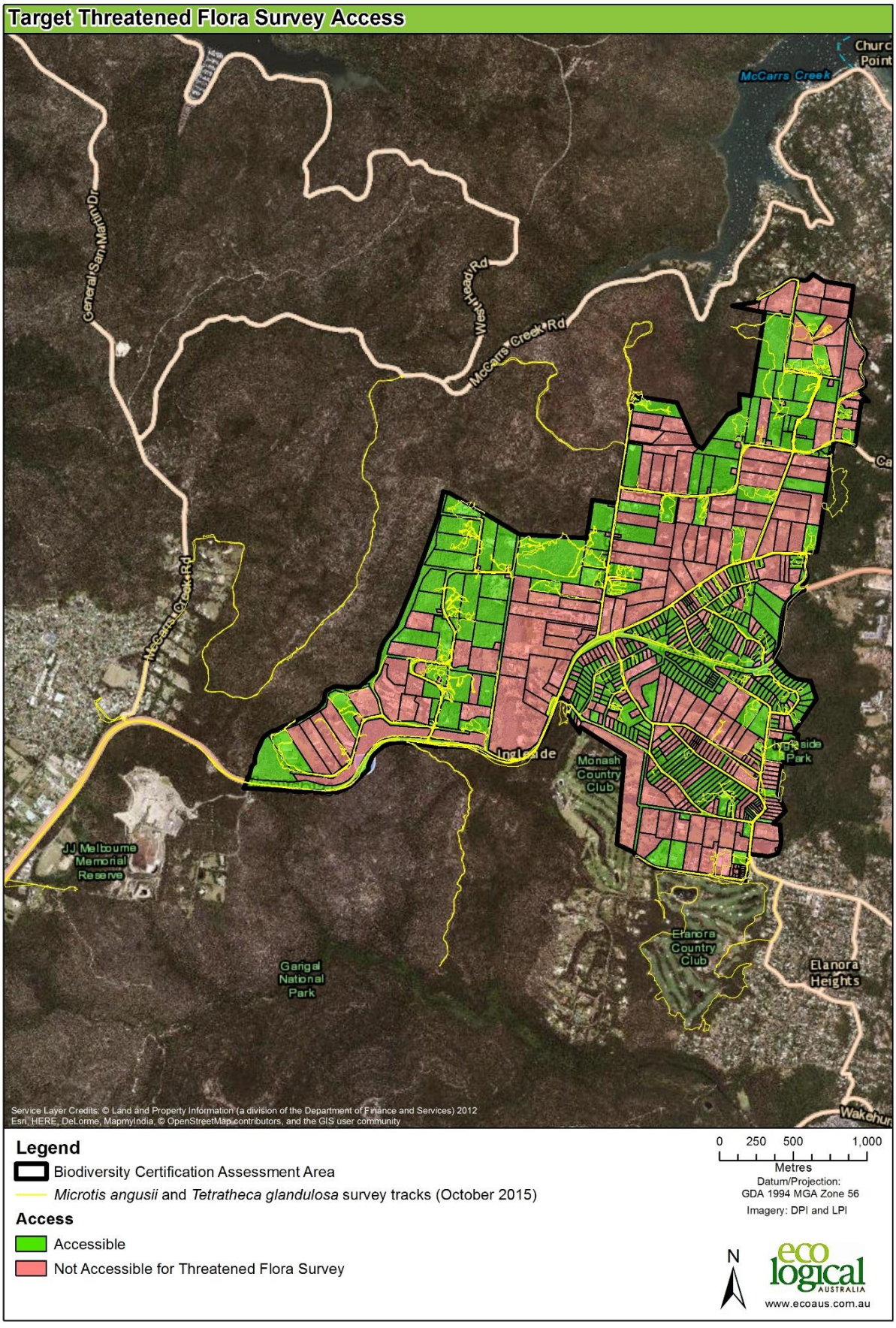

Figure 6: Property access for and survey tracks for target threatened flora survey (*Microtis angusii* and *Tetratheca glandulosa*) in October 2015.

2.6 Limitations

While every effort has been made to ensure that the information provided within this report is of the highest quality, there are a number of limitations which should be noted. These limitations include:

- Accessibility was a key limitation. The ability to validate vegetation communities or targeted surveys for threatened flora and fauna species was limited to areas where property owners provided access. There is potential that habitat within land which was not accessed may provide suitable habitat for threatened species and EECs (refer to **section 3.6** and **Appendix F**).
- Validation of vegetation via aerial photograph interpretation is a subjective process. Confidence levels were used to indicate the accuracy of data. See **Section 3.6**.
- Vegetation mapping for this project included professional judgement as to the original vegetation types for areas of disturbed vegetation, particularly those areas in fragmented or weedy condition. It is noted that due to the high level of disturbance, the classification of the vegetation communities is difficult, and may therefore result in some inaccuracies. The implications of inaccuracies are likely to be low, as these areas are highly disturbed and therefore are expected to have low biodiversity values (in terms of ecosystem credits).
- The BCAA includes a portion of the previous Sydney Metropolitan Catchment Management Area (SMCMA), which is understood to now be merged with the Hawkesbury-Nepean Catchment Management Area (HNCMA). Based on advice from Office of Environment and Heritage (OEH), ecosystem and species credit species were determined using the biometric vegetation types from the HNCMA. The SMCMA vegetation mapping (OEH 2013) of the BCAA mapped three vegetation communities, which are not included as HNCMA biometric vegetation types. There is potential that some threatened flora or fauna species were not predicted by the biodiversity certification calculator. This has been considered in **Section 3.3.2** (Step 2), and likely species to occur within the BCAA were included as candidate species.
- Both flora and fauna species can be cryptic in their habits, exhibit seasonal migratory patterns or dormancy, therefore making them difficult to detect. To account for limitations in field surveys an assessment on the likelihood of each species to occur within the BCAM was undertaken (See **Appendix A**). Species polygons used a conservative approach. See **Section 3.5.4**.
- Fauna species were assessed based on a combination of current knowledge and habitat assessment, and for the purposes of identifying species polygons (for species credit species) a conservative approach was taken of assuming their presence.
- The vegetation field survey was undertaken using hand-held GPS units, which were used to take GPS point locations of flora and fauna observed in the field. It is noted that these units can have errors in the accuracy of the locations taken of approximately 20m (subject to availability of satellites on the day). Differential GPS units were used for the *Microtis angusii* survey, and errors from these units are usually <1m.

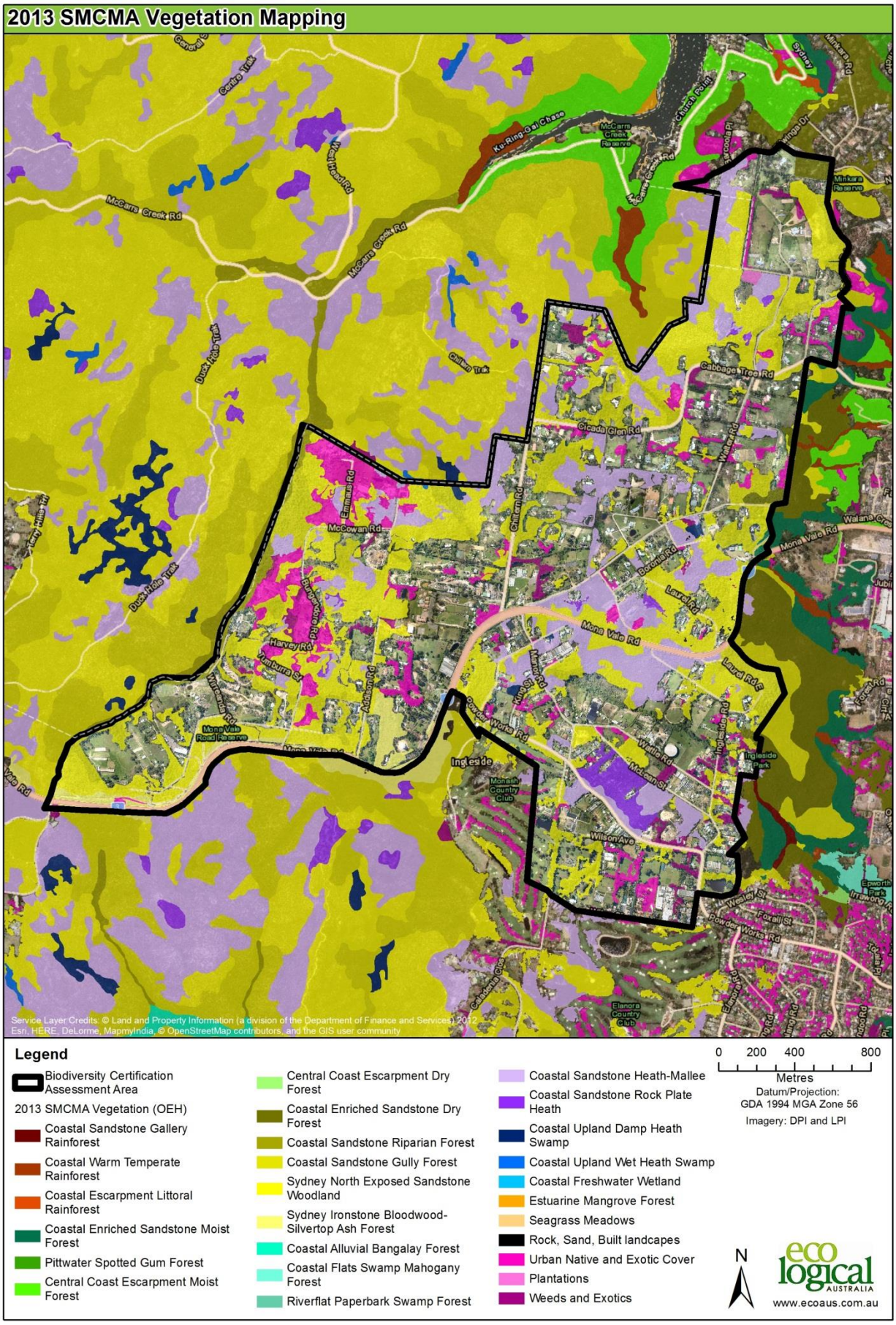

Figure 7: SMCMA vegetation communities

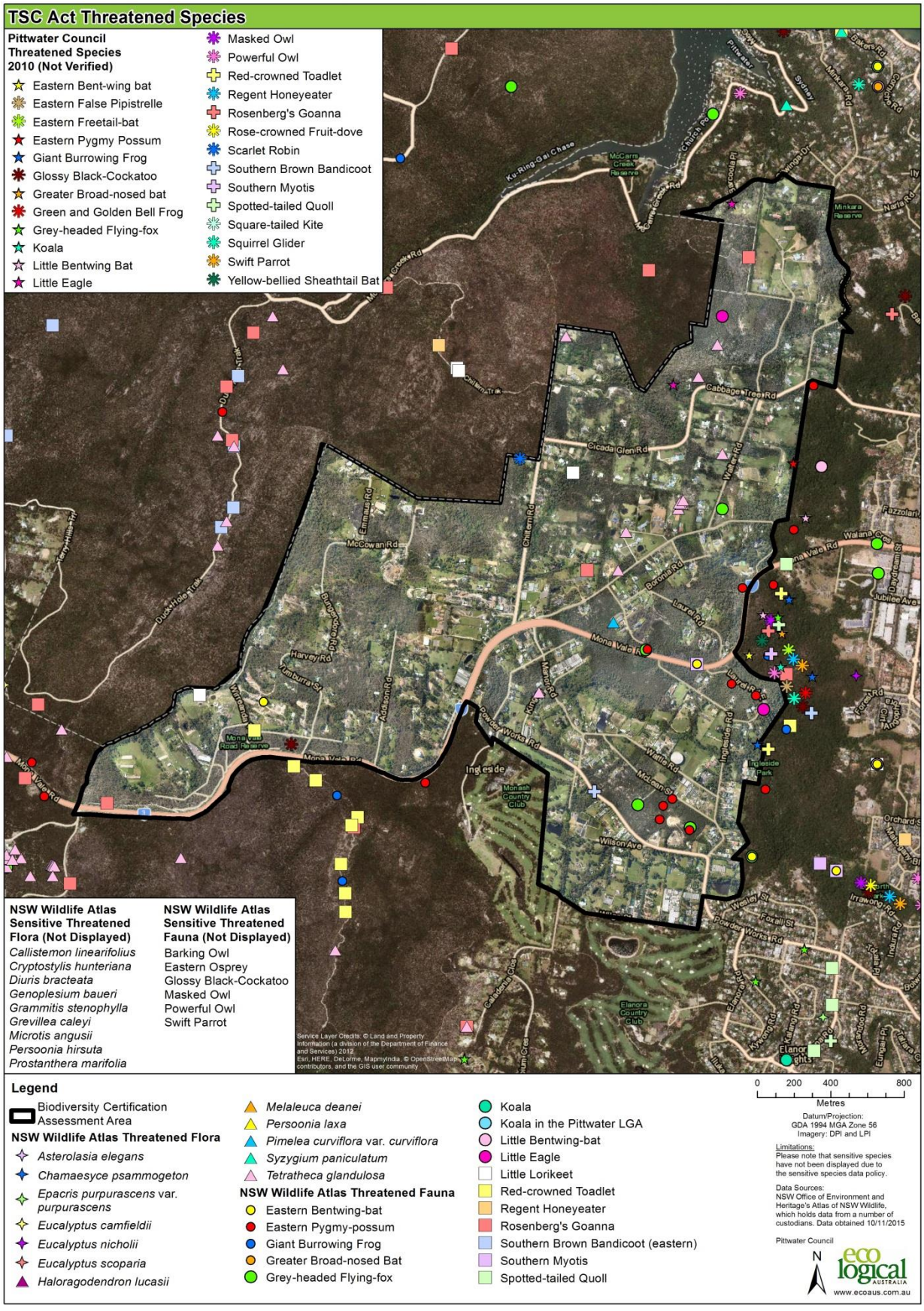

Figure 8: Threatened species records within the BCAA and the immediate surrounds