LODGE
ENVIRONMENTAL

Date: 11 December 2023
Project Code: LE1589

ECOLOGICAL CONSTRAINTS ASSESSMENT & BIODIVERISTY OFFSET ESTIMATION

SOUTH NOWRA INDUSTRIAL AREA

PREPARED FOR
SHOALHAVEN CITY
COUNCIL

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Project Name:

South Nowra Industrial Area – Ecological Constraints Assessment & Biodiversity Offset Estimation

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1.0 INTRODUCTION

Lodge Environmental Pty Ltd were commissioned by Shoalhaven City Council to prepare an Ecological Constraints Assessment (ECA) and Biodiversity Offset Estimation (BOE) to assist in creating a concept design and determine the future strategic planning and assessment pathways for the area known as South Nowra Industrial Lands.

The assessment is conducted in two stages as follows:

- Stage 1 - Ecological Constraints Assessment - field survey and desktop study to identify and map the various ecological constraints;
- Stage 2 Biodiversity Offset Estimation - preliminary Biodiversity Assessment Method (BAM) calculations to estimate total credit obligation and cost needed to offset the development areas identified in Stage 1.

This section fulfils the requirements of the Stage 1 Ecological Constraints Assessment. A desktop study was conducted to review the legislative context, existing literature and databases for known ecological constraints and values of the area. Field survey was also undertaken to identify and map ecological constraints and their value.

1.1 OBJECTIVES

The concept plan for the South Nowra Industrial Lands will be designed to avoid and minimise impacts to ecological values in the first instance. The objective of this ecological constraints assessment is to identify and map areas with high ecological values that should be avoided and conserved.

1.2 SITE DESCRIPTION

The land is known as the South Nowra Industrial Lands (herein referred to as the ***Study Area***) and is located within the Shoalhaven City Council (SCC) Local Government Area (LGA) (**Figure 1**).

The Study Area is located between Albatross Road and the Princes Highway in South Nowra, is approximately 178 ha in size and contains 35 lots. Sections of the Study Area contain native vegetation or have some level of historical disturbance/clearance, likely associated with an agricultural history as well as historic clearance associated with a golf course that was once present. Consolidated patches of vegetation are located adjacent to the northern and southern boundaries of the Study Area. Vegetation disturbance was higher within central patches. Residential dwellings, sheds, warehouses and other artificial structures are widespread across the rural residential lots. The Study Area is located on a gently undulating landscape, with three unnamed state mapped watercourses flowing easterly to Nowra Creek.

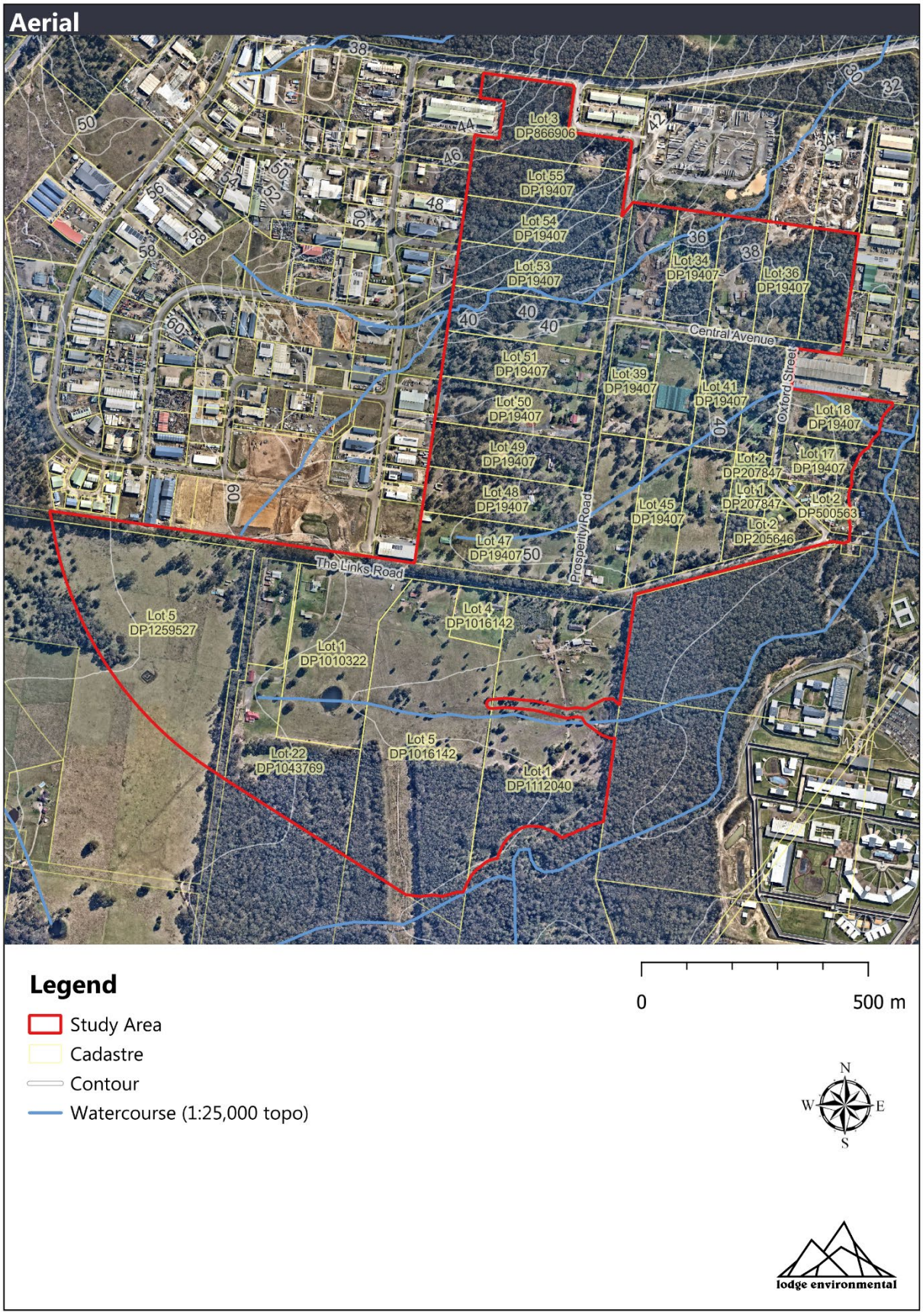


Figure 1: Aerial view of the Study Area

2.0 LEGISLATIVE CONTEXT

The following legislation and planning policies have been reviewed in accordance with the objectives of the Ecological Constraints Assessment for the Study Area:

- Commonwealth
  - *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- State:
  - *Environmental Planning and Assessment Act 1979* (EP&A Act);
  - *Biodiversity Conservation Act 2016* (BC Act);
  - *Rural Fires Act 1997*;
  - *Water Management Act 2000* (WM Act);
  - State Environmental Planning Policy (Biodiversity and Conservation) 2021;
  - State Environmental Planning Policy (Resilience and Hazards) 2021.
- Regional:
  - Illawarra Shoalhaven Regional Plan 2041.
- Local:
  - Shoalhaven Local Environmental Plan 2014;
  - Shoalhaven Development Control Plan 2014.

2.1 COMMONWEALTH LEGISLATION

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. Under this Act an action will require approval from the Minister for the Environment if the action has, will have, or is likely to have, a significant impact on a Matters of National Environmental Significance (MNES). MNES include listed threatened species and ecological communities, migratory species and wetlands of international importance protected under international agreements. Where applicable, the assessment criteria relevant to this Act must be drawn upon to determine whether there would be a significant impact on these species and hence whether referral to the Federal Environmental Minister is required.

2.2 STATE LEGISLATION

2.2.1 Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for the state, providing a framework for the overall environmental planning, and development assessment process.

2.2.2 Biodiversity Conservation Act 2016

The NSW *Biodiversity Conservation Act 2016* (BC Act) aims to slow the decline of threatened species, populations and communities listed under the Act. The BC Act is integrated with the EP&A Act and requires consideration of whether a development (Part 4 of the EP&A Act) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

The schedules of the BC Act lists species, populations and communities as endangered or vulnerable. All developments, land use changes or activities need to be assessed to determine if they will have an unacceptable impact on species, populations or communities listed on these schedules.

The potential impact of proposed development on any threatened species, populations or communities is assessed through application of an Assessment of Significance (AoS) under Section 7.3 of the BC Act at the development application stage. If the impacts on the area are found to be 'significant', a Biodiversity Development Assessment Report (BDAR) would be required, as would concurrence from the Chief Executive of the NSW Office of Environment & Heritage (OEH) including application of the Biodiversity Assessment Methodology (BAM) and entering into the Biodiversity Offset Scheme (BOS). A BDAR would also be deemed necessary if any proposed development were to involve clearance of vegetation mapped on the State Biodiversity Values Map (BVM) or involve native vegetation clearance above the thresholds tables within the BC Act (**Table 1**).

Table 1: Offset scheme thresholds – native vegetation clearance area criteria

Minimum lot size associated with the property	Threshold for clearing, above which the BAM and offsets scheme applies
Less than 1 ha	0.25 ha or more
1 ha, and less than 40 ha	0.5 ha or more
40 ha, and less than 1,000 ha	1 ha or more
1,000 ha or greater	2 ha or more

2.2.3 Rural Fires Act 1997

The *Rural Fires Act 1997* provides requirements for development of land that is bush fire prone. The Study Area contains land that has been identified as bushfire prone land vegetation category 1, 2, 3 and vegetation buffer (**Figure 2**). The *Planning for Bush Fire Protection* (PBP; NSW RFS 2019) document provides a guide for application of bush fire protection measures to be considered for proposed development. Depending on the type of development being proposed, such measures may require the provision of Asset Protection Zones (APZs) which would require clearing of vegetation to reduce bush fire risk. The area of vegetation to be cleared for APZs would need to be assessed under the BC Act, as described in section 2.2.2.

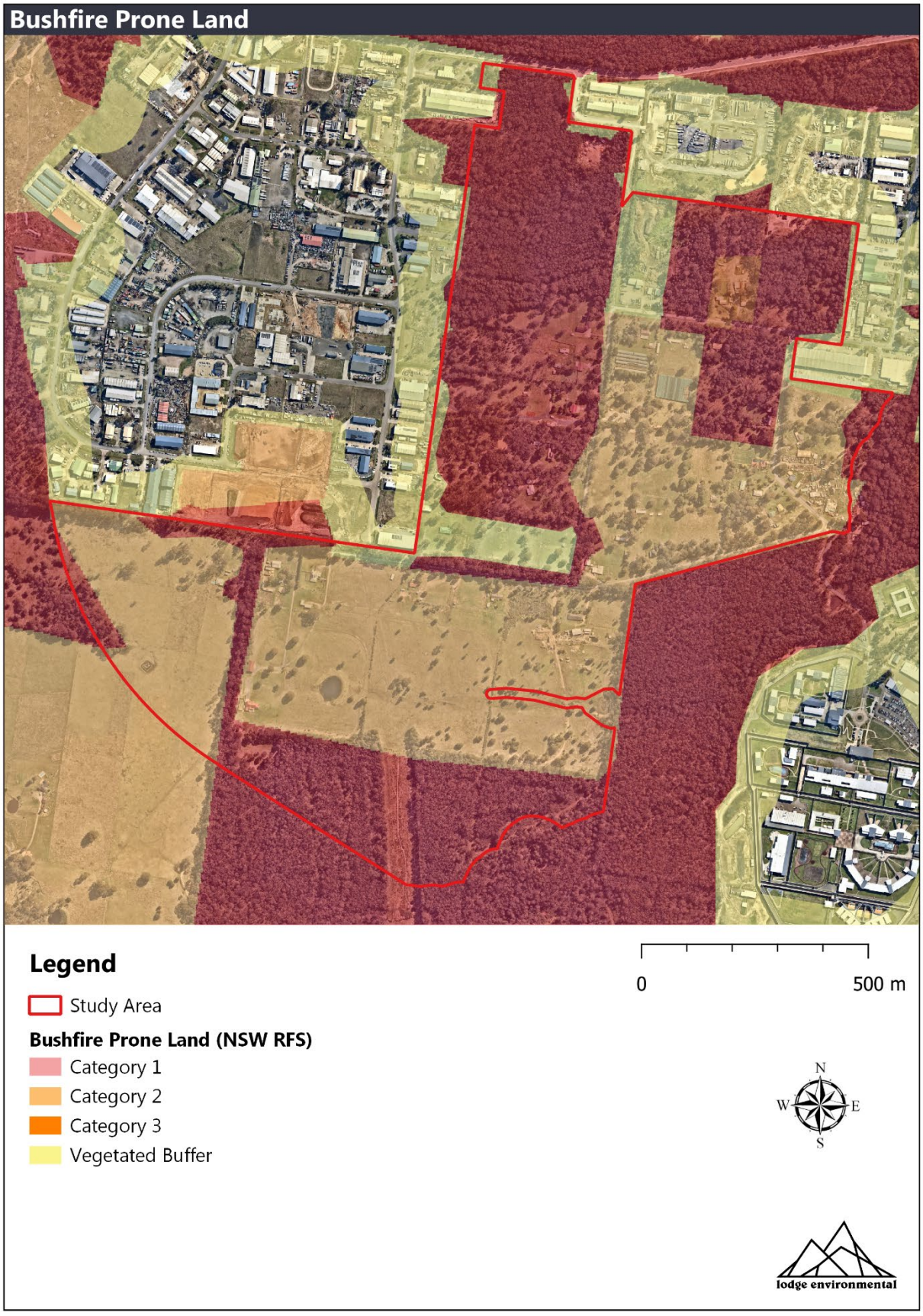


Figure 2: Bushfire Prone Land

2.2.4 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is administered by the NSW Natural Resource Access Regulator (NRAR) and establishes an approval regime for activities on *'waterfront land'* . Waterfront land is defined as land within 40 metres from the highest bank of a river, lake or estuary.

Certain activities within waterfront land are defined as a 'controlled activity' and require approval from the Office of Water. Controlled activities include:

- Erecting a building;
- Carrying out works;
- Removing material from waterfront land, such as plants or rocks;
- Depositing material on waterfront land, such as gravel or fill;
- Any activity which affects the quantity or flow of water in a water source.

The NRAR *Guidelines for Controlled Activities on waterfront land – Riparian corridors* (DPE 2022) recommend that a Vegetated Riparian Zone (VRZ) is provided adjacent to a watercourse to provide a protective buffer between catchment land uses and aquatic habitat. This not only helps improve water quality and aquatic habitat but provides habitat for terrestrial and riparian flora and fauna. The VRZ plus the channel width constitute the 'riparian corridor' (**Figure 3**).

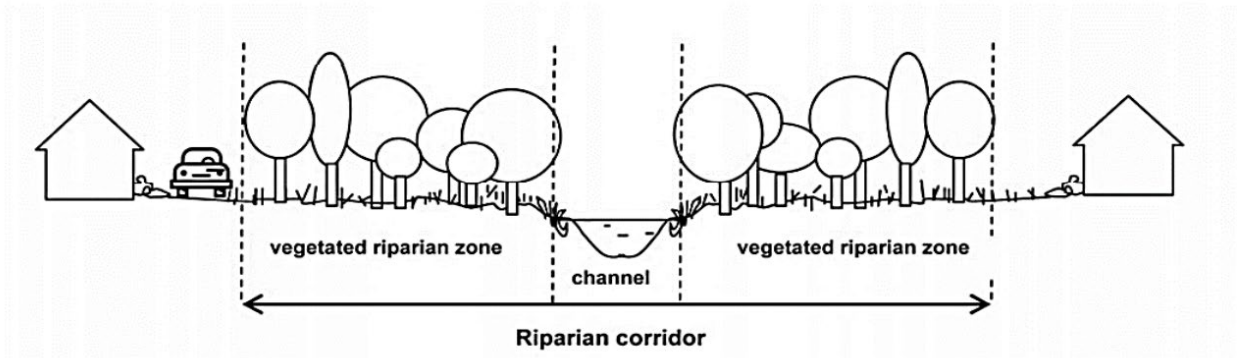


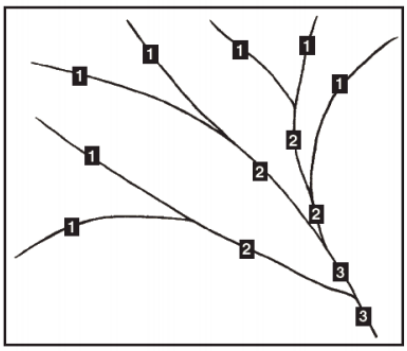
Figure 3: The riparian corridor, comprising a watercourse channel and vegetated riparian zone (NRAR 2018)

The width of the VRZ within waterfront land is measured from the top of the highest bank on both sides of the watercourse, and widths are based on watercourse order as classified under the Strahler Stream Order of watercourses as mapped in NSW Hydro Line Spatial Data[1] (**Figure 4**).

According to the NSW Hydro Line spatial data, there are 3 unnamed watercourses mapped in the Study Area which flow in an easterly and north-easterly direction towards Nowra Creek, which in turn flows north to Shoalhaven River.

The Strahler Stream Order system numbers the smallest headwater streams as 1st Order, and stream order increases downstream through the catchment as streams merge and form larger streams (e.g. when two 1st Order streams join they become a 2nd Order).

[1] Authoritative dataset managed by NSW Spatial Services (Department of Finance, Services and Innovation)



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

Figure 4: The Strahler Order System and recommended riparian corridor widths (NRAR)

Non-riparian corridor works such as asset protection zones, roads, infrastructure and recreational areas can be authorised by NRAR in the outer riparian corridor (outer 50%), so long as an equivalent area connected to the VRZ is offset and the average width of the VRZ is achieved over the watercourse within the site (**Table 2**). The inner 50% of the VRZ must be fully maintained as a functional riparian zone.

Table 2: Riparian corridor matrix

Stream order	Vegetated Riparian Zone (VRZ)	RC off-setting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	●	●	●	●	●	●	●		
2nd	20m	●	●	●	●	●		●		
3rd	30m	●	●	●		●			●	●
4th +	40m	●	●	●		●			●	●

The NRAR Guidelines also note that *'where a watercourse does not exhibit the features of a defined channel with beds and banks, the Office of Water may determine that the watercourse is not waterfront land for the purposes of the WM Act'*.

2.2.5 Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve fish stocks and key fish habitats, conserve threatened species, populations and ecological communities of fish and marine vegetation, and to promote ecologically sustainable development.

2.3 REGIONAL PLANNING INSTRUMENTS

2.3.1 Illawarra Shoalhaven Regional Plan 2041

The Illawarra Shoalhaven Regional Plan (ISRP) sets the strategic framework for the region, and is a 20-year land use plan prepared in accordance with section 3.3 of the *Environmental Planning and Assessment Act 1979.* According to the ISRP, the Study Area is within the South Nowra Employment Precinct which employs over 2,300 people and described as comprising *'110 hectares with potential to accommodate up to 180 new industrial lots'*.

The ISRP also mapped lands identified as High Environmental Values, which include:

- Sensitive biodiversity (ie the Biodiversity Values Map);
- Native vegetation of high conservation value, including vegetation types that have been over-cleared or occur within over-cleared landscapes and threatened ecological communities;
- Key habitat of threatened species;
- Important wetlands, coastal lakes and estuaries;
- Areas of high geological significance.

2.4 LOCAL PLANNING INSTRUMENTS

2.4.1 Shoalhaven Local Environmental Plan 2014

The Shoalhaven Local Environmental Plan 2014 (LEP) is the principle planning instrument for the Shoalhaven LGA. The LEP sets out the planning framework and establishes the requirements for the use and development of land in the LGA. The LEP provides broad direction with regards to what types of development are permitted within specific land use zones.

The Study Area is zoned E4 – General Industrial, as shown in **Figure 5**. The objectives of this zone are:

- To provide a wide range of industrial and warehouse land uses.
- To encourage employment opportunities.
- To minimise any adverse effect of industry on other land uses.
- To support and protect industrial land for industrial uses.
- To allow a diversity of activities that do not significantly conflict with the operation of existing or proposed development.
- To enable other land uses that provide facilities or services to meet the day to day needs of workers in the area.

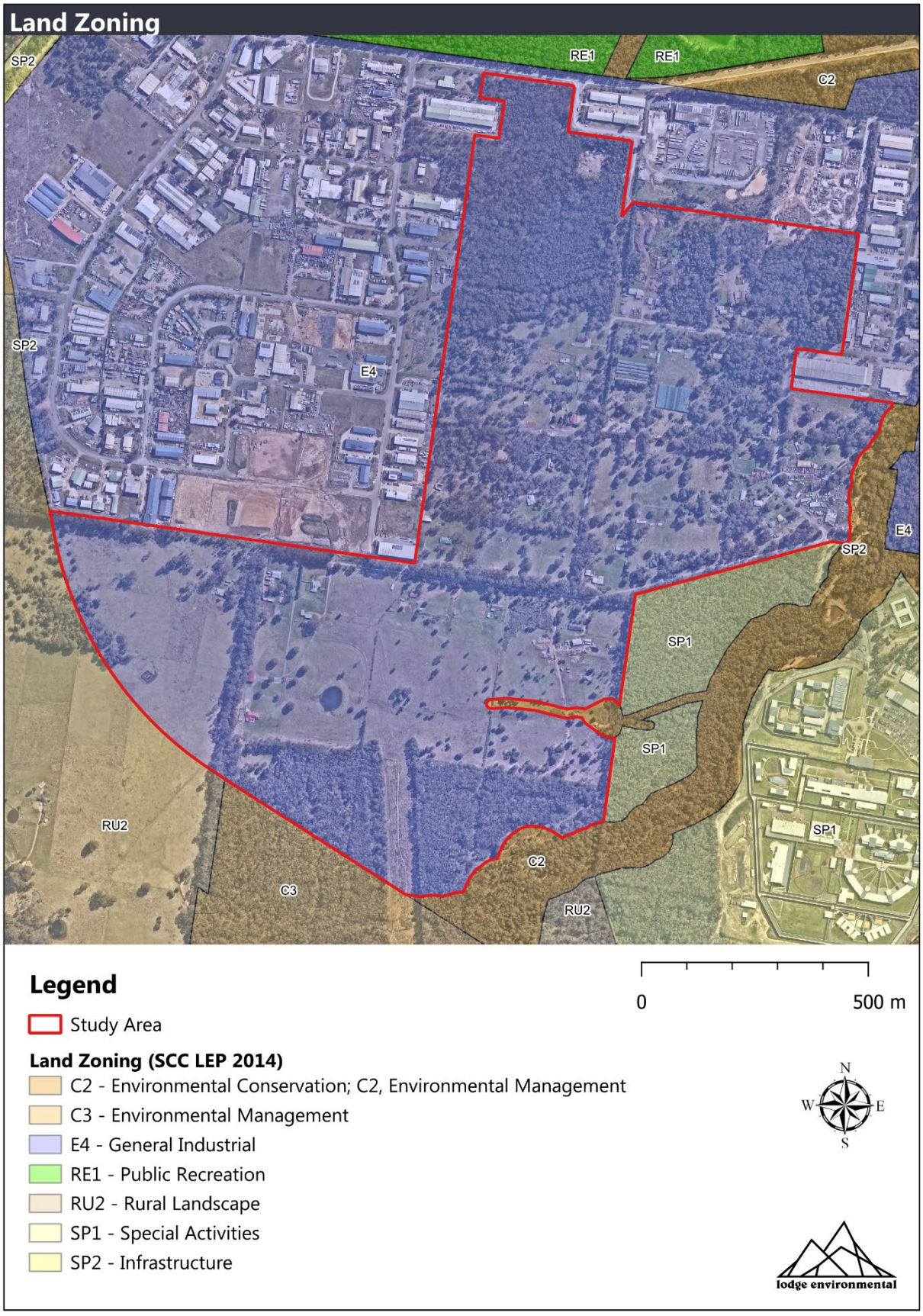


Figure 5: Land Zoning (Shoalhaven LEP 2014)

2.4.2 Relevant Local Clauses

2.4.2.1 Riparian Lands and Watercourses

The Riparian land and watercourses clause (Shoalhaven LEP Clause 7.6) aims to maintain water quality within watercourses, the stability of the bed and banks of watercourses, aquatic and riparian habitats and ecological processes within watercourses and riparian areas within the LGA. The clause applies to all land that is within 50 metres of the top of bank of each watercourse.

The LEP has categorised watercourses in the Local Government Area according to the Riparian Corridor Objective Setting (RCOS) methodology, which is discussed further in section 5.4. Watercourse categories mapped within the study area, and associated 50m buffer of these watercourses as per the LEP is illustrated in **Figure 6.** The northern and central watercourses are "Category 2" whilst the southern watercourse is "Category 3".

Before determining a development application for development on land to which this clause applies, the consent authority must consider:

- whether or not the development is likely to have any adverse impact on the following:
    - the water quality and flows within the watercourse
    - aquatic and riparian species, habitats and ecosystems of the watercourse
    - the stability of the bed and banks of the watercourse
    - the free passage of fish and other aquatic organisms within or along the watercourse
    - any future rehabilitation of the watercourse and its riparian area
- whether or not the development is likely to increase water extraction from the watercourse, and
- any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.

Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

- the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
- if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or
- if that impact cannot be minimised—the development will be managed to mitigate that impact.

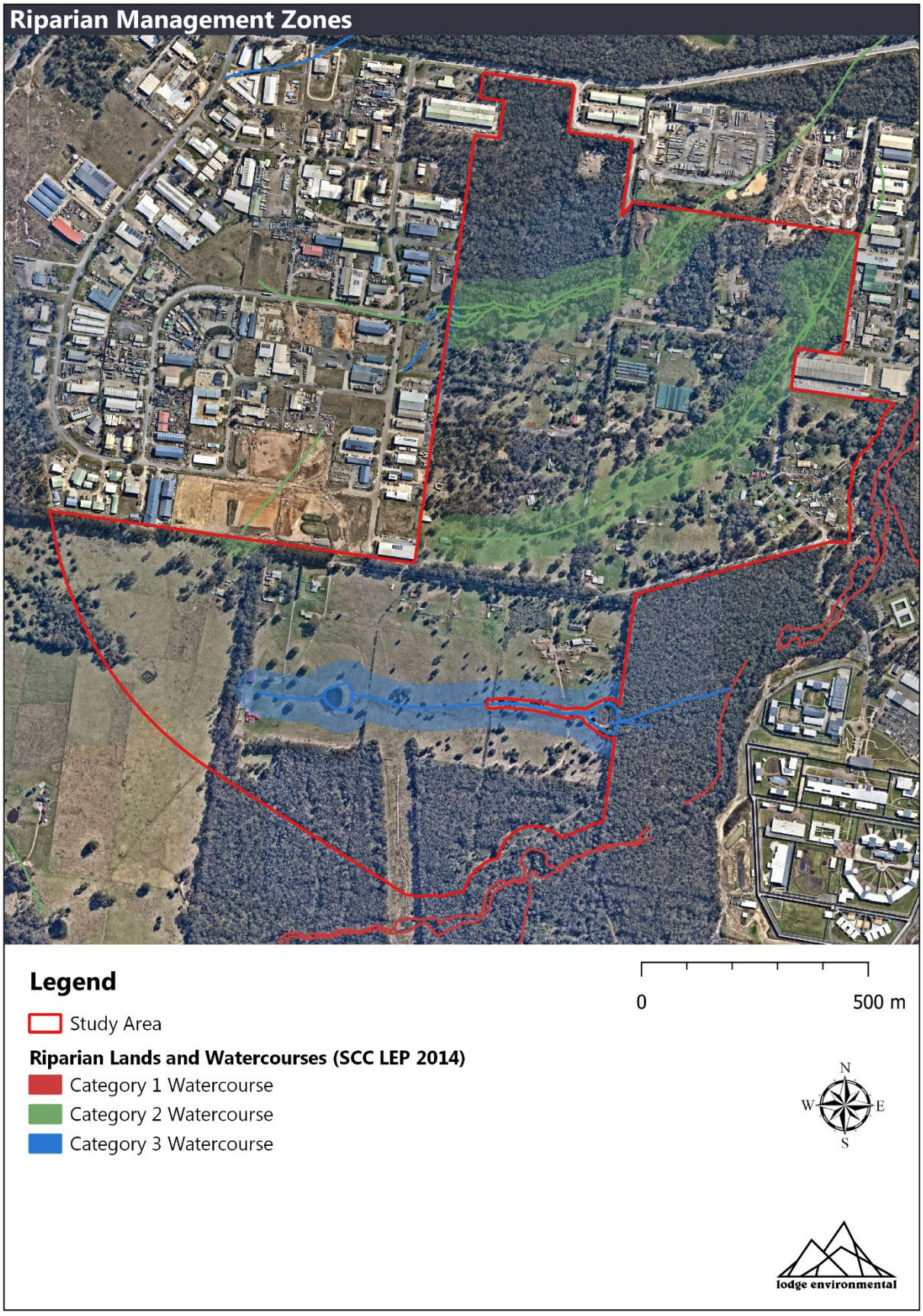


Figure 6: Riparian Management Zones (SCC LEP)

2.4.2.2 Development on land in the vicinity of the Western Bypass Corridor

The Western Bypass Corridor is a tract of land that Shoalhaven City Council has allocated for a potential bypass of the Nowra area at some point in future. This bypass occurs immediately to the south west of the Study Area (**Figure 7**). Clause 7.21 applies to properties that are in the vicinity of the bypass and has the objectives of minimising visual or acoustic impacts on development of land to which the clause applies, and ensuring that development proposed in the vicinity will not compromise, restrict otherwise prevent the future use of the land as a road.

2.4.2.3 Development on land at South Nowra and Nowra Hill

This clause outlines that development consent may be granted for development on each existing lot for the purposes of no more than one dwelling house on each existing lot, and even if the land is subdivided, no more than one dwelling house on the land comprising the existing lot. Furthermore, this clause is repealed on 31 July 2030. Land on which this clause applies is shown in **Figure 7**.

2.4.2.4 Development on land at Nowra Hill and Sussex Inlet

This clause outlines that an original lot may be subdivided, with development consent, to create other lots (the *resulting lots*) if 2 of the resulting lots will:

(a) Each contain at least 1,800 m2 of land in Zone E4 - General Industrial, and

(b) Together contain all of the non-urban land that was in the original lot (where non-urban land refers to land that is zoned C2 Environmental Conservation, C3 Environmental Management or RU2 Rural Landscape).

Land on which this clause applies is shown in **Figure 7**.

2.4.3 Shoalhaven Development Control Plan 2014

The Shoalhaven Development Control Plan 2014 (DCP) aims to make detailed local provisions for all land within the LGA. Specifically, the DCP provides detailed construction, building and environmental controls for the types permitted land use described in the LEP. Environmental controls address issues such as biodiversity, bushfire prone land, trees and vegetation.

DCP chapters which applies to the Study Area include:

- Chapter 2: General and Environmental Considerations
- G2 Sustainable Stormwater Management
- G5 Biodiversity Impact Assessment
- G9 Development on Flood Prone Land
- G11 Subdivision of Land
- G20 Industrial Development

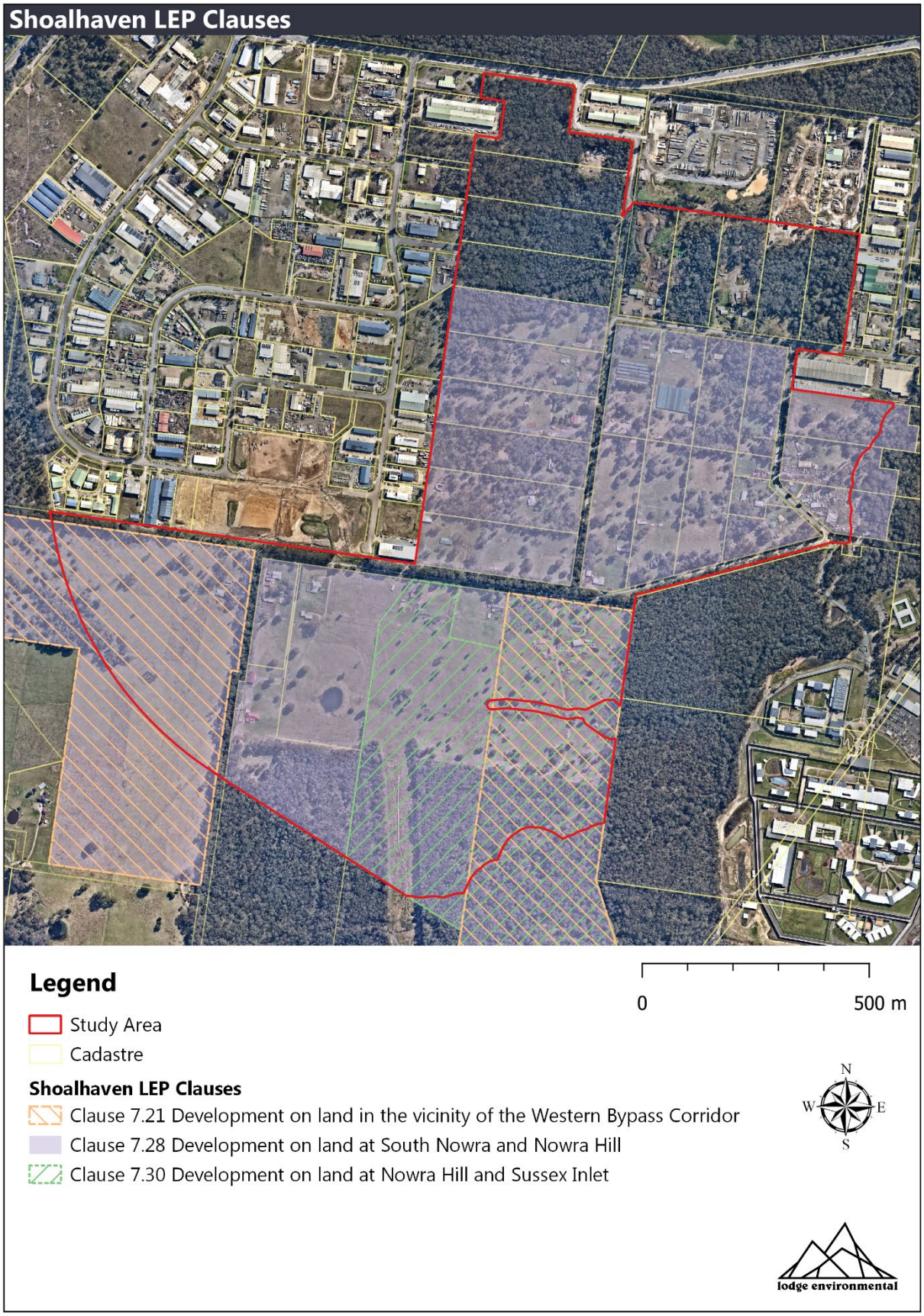


Figure 7: Shoalhaven LEP Clauses

3.0 METHODS

3.1 DATA AND LITERATURE REVIEW

Data records and relevant literature pertaining to the ecology of the Study Area and surrounding areas were reviewed. The material reviewed included:

- NSW BioNet, Atlas of NSW Wildlife database search (10 km) (Accessed 8 February 2023).
- EPBC Act Protected Matter Search Tool (10 km) (Accessed 8 February 2023).
- Review of the State Biodiversity Values Map (Accessed 8 February 2023).
- NSW State Vegetation Type Map (DPE 2022).
- Relevant legislative documents
- Shoalhaven LEP 2014 and DCP 2014.
- Natural Resources Access Regulator (NRAR) Guidelines.
- Previous ecological assessments, including 'Draft Desktop Environmental Assessment' prepared by Peter Dalmazzo (2020)
- Aerial photography.
- Online property report.

3.2 FIELD SURVEY

To address the Ecological Constraints Assessment the following survey methods were undertaken over six site visits occurring from the 13th of February 2023 to the 17th of March 2023 by a team of Lodge Environmental ecologists project managed by Luke Jeffery:

- Stratifying the Study Area into Plant Community Types (PCT) present, confirming the extent and quality of native vegetation (including Threatened Ecological Communities (TEC) and defining conditions zones and areas of exotic vegetation.
- Completing Vegetation Integrity (VI) Plots in accordance with Table 3 of the BAM 2020.
- Opportunistic GPS recordings of habitat bearing trees (HBTs) and significant trees.
- Search for signs of threatened species, observe and record significant flora and fauna – threatened and migratory species, other incidental fauna observations.
- Observe and record current disturbance and threats (e.g. weeds, trampling, litter).
- Identifying potential habitat for threatened flora and fauna species/populations (e.g. HBTs, creeks, boulders etc) and record with a handheld GPS.
- Taking reference photographs of the entire site.

3.3 SURVEY LIMITATIONS

Survey was conducted during the noted times and may be outside of the optimal survey period for some flora and fauna species. It is therefore possible that some species may not have been detected due to their seasonal geographic variation. Cryptic species may not have been obvious. Targeted surveys were not conducted during the site visit. A conservative approach was applied in the assumption of the presence of species that could potentially occur within the site area. In this regard, the survey is considered adequate for the purposes of this report.

4.0 DESKTOP REVIEW

4.1 HIGH ENVIRONMENTAL VALUES

The High Environmental Values (HEV) Map according to the Illawarra Shoalhaven Regional Plan does not identify any areas of HEV within the Study Area. The closest mapped HEV is associated with Nowra Creek, approximately 40 metres east of the Study Area (**Figure 8**). This HEV has been mapped as 'Sensitive biodiversity'.

4.2 BIODIVERSITY VALUES MAP

A review of the State Biodiversity Values Map was conducted on the 8th of February 2023. The Study Area does not contain land that is covered by the Biodiversity Values (BV) Mapping. The closest mapped BV is associated with Nowra Creek, approximately 40 metres east of the Study Area (**Figure 8**). This BV is identified as 'Biodiverse riparian land'.

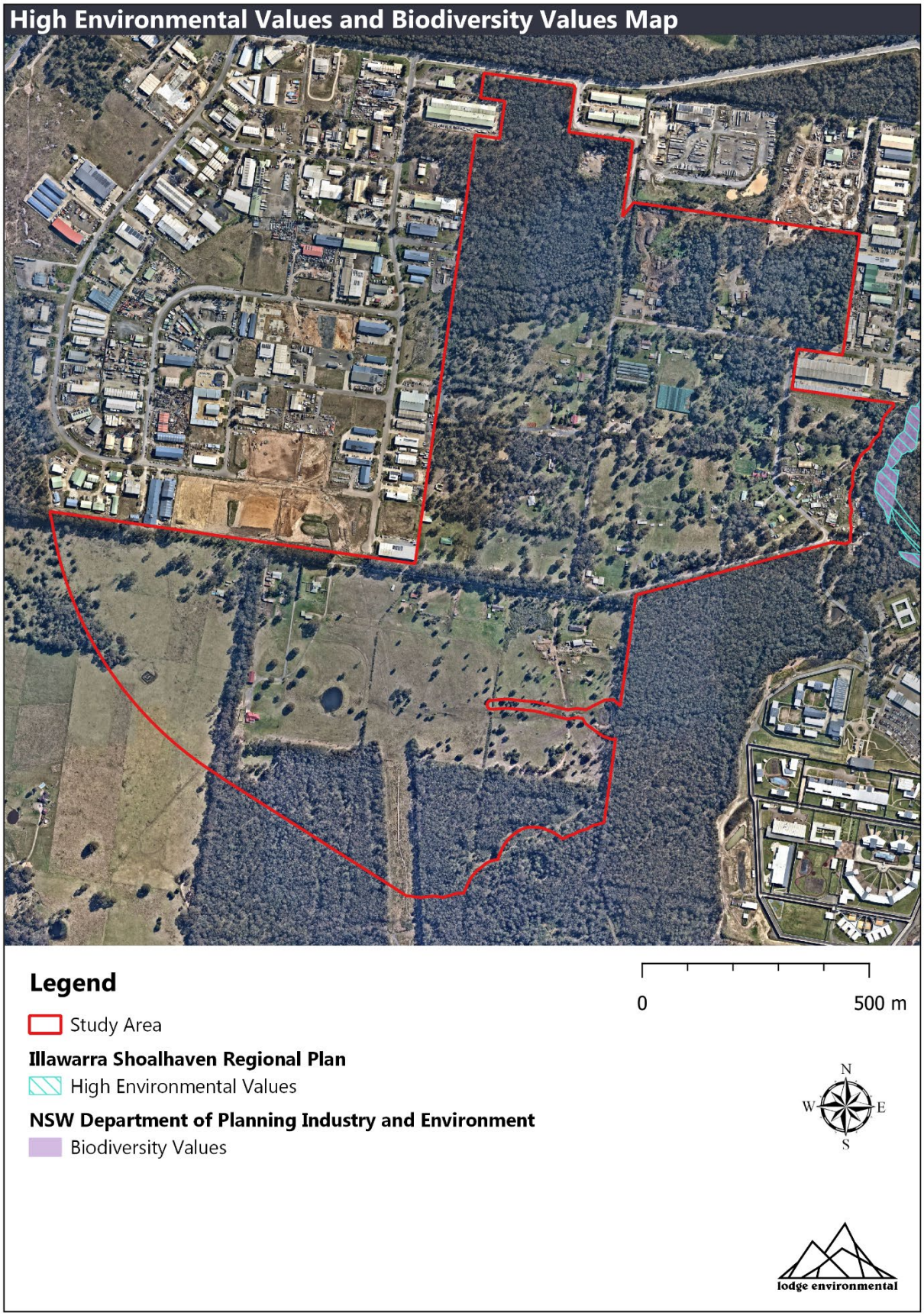


Figure 8: Biodiversity Values Mapping

4.3 EXISITING VEGETATION MAPPING

The following vegetation map sources were reviewed to inform the desktop study of vegetation types and threatened ecological communities within the Study Area:

(i) Biometric Vegetation Map, published by Office of Environment and Heritage 2013 in close consultation with National Parks and Wildlife, Southern Rivers Catchment Management Authority and Shoalhaven City, Bega Valley Shire and Eurobodalla Shire Councils.

(ii) NSW State Vegetation Type Map (SVTM), a regional-scale map of the current extent of NSW PCTs, published by NSW Department of Planning and Environment in 2022, and currently considered the most authoritative source of desktop vegetation mapping of PCTs.

A review of the vegetation communities mapped within the Study Area by OEH (2013) identified the below vegetation communities or PCTs within the Study Area (**Figure 9**):

- PCT 662 - Banksia - Red Bloodwood - Hard-leaved Scribbly Gum heathy open woodland on sandstone plateaux, southern Sydney Basin Bioregion
- PCT 1079 - Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin Bioregion
- PCT 1212 - Spotted Gum - Grey Ironbark - Woollybutt grassy open forest on coastal flats, southern Sydney Basin Bioregion and South East Corner Bioregion
- PCT 1232 - Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion

A review of the vegetation communities mapped within the Study Area by DPE (2022) identified the below vegetation communities or PCTs within the Study Area (**Figure 10**):

- PCT 3045 - South Coast Temperate Gully Rainforest
- PCT 3258 - Sydney Basin Creekflat Blue Gum-Apple Forest
- PCT 3269 - Shoalhaven Lowland Spotted Gum-Paperbark Forest
- PCT 3330 - South Coast Lowland Woollybutt Grassy Forest
- PCT 3896 - Budderoo-Morton Damp Swamp Heath

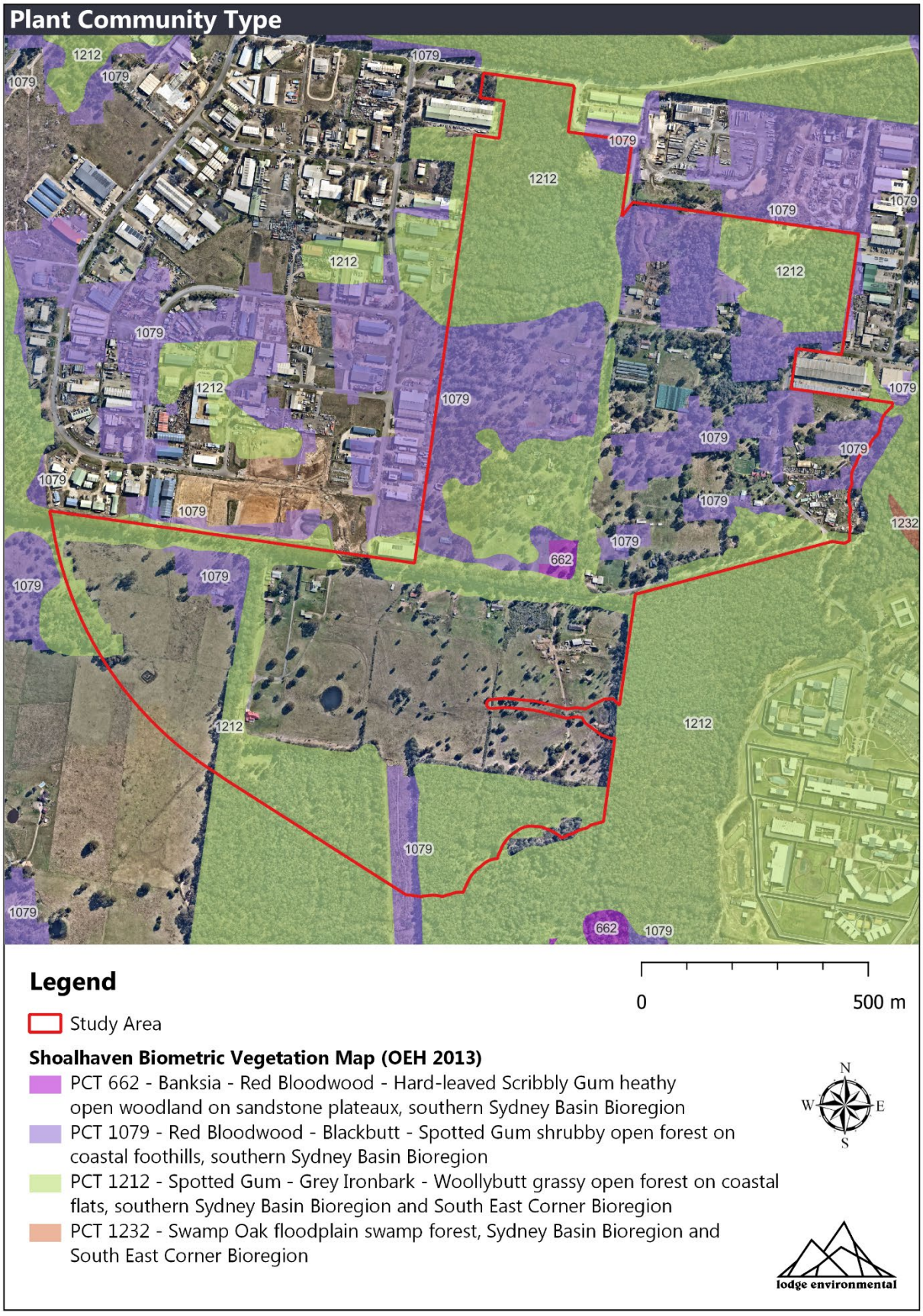


Figure 9: Unvalidated Vegetation (LLS 2014)

Figure 10: Unvalidated Vegetation (DPE 2022)

4.4 THREATENED SPECIES

A review of the DPE and Department of the Environment and Energy (DotEE) databases identified several threatened flora and fauna listed under the BC Act and/or the EPBC Act that have been previously recorded, or are considered to have habitat, within 10 km of the site (**Figure 11**). This initial compilation of potentially occurring species informed the site survey, providing an indication of which species required consideration within the site.

The following threatened ecological communities and flora species were identified as having a potential to occur at the site prior to field survey:

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion – Endangered BC Act and Critically Endangered EPBC Act
- *Acacia pubescens* (Downy Wattle) – Vulnerable BC and EPBC Act
- *Pterostylis gibbosa* (Illawarra Greenhood) – Endangered BC and EPBC Act
- *Pterostylis ventricosa* – Critically Endangered BC Act

The following fauna species **Table 3** were identified as having a moderate-high potential to occur within the site prior to field survey.

Table 3: Potentially occurring threatened fauna

Scientific name	Common name	BC Act	EPBC Act
Birds			
Anthochaera phrygia	Reagent Honeyeater	CE	CE
Artamus cyanopterus cyanopterus	Dusky Wood swallow	V	-
Burhinus grallarius	Bush Stone-Curlew	E	-
Callocephalon fimbriatum	Gang-Gang Cockatoo	V	E
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-
Daphoenositta chrysoptera	Varied Sittella	V	-
Glossopsitta pusilla	Little Lorikeet	V	-
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-
Hieraaetus morphnoides	Little Eagle	V	-
Lophoictinia isura	Square-tailed Kite	V	-
Neophema pulchella	Turquoise Parrot	V	-
Ninox strenua	Powerful Owl	V	-
Tyto novaehollandiae	Masked Owl	V	-
Tyto tenebricosa	Sooty Owl	V	-
Mammals			
Cercartetus nanus	Eastern Pygmy Possum	V	-
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Dasyurus maculatus	Spotted-tail Quoll	V	E
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-

Scientific name	Common name	BC Act	EPBC Act
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-
Myotis macropus	Southern Myotis	V	-
Petaurus australis	Yellow-bellied Glider	V	-
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Scoteanax rueppellii	Greater Broad-nosed Bat.	V	-
Amphibians			
Litoria aurea	Green & Golden Bell Frog	E	V

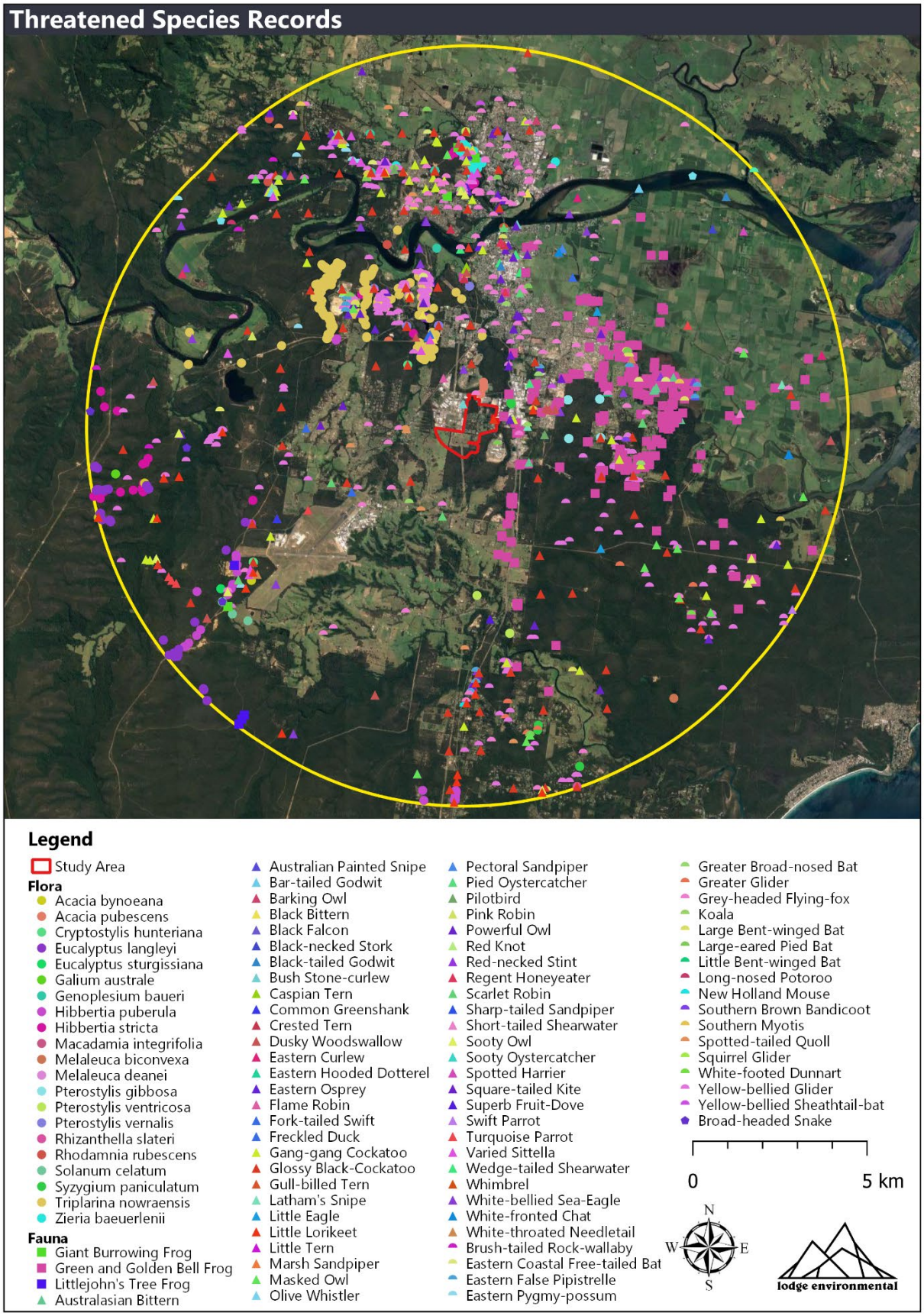


Figure 11: Threatened species recorded within 10 km of the Study Area

5.0 FIELD SURVEY RESULTS

5.1 EXISTING ENVIRONMENT AND HABITAT FEATURES

The native vegetation present within the Study Area aligns with a single PCT. Varying condition states were recorded as a result of historical disturbances and current land use. The vegetation adjacent the northern and southern boundaries of the Study Area is in greater condition and greater connectivity to the surrounding vegetation outside of the Study Area. The central vegetated areas of the Study Area contain poorer condition and often fragmented patches of native vegetation. These poorer condition patches are primarily found around residential dwellings and have often been impacted by historical clearing and current land use. Current disturbances observed include fragmentation, absent or sparsely occurring mid stratum due to active thinning, exotic species incursions and maintained or grazed ground stratum limiting the regeneration potential.

The native vegetation within the Study Area is expected to facilitate the movement and foraging of more mobile native fauna species (i.e. birds and mammals) between the Study Area and the wider locality. Similarly, the recorded hydrolines and farm dams within the Study Area are considered as potential habitat for a range of native amphibian, reptile and fish species, including the threatened species Green and Golden Bell Frog (*Litoria aurea*). Incidental observations of habitat features were recorded during the preliminary site investigations. The habitat features observed range from large-scale habitat features such as PCTs and hydrolines to smaller scale habitat features like moss gardens and termite mounds. **Table 4** further details the habitat features observed across the Study Area and **Figure 12** displays where these features were observed.

Table 4: Habitat features present within the Study Area

Habitat Feature	Description of the feature	Presence of the habitat feature
Habitat-bearing trees	Habitat-bearing trees can be alive or dead (stag) and include any additional sheltering, roosting or nesting features that may be relied upon by native fauna, but are not captured within the traditional definition of a Hollow-bearing tree. These features include; Hollows, crevices, cracks, fissured branches, exfoliating bark, nests, dreys and arboreal termite mounds	Due to the relatively young age of most of the trees within the Study Area (~<30 years), there are fewer hollows than would otherwise be expected. Areas with a high hollow potential occurred within road verges and the Council owned land where older trees are present (**Figure 12**). Further targeted surveys of these hollows are required to determine if the hollows are used by native fauna.
Large Trees	Large Trees are a unique feature within the landscape as they can provide a plentiful and reliable food supply for a wide variety of fauna, nesting opportunities for species that prefer larger trees and play an important role in the carbon cycle. Large trees are particularly significant due to the time they take achieve their size.	Large trees were largely absent within the Study Area, again, likely due to the relatively young age of the native vegetation across the Study Area. Areas where large trees were predominately observed were within the Council owned land to the north of the Study Area (**Figure 12**) and occasionally with private properties.
Stratum complexity	Stratum complexity of an ecosystem can be seen vertically or horizontally. Each layer represents a type of habitat for different	Vegetation zones with higher stratum complexity occurred within the greater conditioned vegetation patches, adjacent to

Habitat Feature	Description of the feature	Presence of the habitat feature
	species. Ultimately the more complex the strata the greater the potential for species diversity that can be found within the area. The complexity of strata also facilitates niche and resource partitioning diversity.	the northern and southern boundaries. Recent under scrubbing and natural regeneration was observed in different vegetation zones. These two zones have the greatest potential to be managed and improved to regenerate the stratum complexity.
Waterbodies	Waterbodies are valuable resource within the landscape for a variety of threatened and non-threatened fauna. In this context, waterbodies can include dams, ponds, streams, creeks, rivers and any other open body of water that may provide habitat for flora and fauna.	Three state mapped hydrolines and several farm dams occur across the Study Area. These waterbodies are of varying condition, however, they have suitable habitat presently or have the potential to contain suitable habitat for the threatened species Green and Golden Bell Frog (**Section 5.7.1.1**)
Moss gardens	Gently sloping or flat land with poor soil drainage often creates moss gardens. Moss garden habitats are a valuable resource for native flora and fauna as they assist with moisture exchange, prevent erosion and absorb pollution.	Small patches of moss gardens were incidentally observed throughout the Study Area and often occurred where disturbance to native vegetation has been limited (**Figure 12**). The moss gardens found within or adjacent to the Regeneration vegetation zone is considered to be the most suitable habitat for the threatened species *Pterostylis gibbosa*, due to the absence of upper stratum species not limiting resources (i.e. light). Additionally, areas of cleared land with a native dominant ground stratum has also been included as records exist of threatened *Pterostylis* species within areas of previously cleared land.
Termite mounds	Termite mounds are used as breeding and foraging resources for native fauna. The termite mounds act as an incubation chamber for eggs before hatching and a foraging resource following hatching.	Termite mounds were incidentally observed throughout the Study Area and often occurred where disturbance to native vegetation has been limited (**Figure 12**). No signs of nesting/feeding were observed within the termite mounds at the time of preliminary site investigations.
Artificial Structures	Artificial structures have the potential to provide unique microhabitats for a variety of threatened and non-threatened fauna, a more notable group that utilise artificial structures is microbats	Artificial structures are present across the Study Area (**Figure 12**). Further targeted surveys of these artificial structures are required to determine if the artificial structures are used by native fauna.

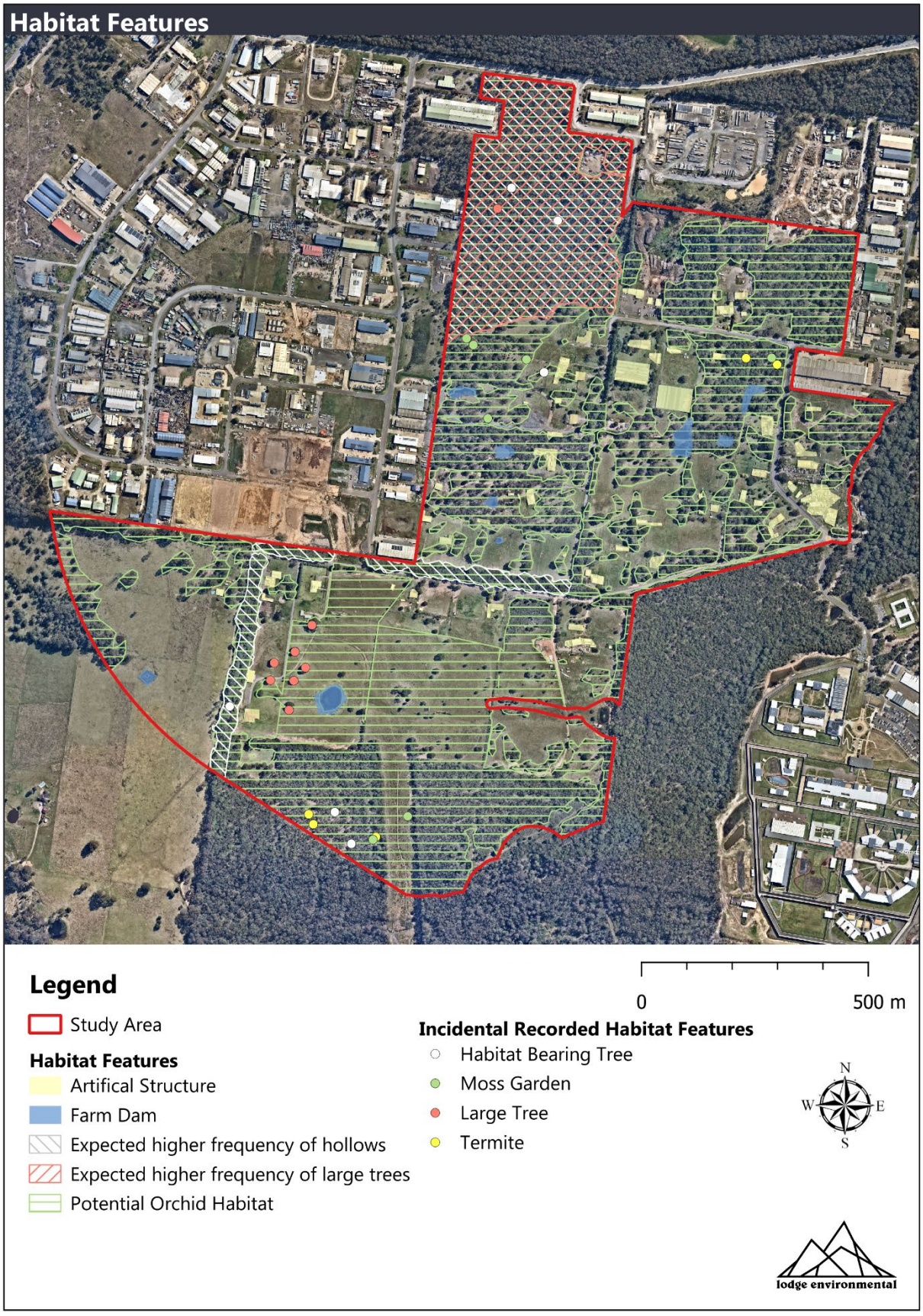


Figure 12: Habitat features recorded throughout the Study Area

5.2 PLANT COMMUNITY TYPES

Following the field assessment and consideration of available data, two Vegetation Types were validated within the Study Area, being:

- PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest
- No PCT – Cleared / Artificial Structures / Exotics / Grasslands

The occurrence of PCT 3269 within the Study Area has five different vegetation zones, being:

- Good condition (32.90 ha)
- Moderate condition (17.71 ha)
- Under scrubbed (4.48 ha)
- Regeneration (1.86 ha)
- Native upper stratum with variable ground stratum (20.02 ha)

Figure 13 depicts the validated vegetation within the Study Area and **Table 5** provides a detailed description of the PCT recorded. Plot locations are also depicted in **Figure 13**. The distribution of plots was limited based on site accessibility, also reflected in **Figure 13**.

5.2.1 PCT Identification

PCT identification was conducted in accordance with the BioNet Vegetation Classification user manual and using the BioNet Vegetation Classification database. The database identifies potential PCTs that match the geographic distribution, vegetation formation and floristics recorded within the Study Area. Potential PCTs were then reviewed alongside observations recorded during the preliminary site surveys to determine the most appropriate PCT for each vegetation zone.

Following a review of the geographic distribution, vegetation formation, current vegetation mapping and floristics of the Study Area (**Table 5**), it was found the PCT 3269 closely matched the characteristics of the Study Area. One alternative PCT, being PCT 3330 – South Coast Lowland Woollybutt Grassy Forest, was considered but ultimately ruled out due to the scarcity of *Eucalyptus tereticornis* (Forest Red Gum), high abundance of *Corymbia maculata* (Spotted Gum) and the mid stratum *Acacia* species not aligning to what was observed within the Study Area.

5.2.2 Vegetation Integrity

Vegetation Integrity (VI) plots were undertaken in accordance with the BAM. The number of plots were informed by Table 3 within the BAM, with 19 plots completed (Appendix B) (**Figure 13**). The VI plots allowed for calculation of a vegetation integrity score for each vegetation zone. The scores per vegetation zone are listed below, as well as within sections 5.2.3 through 5.2.8.

- Good: 87.8
- Moderate: 76.5
- Underscubbed: 52.1
- Regeneration: 49.8
- Native Upper Stratum: 36.8

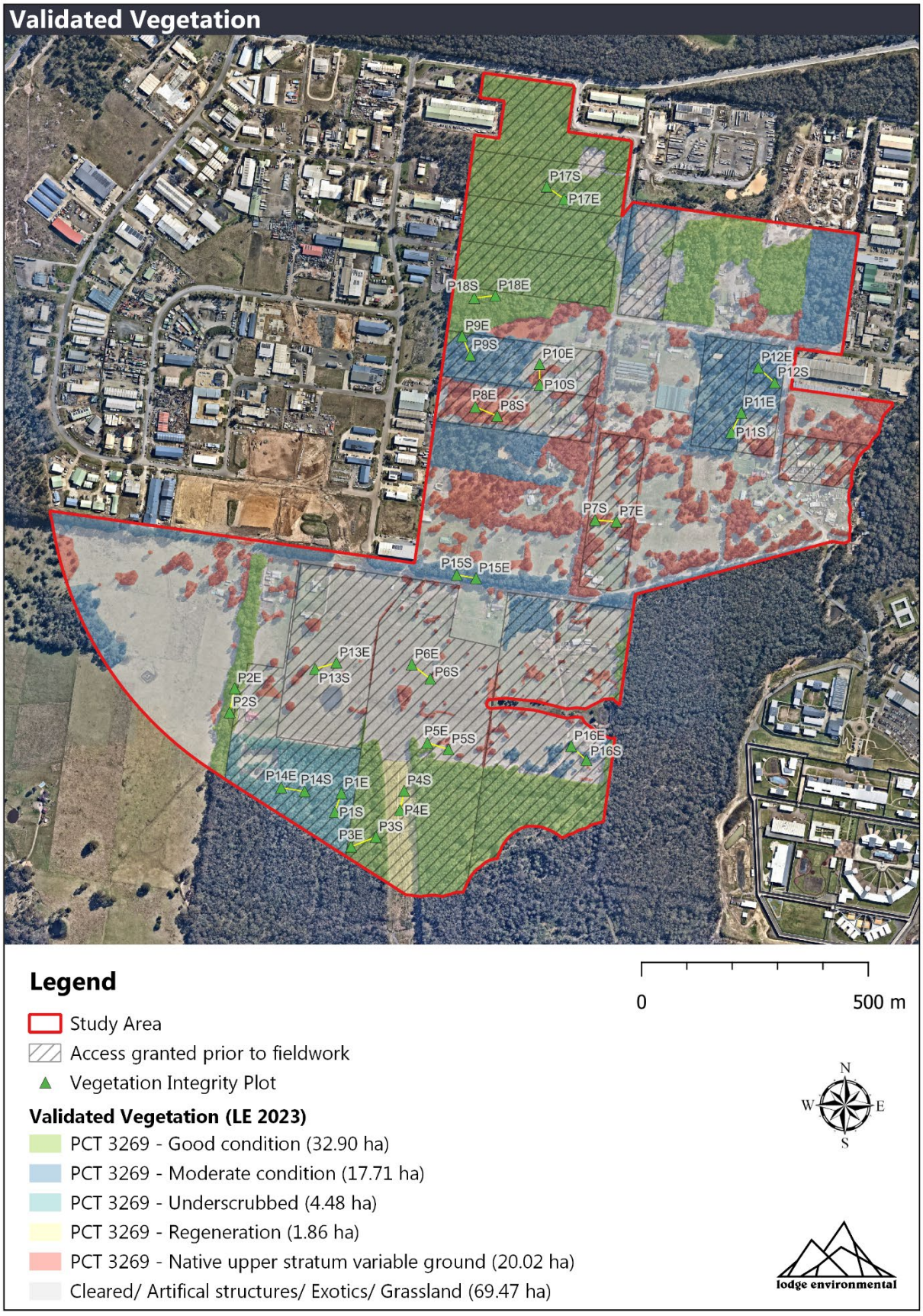


Figure 13: Validated vegetation within the Study Area (LE 2023)

Table 5: PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest Justification Table

PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest			
PCT ID	3269		
Vegetation formation	Grassy Woodlands		
Vegetation class	Coastal Valley Grassy Woodlands		
Extent within Study Area	77.33 ha		
Description	A very tall dry shrubby layered sclerophyll open forest with a ground cover of grasses and graminoids found on low-lying Permian siltstones around Nowra, Shoalhaven region. The tree canopy almost always includes a higher cover of *Corymbia maculata*, very frequently in combination with *Eucalyptus longifolia* and *Eucalyptus paniculata* and commonly *Eucalyptus globoidea*. The mid-stratum is typically layered with a sparse cover of taller small trees including *Melaleuca decora* and *Allocasuarina littoralis.* A sparse lower layer of dry shrubs very frequently includes *Daviesia ulicifolia* with *Pultenaea villosa* and commonly *Acacia falcata* and *Lissanthe strigosa.* The ground layer is a mid-dense cover of grasses, graminoids and forbs, very frequently or commonly including *Entolasia stricta*, *Lomandra longifolia*, *Dianella revoluta*, *Themeda triandra* and *Brunoniella pumilio*. Current survey data indicates a highly restricted distribution below 60 metres asl mainly within a five kilometre radius of Nowra. Past clearing has likely reduced the original extent of this PCT in the gentle depressions and creeks on the Nowra lowlands. This community grades into tall eucalypt forest PCT 4020 on some creek flats and dry shrub forest PCT 3273 and heathy woodland PCT 3654 on soils derived from Permian sandstone.		
Geography and landscape of the Study Area	The Study Area is a gently undulating landscape located south of Nowra and approximately 60-70 metres above sea level. With reference to the Wollongong 1:250,000 geological map (SI56-09) the soil within the Study Area has been mapped as 'Siltstone, shale, sandstone' (Psb) of the Berry Formation of the Permian Quaternary.		
Characteristic species recorded within the Study Area	Upper Stratum Species: *Allocasuarina littoralis* *Corymbia maculata* *Eucalyptus eugenioides* *Eucalyptus longifolia* *Eucalyptus paniculata* *Eucalyptus punctata*	Mid Stratum Species: *Acacia falcata* *Acacia irrorata* *Acacia longifolia* *Acacia mearnsii* *Acacia stricta* *Acacia ulicifolia* *Bursaria spinosa* *Cassytha pubescens* *Daviesia ulicifolia* *Exocarpus cupressiformis* *Glycine clandestina* *Glycine tabacina* *Hakea sericea* *Hardenbergia violacea* *Kunzea ambigua* *Leptospermum continentale* *Leucopogon juniperinus* *Lissanthe strigosa* *Macrozamia communis* *Marsdenia rostrata* *Melaleuca decora* *Melaleuca linariifolia* *Melaleuca styphelioides*	Ground Stratum Species: *Aristida vagans* *Brunoniella australis* *Brunoniella pumilio* *Caesia parviflora* *Centella asiatica* *Cheilanthes sieberi* *Cymbopogon refractus* *Dianella caerulea* *Dianella longifolia* *Dichelachne micrantha* *Dichondra repens* *Echinopogon caespitosus* *Entolasia marginata* *Entolasia stricta* *Eragrostis brownii* *Gonocarpus tetragynus* *Gonocarpus teucrioidies* *Goodenia hederacea* *Goodenia paniculata* *Hypericum gramineum* *Imperata cylindrica* *Juncus usitatus* *Lagenophora stipitata*

PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest			
		Notelaea venosa *Ozothamnus diosmifolius* *Parsonsia straminea* *Pimelea linifolia* *Pittosporum undulatum* *Pultenaea retusa* *Pultenaea villosa* *Zieria smithii*	*Lepidoperma gunnii* *Lepidosperma laterale* *Lomandra confertifolia* *Lomandra filiformis* *Lomandra gracilis* *Lomandra longifolia* *Lomandra multiflora* *Microlaena stipoides* *Opercularia aspera* *Panicum simile* *Paspalidium distans* *Poa sieberiana* *Pratia purpurascens* *Schoenus apogon* *Themeda australis* *Tricoryne elatior* *Wahlenbergia gracilis*
TEC Status	There is two TECs associated with PCT 3269, being: Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion – Endangered under the BC Act, and Illawarra South Coast Lowland Grassy Woodland - Critically Endangered under the EPBC Act.		
Estimate of percent cleared	56.36%		

5.2.3 Good condition

Areas represented by good condition PCT 3269 contained all three strata, were well-connected and showed very few signs of disturbance such as exotic species incursions, clearing or pollution (**Figure 14**).

The upper stratum was dominated by three main species: *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Ironbark). Although the abundance and cover of these species varied throughout the vegetation zone, their presence was nearly always recorded. Other species recorded within the upper stratum included *Eucalyptus eugenoides* (Thin-leaved Stringybark) and *Eucalyptus punctata* (Grey Gum).

Mid stratum was typically dominated by a thicket of *Kunzea ambigua* (Tick Bush). Areas where *Kunzea ambigua* was less abundant tended to occur within road alignments. Other species that were almost always present within the mid stratum included: *Acacia falcata* (Hickory Wattle), *Acacia stricta* (Straight Wattle), *Melaleuca decora* and *Pimelea linifolia* (Slender Rice Flower), with varying abundance and cover. Less frequent mid stratum species included *Leucopogon juniperinus* (Prickly Beard-heath), *Acacia ulicifolia* (Prickly Moses), *Hakea sericea* (Needlebush), *Pittosporum undulatum* (Native Daphne), *Olearia viscidula* (Wallaby Weed), *Allocasuaria littoralis* (Black She-oak) and *Melaleuca steyphelioides* (Prickly-leaved Tea Tree).

Ground stratum was dominated by grass and grass-like species, with the most frequent occurring species including *Entolasia stricta* (Wiry Panic), *Entolasia marginata* (Borded Panic), *Panicum simile* (Two-coloured Panic), *Eragrostis brownii* (Brown' s Lovegrass), *Cymbopogon refractus* (Barbed

Wire Grass), *Microleana stipoides* (Weeping Grass) and *Echinopogon caespitosus* (Bushy Hedgehog Grass). Forb species often recorded within the ground stratum include *Brunoniella pumilio* (Dwarf Brunoniella), *Goodenia paniculata* (Branched Goodenia), *Dianella longifolia* (Blueberry Lily), *Dianella caerulea* (Blue Flax-lily) and *Centella asiatica* (Indian Pennywort).

The vegetation integrity score for PCT 3269 – Good Condition is 87.8.

Figure 14: Good condition PCT 3269 vegetation zone

5.2.4 Moderate condition

Moderate condition vegetation zones of PCT 3269 typically only contained upper and ground stratum species, with the mid stratum being largely absent (**Figure 15**). Disturbances such as fragmentation, exotic species incursion and pollution were often recorded within this vegetation zone.

Similar to the good condition vegetation zones, the upper stratum was dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Ironbark) with varying abundance and cover.

Mid stratum was largely absent within the moderate condition vegetation zone. However, when present included *Melaleuca decora*, *Pittosporum undulatum* (Native Daphne), *Acacia irrorata* (Green Wattle) and *Notelea venosa* (Veined Mock-olive). Mid stratum species such as *Acacia falcata* (Hickory Wattle) and *Kunzea ambigua* (Tick Bush) were also recorded however, at a lower abundance than within the good condition vegetation zone. Vine species were common within

the moderate conditioned mid stratum. Vine species recorded include: *Parsonsia straminea* (Common Silkpod), *Pandorea pandorana* (Wonga Wonga Vine), *Hardenbergia violacea* (Purple Coral Pea), *Marsdentia rostrata* (Milk Vine) and *Glycine* species.

Ground stratum contained the same dominant species as within the good condition vegetation zone, however at lower abundance levels. Species such as *Fimbristylis dichtoma* (Common Fringe-sedge), *Pratia purpurscens* (Whiteroot) and *Goodenia paniculata* (Branched Goodenia) were common throughout this vegetation zone, often in large patches. Common ground stratum species found within this vegetation zone include *Aristida vagans* (Threeawn Speargrass), *Chilanthes sieberi*, *Lepidosperma laterale*, *Euchiton sphaericus*, *Cyperus polystachyos* and *Dichondra repens* (Kidney Weed).

Exotic species incursion was recorded in all the moderate condition vegetation zones. Exotic species frequently observed include *Conyza borariensis* (Flaxleaf fleabane), *Bidens pilosa* (Cobbler' s Peg), *Asparagus aethiopicus* (Asparagus Weed), *Hypochaeris radicata* (Catsear), *Senecio madagascariensis* (Fireweed), *Phytolacca octandra* (Inkweed), *Ligustrum sinense* (Small-leaved Privet), *Lantana camara* (Lantana) and *Verbena bonariensis* (Purpletop).

The vegetation integrity score for PCT 3269 – Moderate Condition is 76.5.

Figure 15: Moderate condition vegetation zone

5.2.5 Under scrubbed

PCT 3269 was recorded in an underscrubbed condition state within a southern lot (Lot 22 DP 1043769) of the Study Area (**Figure 16**). At the time of the preliminary site investigations signs of disturbance and clearing were evident, resulting in less mid and ground stratum species than would otherwise be expected. In some instance, species within the mid and ground stratum were difficult to identify due to recent disturbance/slashing removing critical identification features.

Despite the disturbance to the mid and ground stratum, the upper stratum appeared to be unaffected and consistent with the good condition vegetation zones. Dominant species recorded included *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Ironbark) with a sparse presence of *Eucalyptus eugenoides* (Thin-leaved Stringybark) observed.

The mid stratum, when present, contained a similar assemblage of dominant species to that of the good condition vegetation zone, however, at significantly lower abundance and cover. Species recorded included *Acacia falcata* (Hickory Wattle), *Acacia stricta* (Straight Wattle), *Kunzea ambigua* (Tick Bush), *Pimelea linifolia* (Slender Rice Flower), *Leucopogon juniperinus* (Prickly Beard-heath), *Glycine clandestina* and *Exocarpos cupressiformis* (Native Cherry).

Ground stratum within the under scrubbed vegetation zone was dominated by grass and forb species matching the good condition vegetation zone, however, at lower abundance and cover due to the recent and likely ongoing disturbance. Additionally, *Lagenophora stipitata*, *Cyanthillium cinereum* (Iron Weed) and *Caesia parviflora* (Pale Grass-lily) were recorded within this vegetation zone.

Exotic species incursion was also observed within this vegetation zone. However, the recent disturbance was also experience by the exotic species and resulting in a lower cover and abundance of weeds. Exotic species recorded include *Lantana camara* (Lantana), *Taraxacum offincinale* (Dandelion), *Axonopus compresus* (Broad-leaved Carpet Grass) and *Hypochaeris radicata* (Catsear).

The vegetation integrity score for PCT 3269 – Underscrubbed is 52.1.

Figure 16: Under scrubbed vegetation zone

5.2.6 Regeneration

The zone labelled *Regeneration* was located within a powerline easement and between two patches of good condition vegetation (**Figure 17**). It is likely that this zone would have presented in a good condition in the absence of clearance and maintenance associated with the powerline easement. Despite the disturbance associated with the powerline easement, widespread regeneration of native species was observed.

The upper stratum of this vegetation zone is absent, likely due to frequent ongoing maintenance of the easement, however regenerating and juvenile *Eucalyptus* species were recorded within this vegetation zone.

Mid stratum was also largely absent, again, likely due to continual maintenance of the easement. However, when present, species such as *Acacia falcata* (Hickory Wattle), *Acacia stricta* (Straight Wattle), *Kunzea ambigua* (Tick Bush), *Pimelea linifolia* (Slender Rice Flower) and *Leucopogon juniperinus* (Prickly Beard-heath) were recorded.

Ground stratum species within this vegetation zone was diverse and consisted of similar species found within all surrounding, undisturbed vegetation zones. Grass and grass-like species were represented by *Fimbristylis dichtoma* (Common Fringe-sedge) as the most dominant.

Exotic species incursion was again observed within this vegetation zone. Exotic species recorded included *Conyza bonariensis* (Flaxleaf Fleabane), *Taraxacum officinale* (Dandelion), *Senecio madagascariensis* (Fireweed) and *Bidens pilosa* (Cobbler' s Peg).

The vegetation integrity score for PCT 3269 – Regeneration is 49.8.

Figure 17: Regeneration vegetation zone

5.2.7 Native upper stratum with variable ground stratum

The vegetation zone labelled *Native upper stratum and variable ground stratum* was predominantly recorded within the central areas of the Study Area and typically associated with residential dwellings or paddocks (**Figure 18**). This vegetation zone consistently displayed a native upper stratum, a largely absent mid stratum and varying ground stratum where native and/or exotic species were present.

The upper stratum was dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Ironbark) with the occasional *Eucalyptus eugenoides* (Thin-leaved Stringybark) observed. Moderate abundance of *Melaleuca decora* and *Melaleuca styphelioides* (Prickly-leaved Tea Tree) was recorded, primarily closer to mapped hydrolines and farm dams.

Mid stratum species were largely absent within this vegetation zone. When present, the species recorded were the consistent with mid stratum species observed within the other vegetation zones.

The ground stratum of this vegetation zone was highly variable, reflecting the ecotone between rural residential land use and the adjacent consolidated good condition vegetation. Dominant native species recorded within this vegetation zone were consistent with the ground stratum species recorded within the other vegetation zones. Exotic grass species were recorded in moderate abundance including *Axonopus compresus* (Broad-leaved Carpet Grass), *Setaria parviflora* (Pigeon Grass), *Sporobolus africanus* (Parramatta Grass) and *Paspalum dilatum* (Paspalum).

The vegetation integrity score for PCT 3269 – Native Upper Stratum Variable Ground Stratum is 36.8.

Figure 18: Native upper stratum with variable ground stratum vegetation zone

5.2.8 Cleared / Artificial Structures / Exotics / Grasslands

This vegetation zone comprises of multiple components, including cleared land, artificial structures, exotic species dominant vegetation and grasslands with variable composition. The composition of the grasslands varied across the Study Area, with some patches containing a high amount of native grasses, grass-like and forb species, and other patches containing a high amount of exotic species. Within this vegetation zone, two VI plots (Plot 6 and 13) were completed, where a relatively high amount of native diversity was observed (**Figure 19**). The BAM-C calculated the VI score of these plots to be below 20.

As per Section 9.2.1 of the BAM 2020, impacts on a native vegetation zone that has a vegetation integrity score of ≥20, where the PCT is not representative of a TEC or associated with a threatened species, does not require offsetting. As the VI score for the grasslands is below 20 and is not associated with a TEC or threatened species, the grasslands were consolidated into the cleared, artificial structures and exotics vegetation zone.

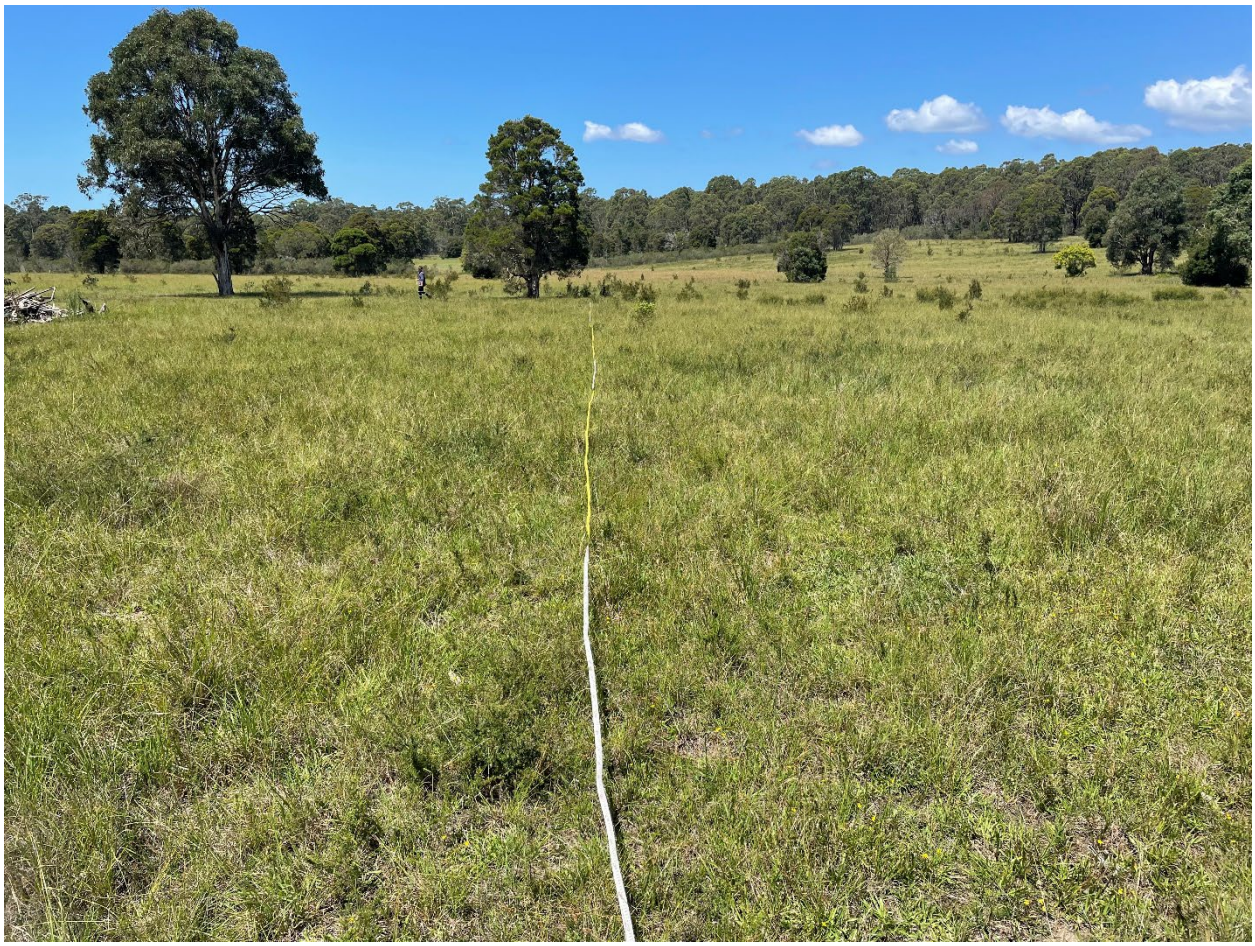


Figure 19: Grasslands vegetation zone

5.3 THREATENED ECOLOGICAL COMMUNITY

Threatened Ecological Communities (TEC) are ecological communities that are at the risk of extinction from a number of pressures, including:

- Clearing of native vegetation
- Inappropriate fire regimes
- Exotic and/or invasive species
- Climate change
- Water diversion
- Pollution
- Urban development.

TECs are afforded considerable protection via their listing under both the State BC Act and Commonwealth EPBC Act.

PCT 3269 – Shoalhaven Lowlands Spotted Gum-Paperbark Forest can be associated with two TECs, being:

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion – listed as *Endangered* under the BC Act, and
- Illawarra and South Coast Lowland Forest and Woodland Ecological Community – listed as *Critically Endangered* under the EPBC Act.

For a PCT to meet a TEC status a range of criteria must be met. An assessment of the relevant TEC criteria and determinations is contained below.

5.3.1 Threatened Ecological Community Association

5.3.1.1 Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion (*Endangered*)

PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest can be associated with the TEC Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion (ILGW) under the Biodiversity Conservation Act 2016 (BC Act). The NSW Scientific Committee outlines the legal definition of each TEC which are used to determine if a PCT is considered to represent the associated TECs.

ILGW occurs near coastal areas below 200 metres on gently undulating terrain, with most of this community having been cleared and now and occurring predominately as scattered fragments. Characteristic tree species include *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus eugenioides* (Thin-leaved Stringybark), *Eucalyptus longifolia* (Woollybutt), *Eucalyptus bosistoana* (Coast Grey Box) and *Melaleuca decora*. Common shrub species include *Acacia mearnsii* and *Dodonaea viscosa* subsp. *angustifolia*.

A comparison of the occurrence of PCT 3269 within the Study Area to the determining factors listed within the NSW Scientific Committee Final Determinations for ILGW is detailed below in **Table 6**.

Table 6: Comparison of PCT 3269 - Shoalhaven Lowlands Spotted Gum-Paperbark Forest within the Study Area and the final determinations for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Key attribute	NSW Scientific Committee Final Determination – ILGW	PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest within the Study Area
Location	Illawarra Lowlands Grassy Woodland has been recorded from the local government areas of Wollongong City, Shellharbour City and Kiama Municipality (within the Sydney Basin Bioregion).	The Study Area is located within the Shoalhaven LGA which is not listed within the final determination. However, the Shoalhaven LGA is listed as an associated LGA on the threatened species profile for the TEC.
Soils and landscape position	Illawarra Lowlands Grassy Woodland occurs on relatively gently sloping to undulating lands less than about 200 m elevation on Berry Siltstone, Budgong Sandstone and Quaternary alluvium.	The Study Area is mapped on the Wollongong 1:250 000 geological map as being situated on 'Psb' Siltstone, shale, sandstone within the Berry formation. The entire Study Area occurs at elevations below 50 meters above sea level.
Floristic composition	Illawarra Lowlands Grassy Woodland is characterised by the florist assemblage species outlined in paragraph 1.	Of the 72 characteristic species listed, 42 were recorded within the Study Area.
Characteristic tree species	Characteristic tree species in the Illawarra Grassy Lowlands Woodland are *Eucalyptus terticornis*, *Eucalyptus eugenoides*, *Eucalyptus longifolia*, *Eucalyptus bosistoana* and *Melaleuca decora*.	PCT 3269 within the Study Area is characterised by an upper stratum dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Iron Bark). *Eucalyptus eugenioides* (Thin-leaved Stringybark) and *Melaleuca decora* were frequently recorded across the Study Area. Very few *Eucalyptus terticornis* were recorded – approximately 4 within an isolated row.
Disturbance	Most remnants are small and fragmented and their long-term viability is threatened. Some remnants consist of regrowth after clearing or other disturbances.	The majority of PCT 3269 within the Study Area is subject to ongoing disturbances, including; • Historical clearance • Under scrubbing • Lawn and garden maintenance • Grazing

Following a review of the determining factors listed by NSW Scientific Committee Final Determinations and discussions with DPE representatives, the occurrence of PCT 3269 within the Study Area aligns with the location, soils and landscape position of the TEC ILGW. Although the floristic and characteristic tree species may not strongly align with the listed species the Final Determination states "*the total species list of the community is considerably larger than that given, with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed may be present*".

Therefore, the occurrence of PCT 3269 – Shoalhaven Lowlands Spotted Gum-Paperbark Forest within the Study Area is considered to represent the TEC Illawarra Lowlands Grassy Woodlands in the Sydney Basin Bioregion under the BC Act.

5.3.1.2 Environment Protection and Biodiversity Conservation Act 1999

Illawarra and South Coast Lowland Forest and Woodland Ecological Community (LFW) is listed as *Critically Endangered* under the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act). Commonwealth threatened status and listings focus legal protection on patches of threatened ecological communities that are most functional, have a high abundance of native species and in comparatively good condition. Condition thresholds and key diagnostic characteristics assist in identifying if the EPBC Act is to apply to a patch of native vegetation. For

the native vegetation to be considered as LFW under the EPBC Act, areas of the ecological community must meet:

- The key diagnostic characteristics, and
- At least the minimum condition thresholds for moderate condition

Key Diagnostic Characteristics

A comparison of the occurrence of PCT 3269 within the Study Area and with the Approved Listing Advice prepared by the Department of Environment Climate Change, Energy and Water (DECCEW) (2016) for LFW is detailed below in **Table 7**.

Table 7: Comparison of PCT 3269 - Shoalhaven Lowlands Spotted Gum-Paperbark Forest within the Study Area and the listing advice for Illawarra and South Coast Lowland Forest and Woodland Ecological Community

Key attribute	DECCEW Listing Advice Key Characteristic	PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest within the Study Area
Location	The ecological community occurs within the state of New South Wales in the Jervis, Ettrema and Illawarra subregions of the Sydney Basin Bioregion and the Bateman subregion of the South East Corner Bioregion.	The Study Area is located within the Jervis IBRA subregion of the Sydney Basin Bioregion.
Landscape position and canopy cover	The ecological community occurs below approximately 350 m above sea level, on the coastal plain or foothills between the immediate coastal strip and the escarpment.	The entire Study Area occurs at elevations below 50 metres above sea level and is sited between the coast and the escarpment.
Floristic composition	The ecological community is a forest or woodland with at least 10% foliage cover .	Native vegetation across the Study Area contains 10% canopy cover.
Characteristic tree species	*Eucalyptus tereticornis* (Forest Red Gum) or *E.longifolia* (Woollybutt) is typically present and often dominant in the mature tree canopy. One or more of the following canopy species may also be dominant, especially where there has been selective removal of trees (for example, *E.tereticornis*) from some patches of the ecological community: *Angophora floribunda* (Rough-barked Apple); *E. bosistoana* (Coast Grey Box); *E. eugenioides* (Thin-leaved Stringybark); *E. globoidea* (White Stringybark). Amongst the other tree species commonly found in the ecological community, but not typically dominant are: *Corymbia maculata* (Spotted Gum); *E. amplifolia* subsp. *amplifolia* (Cabbage Gum); *E. botryoides* (Bangalay); *E. paniculata* subsp. *paniculata* (Grey Ironbark); *E. pilularis* (Blackbutt); and *E. quadrangulata* (Coastal White Box).	PCT 3269 within the Study Area is characterised by an upper stratum dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus longifolia* (Woollybutt) and *Eucalyptus paniculata* (Grey Iron Bark). *Eucalyptus eugenioides* (Thin-leaved Stringybark) and *Melaleuca decora* were frequently recorded across the Study Area. Very few *Eucalyptus tereticornis* were recorded – approximately 4 within an isolated row.

An initial review of the key characteristics within the Approved Conservation Advice by DECCEW suggested the occurrence of PCT 3269 within the Study Area to be considered as marginal representation of the TEC LFW due to the scarcity of characteristic tree species across the Study Area. Predominately *Eucalyptus tereticornis* (Forest Red Gum), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus bosistoana* (Coast Grey Box), *Eucalyptus botryoides* (Bangalay) and

Eucalyptus quadrangulata (Coastal White Box). However, following discussions with DPE representatives, it was agreed that *Eucalyptus longifolia* (Woollybutt) is a co-dominant tree species and a suitable number of the tree species recorded across the Study Area align with characteristic tree species listed by DECCEW. In addition to no contra-indicative species of LWF being listed by DECCEW.

Accordingly, the occurrence of PCT 3269 – Shoalhaven Lowlands Spotted Gum-Paperbark Forest within the Study Area is considered to meet the key diagnostic characteristics of the TEC Illawarra and South Coast Lowland Forest and Woodland Ecological Community under the EPBC Act.

Condition Thresholds

The condition thresholds for LFW are designed to identify the best patches for national protection. As LFW has been heavily cleared and degraded, many remnants are small, isolated and modified patches. Any remnants that remain largely intact or are connected to other native vegetation and form a large patch are a high priority for protection and management. Small, isolated patches that have or will experience disturbances may not meet the condition thresholds and are considered to not significantly contribute to the conservation potential of LFW.

Patches of LWF that meet the description of Category A and Category B are classes as 'High Condition' patches. High Condition patches are provided the highest protections. Patches of LWF that meet the description for Category C and Category D are considered 'Moderate Condition'. Moderate Condition patches are the lowest threshold for a patch of LFW to meet the condition class of this community. Condition thresholds for patches of LFW are detailed in **Table 8**. **Table 9** details the VI plot data and the corresponding condition threshold of LFW. **Figure 20** shows the extent of LFW within the Study Area; however, due to restricted access to certain properties, assumptions based on evidence gathered outside of the property was used to determine the categorisation and not VI plot data.

Table 8: Condition thresholds for patches of Illawarra and South Coast Lowland Forest and Woodland

<table>
<tr><th>Category and rationale</th><th>Patch size thresholds</th><th colspan="3">Biotic thresholds</th></tr>
<tr><td rowspan="2">A. High condition class
A larger patch with good quality native understorey and/or many very large trees</td><td rowspan="2">The patch is at least 2 ha.</td><td colspan="3">50% of its total understorey vegetation cover* is comprised of native species (exotic annuals are excluded from this assessment)
and</td></tr>
<tr><td>At least 6 native plant species per 0.5 ha in the ground layer</td><td>OR</td><td>the patch has at least ten trees that are
either
very large (at least 60cm diameter at breast height dbh)
or
have hollows.</td></tr>
<tr><td>B. High condition class
A patch with very good quality native understorey with a species rich ground layer</td><td>The patch is at least 0.5 ha.</td><td colspan="3">At least 70% of the understorey vegetation cover* is comprised of native species (exotic annuals are excluded from this assessment)
and
with at least 10 native plant species per 0.5 ha in the ground layer</td></tr>
<tr><td>C. Moderate condition class
A patch with good quality native understorey</td><td>The patch is at least 0.5 ha.</td><td colspan="3">At least 50% of its total understorey vegetation cover* is comprised of native species (exotic annuals are excluded from this assessment)
and
with at least 6 native plant species per 0.5 ha in the ground layer</td></tr>
<tr><td rowspan="2">D. Moderate condition class
A patch that makes other important ecological contributions</td><td rowspan="2">The patch is at least 0.5 ha.</td><td colspan="3">At least 30% of total perennial understorey vegetative cover* is comprised of native species
and</td></tr>
<tr><td>the patch is contiguous** with another patch of native vegetation *** (at least 1 ha in area)</td><td>OR</td><td>the patch has at least one large locally indigenous tree (at least 50 cm diameter at breast height (dbh)),
or
at least one tree with hollows</td></tr>
<tr><td colspan="5">*Understorey vegetation cover includes vascular plant species of both the ground layer and the shrub layer (where present). The ground layer includes herbs (graminoids and forbs) and low (≤0.5 m) shrubs, but does not include cryptogams, leaf litter or exposed soil.
**Contiguous with another patch of native vegetation means the patch is continuous with or in close proximity (within 100 m) to another area of native vegetation.
***'Native vegetation' refers to areas where ≥50% of the perennial vegetation cover is comprised of native plant species.</td></tr>
</table>

Table 9: VI Plot data and LFW Condition thresholds/

Plot	Patch Size (ha)	Biotic threshold	EPBC listing (Yes/No)?	Category
1	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
2	1.8	• Native understorey vegetation cover is greater than 70%, and • Greater than 10 native plant species per 0.5 ha in the ground layer	Yes	Category B
3	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
4	1.86	• Native understorey vegetation cover is greater than 70%, and • Greater than 10 native plant species per 0.5 ha in the ground layer	Yes	Category B
5	<0.5	-	No	-
6	>2	Native understorey vegetation cover is less than 30%	No	-
7	>2	Native understorey vegetation cover is less than 30%	No	-
8	1.3	• Native understorey vegetation cover is greater than 30% and less than 50% • Contiguous with another patch of native vegetation	Yes	Category D
9	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
10	<0.5	-	No	-
11	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
12	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
13	>2	Not contiguous with another patch of native vegetation	No	-
14	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
15	1.4	Native understorey vegetation cover is less than 30%	No	-
16	<0.5	-	No	-
17	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A
18	>2	• Native understorey vegetation cover is greater than 50%, and • Greater than 6 native species per 0.5 ha in the ground layer	Yes	Category A

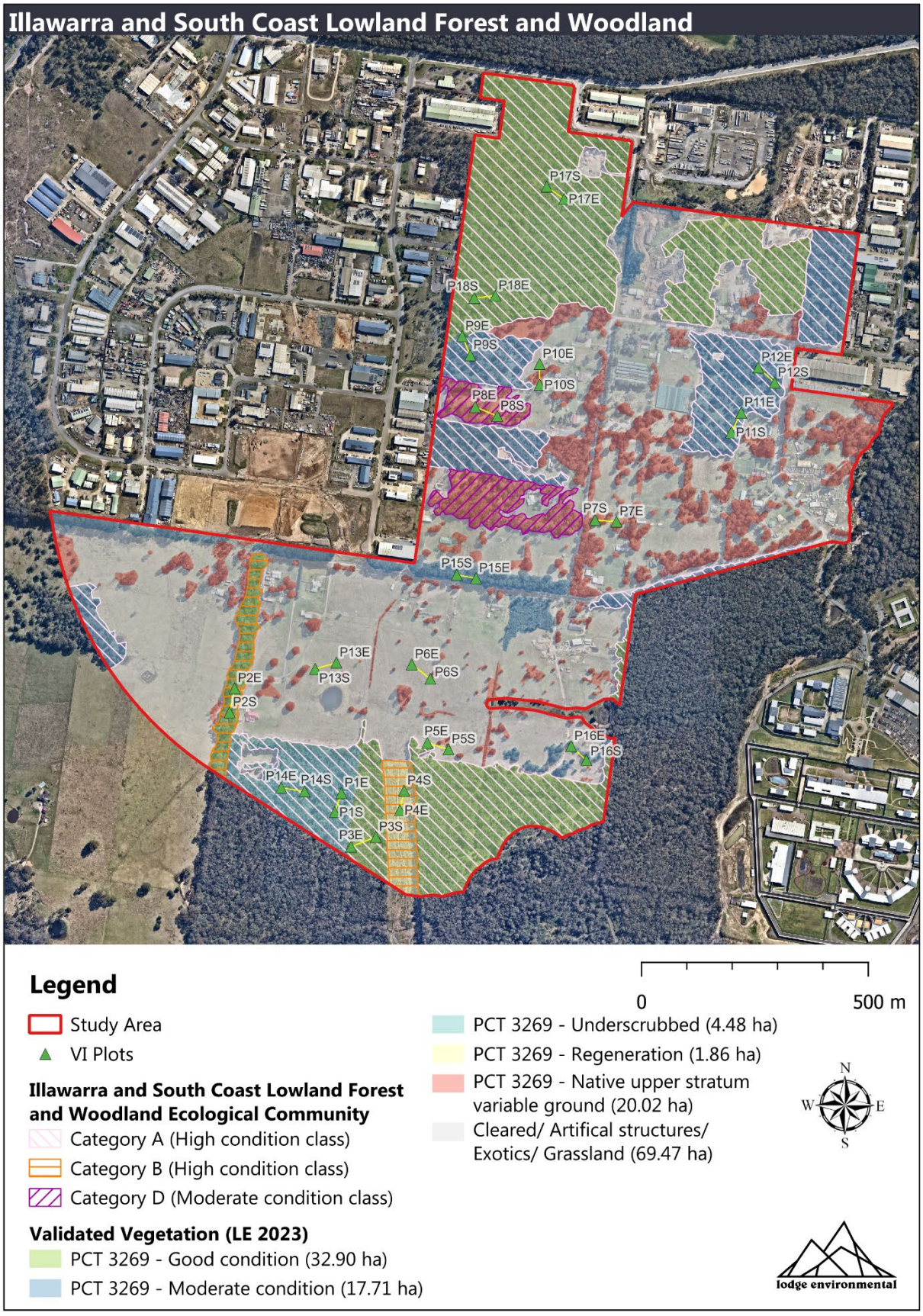


Figure 20: Patches of Illawarra and South Coast Lowland Forest within the Study Area

5.4 WATERCOURSES AND RIPARIAN CORRIDORS

According to the NSW Hydro Line spatial data, there are 3 unnamed watercourses mapped in the Study Area which flow in an easterly and north-easterly direction towards Nowra Creek, which in turn flows north to Shoalhaven River. These watercourses have been the subject of a number of studies to determine appropriate riparian corridor widths required for their protection.

A review of these studies and methodologies used to map and categorise the subject watercourses is provided below.

5.4.1 Riparian Corridor Management Study (DIPNR 2004)

In 2004, the then NSW Department of Infrastructure, Planning and Natural Resources published an assessment of waterways according to a "Riparian Corridor Objective Setting" for waterways in the Wollongong Local Government Area and the Calderwood Valley in the Shellharbour Local Government Area. In 2006, this study was extended to selected watercourses in Nowra and Bomaderry, including those in the Study Area (DNR 2006).

This methodology categorises watercourses based on the objectives for their protection and/or restoration, and sets recommended vegetated buffer widths according to the objectives, as follows:

- Category 1 – Environmental corridor: The overarching objective is to provide biodiversity linkages by maintaining connectivity for the movement of aquatic and terrestrial species along the riparian corridor and between key destinations. The recommended riparian corridor is a Core Riparian Zone (CRZ) width of 40 metres either side, measured from top of bank, as well as an additional 10 metres Vegetated Buffer (VB).
- Category 2 – Terrestrial and aquatic habitat: The overarching objective is to provide basic habitat and preserve or emulate as much as possible a naturally functioning stream (not necessarily linking key destinations). The recommended riparian corridor is a Core Riparian Zone (CRZ) width of 20 metres either side, measured from top of bank, as well as an additional 10 metres Vegetated Buffer (VB).
- Category 3 – Bank stability and water quality: The overarching objectives are to prevent accelerated rates of soil erosion and to enhance water quality. This category generally covers minor watercourses, and/or where there are limits to long term values due to heavy impact, degradation or compromise from development, channelisation or piping of sections. The recommended riparian corridor is a Core Riparian Zone (CRZ) width of 10 metres either side, measured from top of bank. No Vegetated Buffer is required for this category.

DNR (2006) identified the northern and central watercourses as Category 2 and the southern watercourse as Category 3.

5.4.2 Nowra Bomaderry Structure Plan (SCC 2008)

The Nowra Bomaderry Structure Plan (NBSP) was prepared by Shoalhaven City Council in 2006 and endorsed by NSW Department of Planning in 2008. The NBSP provided a strategic direction for future development in the Nowra-Bomaderry region, including planning for a future industrial area at South Nowra, in which the Study Area is located.

As part of the development of the NBSP, GHD (2008) was engaged to undertake detailed mapping of watercourses and riparian land according to the Riparian Corridor Objective Setting (RCOS) methodology. This study included field survey verification of watercourses and 'top of bank' mapping using Differential GPS, as the basis for applying riparian corridor widths to mapped watercourses.

GHD (2008) mapped the watercourses in the Study Area as follows:

- Northern watercourse – This watercourse was mapped by DNR as Category 2. GHD maintained the DNR categorisation, however revised the watercourse position, and removed part of the watercourse from the map.
- Central watercourse – This watercourse was originally mapped by DNR as Category 2, but GHD were unable to locate it during field surveys. Due to the lack of either intermittent or ephemeral waterflow, it was not considered to be a watercourse and GHD removed it from the map. GHD's position was that there were several dams in the area which resulted in the lack of a defined watercourse, and if these dams were to be removed at a later date, the hydrology of this area would change. GHD also recommended this area be managed for potential flood protection rather than for environmental values, should development occur within this area.
- Southern watercourse – This watercourse was mapped by DNR as a Category 3. GHD maintained the DNR categorisation, however removed a section of the watercourse from the map.

5.4.3 Shoalhaven LEP 2014

As discussed in **Section 2.4.2.1**, Clause 7.6 of the Shoalhaven LEP refers to *Riparian land and watercourses*, and provides a map to indicate the land to which this clause applies. The LEP has adopted the RCOS methodology, and appears to be a combination of DNR (2006) and GHD (2008) mapping of watercourses in the Study Area, as follows:

- The northern watercourse is mapped as Category 2, with delineation including the length of the watercourse mapped by DNR (2006) with the top of bank mapping conducted by GHD (2008) – ie, the section of watercourse removed from the map by GHD has been retained;
- The central watercourse is mapped as Category 2, with delineation following the DNR (2006) map;
- The southern watercourse is mapped as Category 3, with delineation following the length of the watercourse mapped by DNR (2006) – ie, the section of watercourse removed from the map by GHD has been retained.

5.4.4 NSW Hydro Line Mapping

The *Water Management (General) Regulation 2018* Hydro Line spatial data is a dataset of mapped watercourses and waterbodies in NSW, published and maintained by the NSW Spatial Services (Department of Finance, Services and Innovation). The Hydro Line spatial data is used to determine the Strahler stream order of a watercourse, and the associated indicative riparian buffer widths required under the WM Act.

According to the NSW Hydro Line spatial data, there are 3 unnamed watercourses mapped in the Study Area which flow in an easterly and north-easterly direction towards Nowra Creek, which in turn flows north to Shoalhaven River. **Figure 21** presents a summary and comparison of previous watercourse mapping and categorisation, including:

- NSW Hydro Lines - According to Strahler Stream order, the northern watercourse is a 2nd order watercourse, whilst the central and southern watercourses are 1st order watercourses;
- the GHD (2008) mapping of watercourses with top of bank delineation and categories according to the Riparian Corridor Objective Setting (RCOS) methodology;
- The LEP Clause 7.6 mapping of watercourses and categories according to the Riparian Corridor Objective Setting (RCOS) methodology.

5.4.5 Field Validated Riparian Land

Mapped watercourses and riparian corridors were validated as part of the site assessment conducted by Lodge Environmental using the categorisation method from Riparian Corridor Management Study (DIPNR 2004). As a result, the northern watercourse was the only one confirmed as a watercourse within the Study Area. It has a defined top of bank, and evidently performs a hydrological function as well as an ecological function, with intact areas of native vegetation along the riparian corridor.

The central and southern watercourses were not well defined, and there was no evidence of them performing either a hydrological (drainage) function nor providing habitat function or connectivity in the study area.

A map of 'field validated riparian land' was prepared (**Figure 22**), and includes:

- The field validated watercourse in the north of the study area, with top of bank mapping performed by desktop methods (LiDAR analysis) and field validation;
- Categorisation of the watercourse as a "Category 2" watercourse, which has the objective of supporting terrestrial and aquatic habitat;
- A Riparian Corridor mapped according to the provisions of the "Objective Setting" methodology, which requires a Core Riparian Zone of 20 metres width, measured from the top of bank, as well as additional 10 metres vegetated buffer;
- Consideration of ecological function, potentially as habitat for Green and Golden Bell Frog. For the purposes of this map, GGBF habitat includes land with a "high" score for habitat suitability for this species, as mapped by OEH (date unspecified – discussed further in section 5.7.1.1), with validation within the study area by Lodge Environmental ecologists.

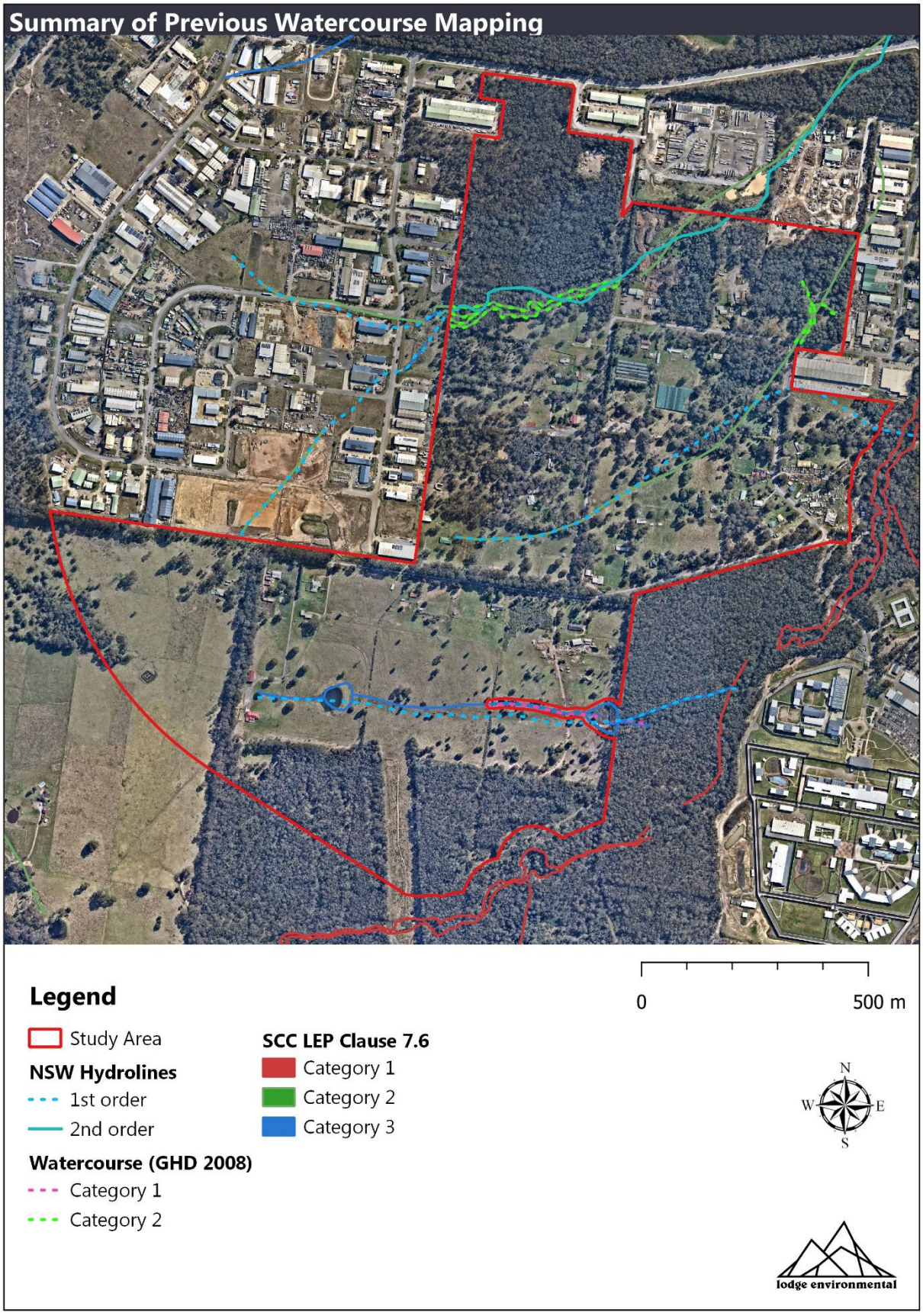


Figure 21: Previously Mapped Watercourses and Categories

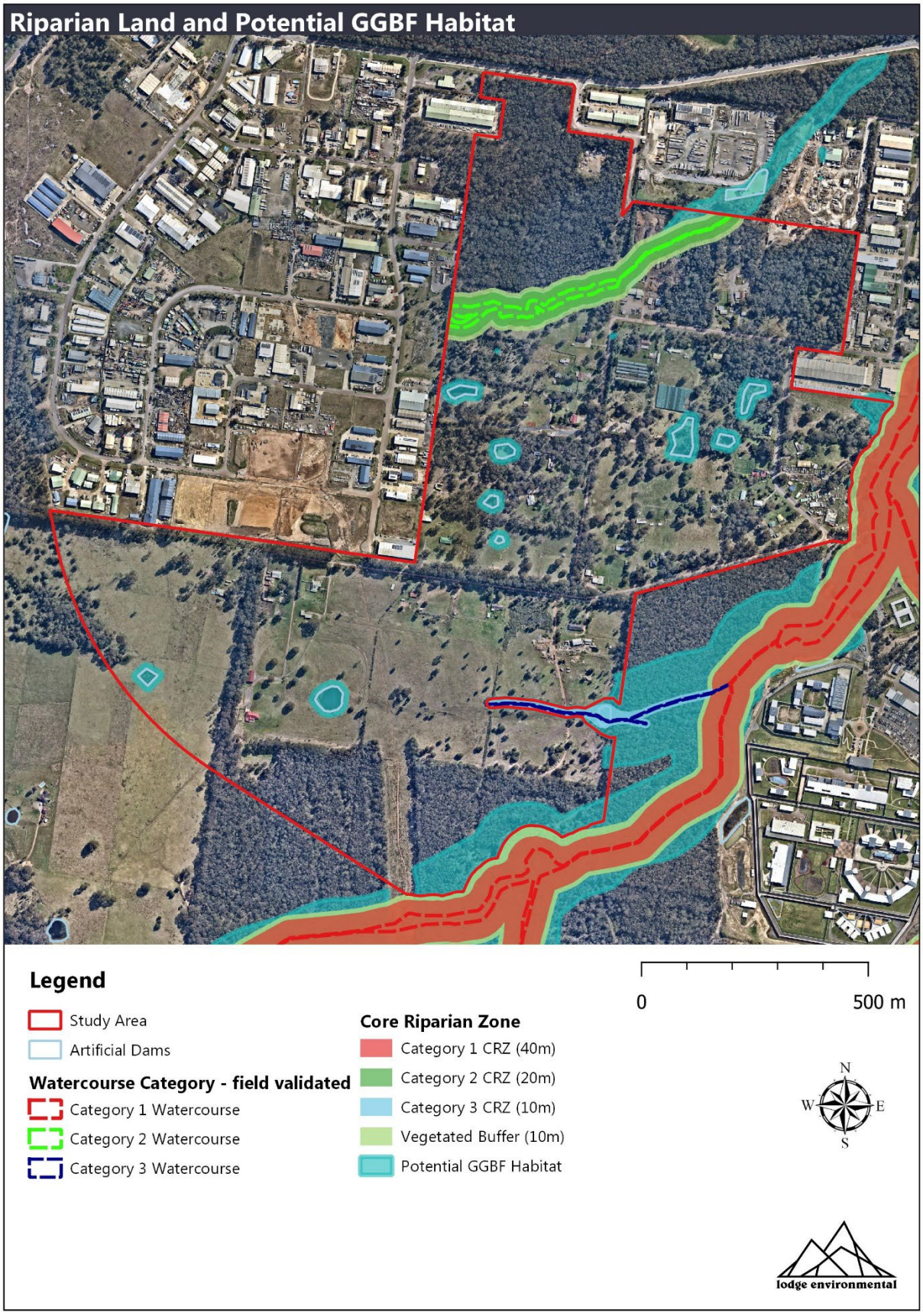


Figure 22 Field Validated Riparian Land and Potential GGBF Habitat

5.4.5.1 Riparian Condition and Management

Vegetation structure and condition of the riparian zone closely aligned with the vegetation condition zones detailed in **Section 5.2.3** – **Section 5.2.8**. General vegetation management techniques recommended for each vegetation zone is detailed in **Table 10** with the different condition riparian zones shown in **Figure 23**. To ensure successful regeneration of the riparian corridor within the Study Area, management and regeneration of the riparian corridor in the upper catchment is recommended. This approach will assist with the eradication of exotic species and facilitate the revegetation of the riparian corridor within the Study Area and further downstream.

Table 10: Riparian vegetation zone and recommended vegetation management techniques

Riparian Vegetation Zone	Area (ha)	Description	Management Techniques
Good	2.72	All three strata present with low to no exotic species incursion.	• Removal of exotic species • Removal of waste (building debris and general waste)
Moderate	0.33	All three strata present with exotic species incursion occurring at low to moderate frequencies.	• Removal of exotic species • Removal of waste (building debris and general waste) • Assisted revegetation where required
Native upper stratum and variable ground	0.47	Only native upper stratum species present, no mid stratum species present, ground stratum has a variable composition with sections heavily dominated by exotic species.	• Removal of exotic species • Removal of waste (building debris and general waste) • Assisted revegetation with the aim of increasing canopy cover and restoring mid stratum
Cleared/exotics	0.75	Cleared land, currently being used for industrial purposes.	Current land use unlikely to respond to management techniques. Appropriate fencing and erosion control methods should be in place to prevent sediment running into the watercourse and limit the spread of weed propagules.
Instream	0.87	-	• Removal of exotic species • Removal of waste (building debris and general waste)

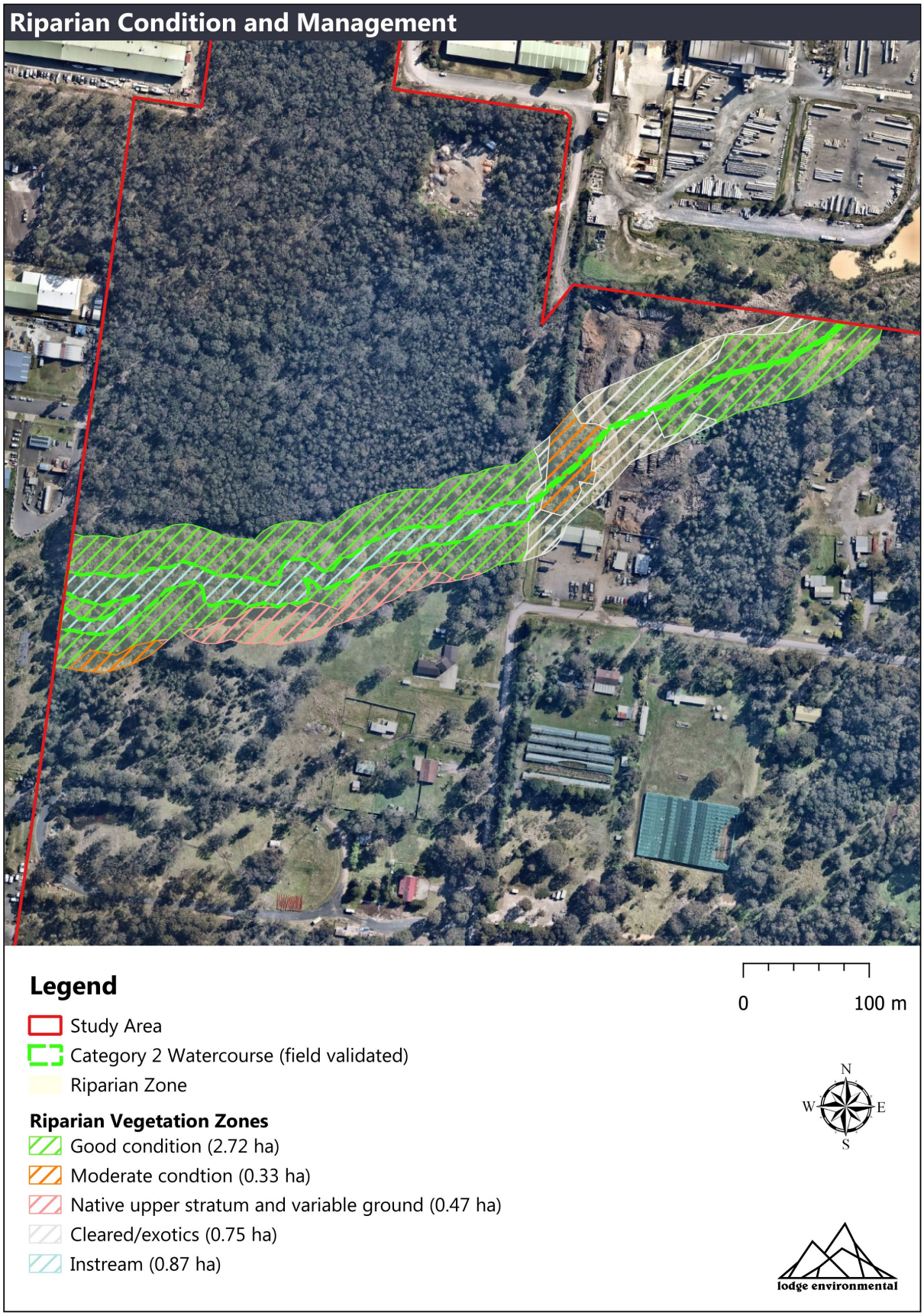


Figure 23: Riparian vegetation zones within the Study Area

5.5 HABITAT CONNECTIVITY

Habitat connectivity is essential for long-term conservation of a diverse range of species and ecological communities. In isolated habitats, the potential for many fauna species to move between different areas to feed and to breed is limited. Urban development can result in reduced habitat and increased fragmentation and isolation of habitats.

Lodge Environmental conducted a review of available spatial layers to indicate areas of potential habitat connectivity for a range of species with potential to occur in the Study Area and wider locality. Layers include:

- National Parks and Reserves (NSW and Commonwealth);
- State Forests;
- Biodiversity Values Map;
- LEP Environmental Zoning types;
- LEP Terrestrial Biodiversity overlay;
- Major watercourses and waterways.

As illustrated in **Figure 24**, the Study Area is situated on the outskirts of the Nowra town centre with rural and rural residential areas in the near vicinity. The arrows indicate potential movement corridors classed as 'Primary', 'Secondary' or 'Tertiary' depending on the corridor's quality, location and likelihood of native fauna utilisation from the Study Area out to the east coast and Jervis Bay to the east, and escarpment areas to the west.

The Study Area may present a 'stepping stone' for fauna movement between coastal areas to the east and the escarpment to the west.

The BCD have provided mapping for Biodiversity Corridors within the Illawarra Shoalhaven Regional Plan (ISRP) (**Figure 25**). The mapping reflects a regionally significant biodiversity corridor in the southern Nowra locality linking two major biodiversity destinations of Jervis Bay and Morton National Park utilising existing public reserves as 'steppingstones' but also the remnant native vegetation on private land.

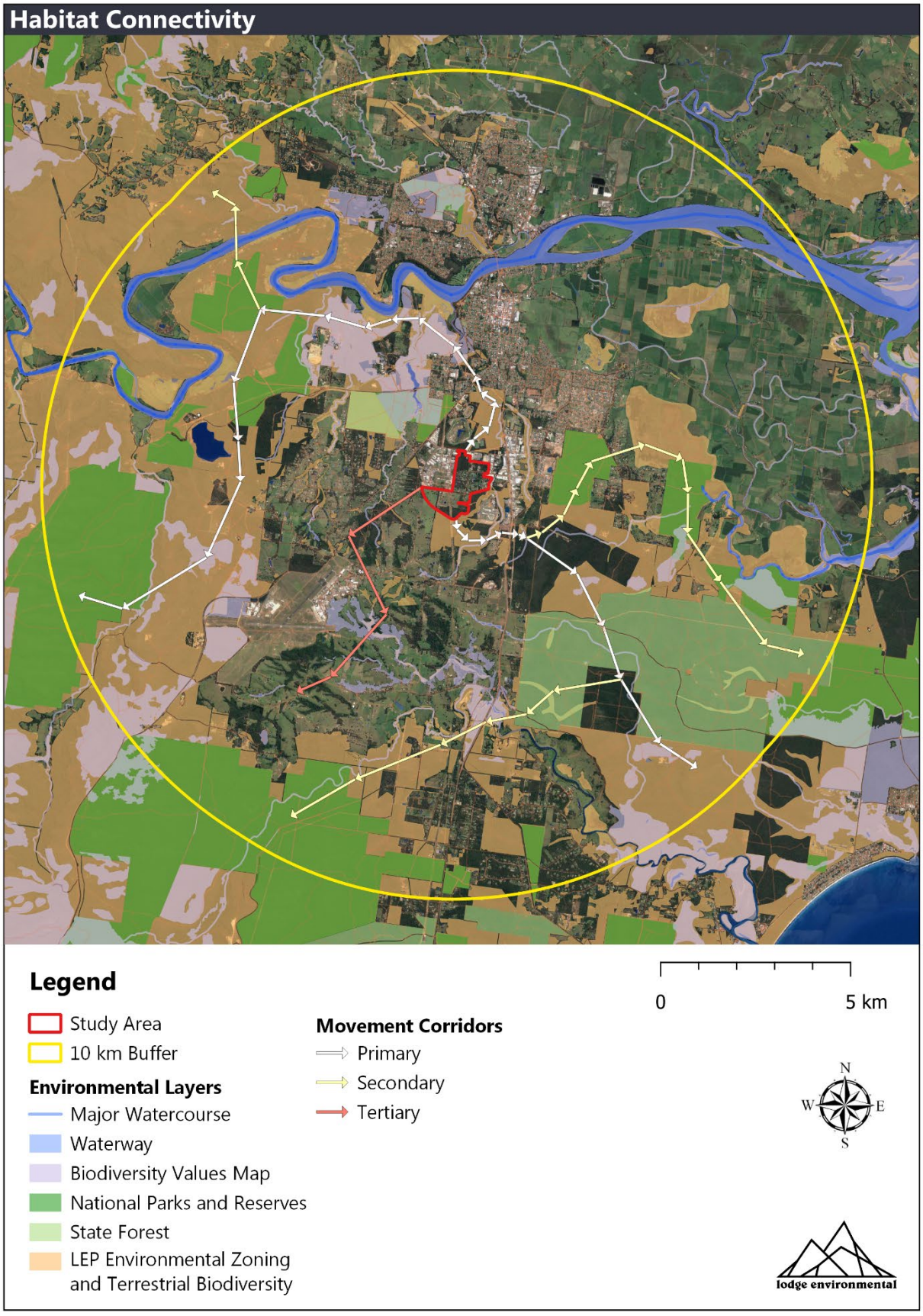


Figure 24: Habitat Connectivity

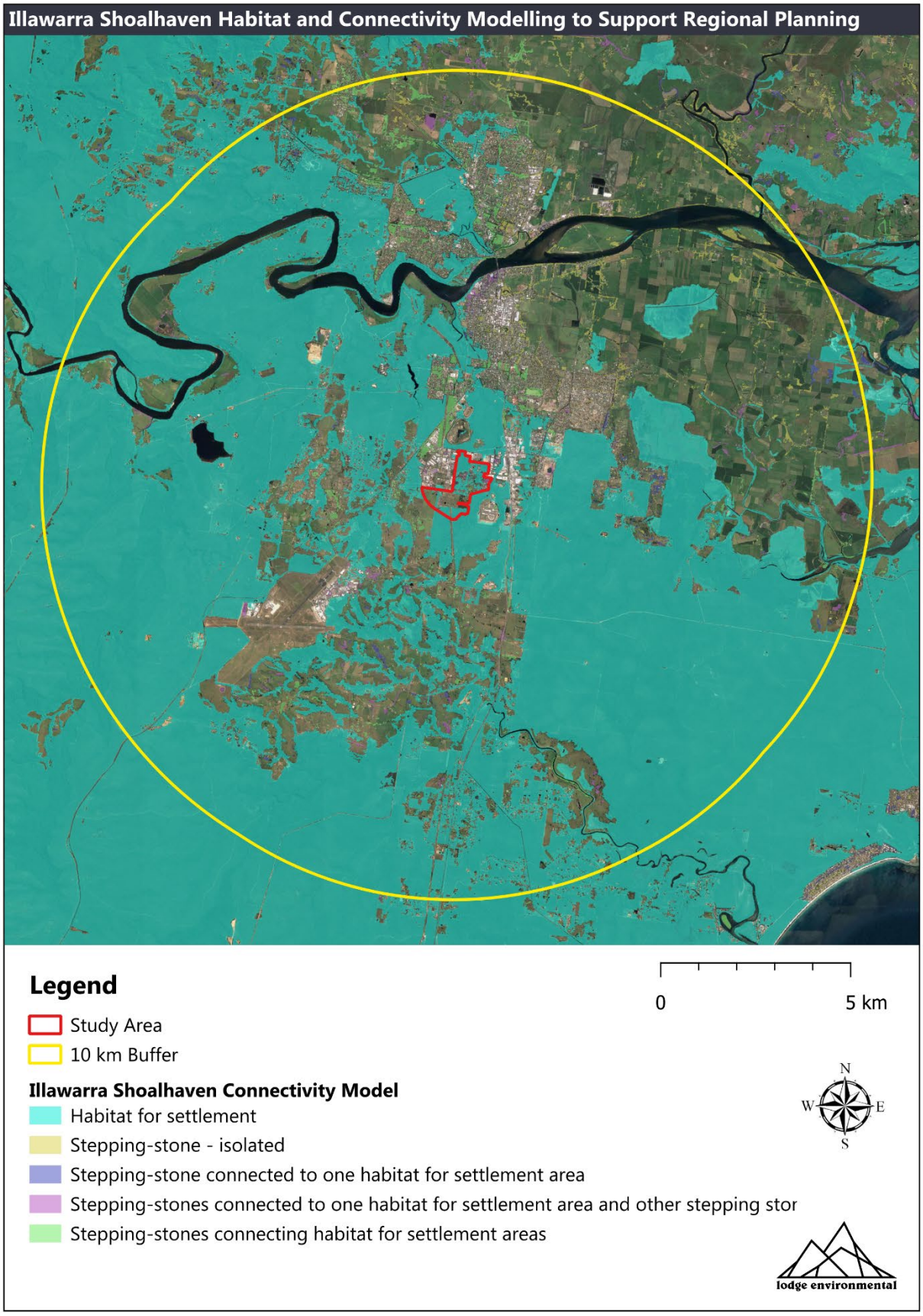


Figure 25: NSW Department of Planning and Environment - Illawarra Shoalhaven Habitat and Connectivity Modelling to Support Regional Planning

5.6 FLORA

A total of 176 species were recorded during the site inspection (134 native and 46 exotic). A species list is provided in **Appendix A**. Targeted surveys were not conducted as part of this assessment.

5.6.1 Threatened Flora Species

A review of the threatened flora species listed under the BC Act and/or the EPBC Act identified 21 species that have been previously recorded within 10 kilometres of the Study Area. Of these previously identified threatened flora species, a total of 5 are considered by the Biodiversity Assessment Method Calculator (BAM-C) as potential candidate species. An additional species, *Pterostylis gibbosa* (Illawarra Greenhood), is recommended to be included as the records within 10 km and habitat constraints of this species suggests the Study Area contains suitable habitat. **Table 11** details the BAM-C flora candidate species and any habitat constraints of the Study Area to be considered.

Table 11: BAM-C Flora Candidate Species

Candidate Species (Common name)	BC Act	EPBC Act	BAM-C Habitat Constraint	Potential SAII	Study Area Considerations
Acacia pubescens (Downy Wattle)	V	V	-	False	Records of this species are located directly north of the Study Area on the north side of Flinders Road. This species occurs in open woodland and forest, in a variety of plant communities and occurs on alluviums, shales and at the intergrade between shales and sandstones
Cryptostylis hunteriana (Leafless Tongue Orchid)	V	V	-	False	The location details of this species' records are withheld, however, 101 sightings have been recorded within 10 km of the Study Area. This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.
Pterostylis gibbosa (Illawarra Greenhood)	E	E	-	False	Location details of this species' records are withheld, however, 109 sightings have been recorded within 10 km of the Study Area. Near Nowra, the species grows in an open forest of *Corymbia maculata* (Spotted Gum), *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus paniculata* (Grey Ironbark). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage.
Pterostylis vernalis	CE	CE	Moss Gardens	True	Location details of this species' records are withheld, however, 28 sightings have been recorded within 10 km of the Study Area. This species grows in open sites around moss gardens in shallow soil over sandstone

Candidate Species (Common name)	BC Act	EPBC Act	BAM-C Habitat Constraint	Potential SAII	Study Area Considerations
					sheets or moss gardens on heavy laterite associated soils, in heath and dry heathy forest/woodland.
Rhodamnia rubescens (Scrub Turpentine)	CE	CE	-	True	The closest record of this species is located approximately 8 km north west of the Study Area and was recorded in 2011. This species occurs in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.
Triplarina nowraensis (Nowra Heath Myrtle)	E	E	-	False	Over 400 records are located in or adjacent to the Triplarina Nature Reserve approximately 1.5 km north west of the Study Area. This species occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone.

As a result, targeted surveys will be required to determine the presence or absence of the above listed species that are considered to have a moderate to high potential within any vegetation areas proposed for clearance and undertaken voluntarily for conservation areas. These surveys must be undertaken during confirmed periods to accurately ascertain the presence/absence (**Table 12**). Targeted surveys should focus on areas of suitable habitat for each species across the Study Area.

Table 12: Threatened flora species survey period

Species name (Common name)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia pubescens (Downy Wattle)												
Cryptostylis hunteriana (Leafless Tongue Orchid)												
Pterostlyis gibbosa (Illawarra Greenhood)												
Pterostylis vernalis												
Rhodamnia rubescens (Scrub Turpentine)												
Triplarina nowraensis (Nowra Heath Myrtle)												

5.7 FAUNA

A total of 20 fauna species were identified within the site. A species list is included in **Appendix B**. Targeted surveys were not conducted as part of this assessment.

5.7.1 Threatened Fauna Species

There was no threatened fauna species identified within the Study Area during the site surveys.

A review of the threatened fauna species listed under the BC Act and/or the EPBC Act identified 80 species that have been previously recorded within 10 kilometres of the Study Area. Of these previously identified threatened fauna species, a total of 25 are considered by the BAM-C as potential candidate species. **Table 13** details the BAM-C fauna candidate species and any habitat constraints of the Study Area to be considered. Boldened text denotes species considered to have a moderate to high potential to occur within the Study Area and targeted surveys for these species is recommended.

Target surveys, as per the BAM 2020, will be required to determine presence or absence of candidate species. These surveys must be conducted following the NSW survey guidelines for threatened species and during the survey period for the species as outline by BioNet.

Table 13: BAM-C Fauna candidate species

Candidate Species (Common name)	BC Act	EPBC Act	BAM-C Habitat Constraint	Potential SAII
Anthochaera Phrygia (Regent Honeyeater) (Breeding)	CE	CE	As per Important Habitat Map	True
***Callocephalon fimbriatum* (Gang-gang Cockatoo) (Breeding)**	**V**	**E**	**Eucalypt tree species with hollows at least 3 m above the ground and with hollow diameter of 7 cm of larger**	**False**
***Calyptorhynchus lathami* (Glossy Black-Cockatoo) (Breeding)**	**V**	**-**	**Living or dead tree with hollows greater than 15 cm diameter and greater than 8 m above the ground**	**False**
***Cercartetus nanus* (Eastern Pygmy-possum)**	**V**	**-**	**-**	**False**
Chalinolobus dwyeri (Large-eared Pied Bat)	V	V	1. Cliffs 2. Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within 2 km of old mines or tunnels	True
Haliaeetus leucogaster White-bellied Sea-Eagle (Breeding)	V	-	Living or dead mature trees within suitable vegetation within 1 km of a rivers, lakes, large dams or creeks, wetlands and coastlines	False

Candidate Species (Common name)	BC Act	EPBC Act	BAM-C Habitat Constraint	Potential SAII
Heleioporus australiacus Giant Burrowing Frog	V	V	-	False
***Hieraaetus morphnoides* (Little Eagle) (Breeding)**	**V**	**-**	**Nest trees – live (occasionally dead) large old trees within vegetation**	**False**
Isoodon obesulus obesulus (Southern Brown Bandicoot)	E	E	Requires dense ground cover in a variety of habitats	False
Lathamus discolor (Swift Parrot) (Breeding)	E	CE	As per Important Habitat Map	True
***Litoria aurea* (Green and Golden Bell Frog)**	**E**	**V**	**1. Semi-permanent/ephemeral wet areas 2. Within 1 km of wet areas, swamp or waterbodies**	**False**
***Lophoictinia isura* (Square-tailed Kite) (Breeding)**	**V**	**-**	**Nest trees**	**False**
Miniopterus orianae oceanensis (Large Bent-winged Bat) (Breeding)	V	-	Caves, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC – in cave"	True
Mixophyes balbus Stuttering Frog	E	V	-	True
***Myotis Macropus* (Southern Myotis)**	**V**	**-**	**Waterbodies with permanent pools/stretches 3 m or wider, including rivers, large creeks, billabongs, lagoons, estuaries, dams and other waterbodies, on or within 200 m of the site**	**False**
Ninox connivens (Barking Owl) (Breeding)	V	-	Living or dead trees with hollows greater than 20 cm diameter and greater than 4 m above the ground	False
***Ninox strenua* (Powerful Owl) (Breeding)**	**V**	**-**	**Living or dead trees with hollow greater than 20 cm diameter**	**False**
Pandion cristatus (Eastern Osprey) (Breeding)	V	-	Presence of stick-nests in living and dead trees (>15 m) or artificial structures within 100 m of a floodplain for nesting	False

Candidate Species (Common name)	BC Act	EPBC Act	BAM-C Habitat Constraint	Potential SAII
Petauroides volans **Greater Glider**	**E**	**E**	**-**	**False**
Petaurus norfolcensis (Squirrel Glider)	V	-	-	False
Petrogale penicillata (Brush-tailed Rock-wallaby)	E	V	Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines	True
Phascogale tapoatafa (Brush-tailed Phascogale)	V	-	-	False
Phascolarctos cinereus (Koala)	E	E	Prescence of koala use trees	False
Pteropus poliocephalus (Grey-headed Flying Fox) (Breeding)	V	V	Breeding camps	False
Tyto novaehollandiae **(Masked Owl) (Breeding)**	**V**	**-**	**Living or dead trees with hollows greater than 20 cm diameter**	**False**

5.7.1.1 Green and Golden Bell Frog

Green and Golden Bell Frog (*Litoria aurea*) is listed as *Endangered* under the NSW BC Act and *Vulnerable* under the Commonwealth EPBC Act. Consideration to this species is required due to the relatively close proximity to a key population located at the Crookhaven floodplain. Habitat for the Green and Golden Bell Frog includes waterbodies that are unshaded, free of predatory fish, have a grassy area nearby and diurnal sheltering sites available, all of which can be found adjacent to the dams and hydrolines within the Study Area.

The key population for Green and Golden Bell Frog occurs approximately 4 kilometres east of the Study Area in the Crookhaven floodplain, and a management plan exists for this population (DECC 2007), which includes the objective to *'identify and where possible ameliorate threats and other issues/factors affecting, or likely to impact on, the conservation of the species within the Crookhaven River floodplain study area'*.

Figure 26 illustrates mapping undertaken by Office of Environment and Heritage (OEH, date unspecified) as a result of a habitat modelling exercise for Green and Golden Bell Frog in the vicinity of the Crookhaven floodplain key population. The model provides a score of Green and Golden Bell Frog habitat suitability based on current land use, vegetation types, stream types and proximity, wetlands and known habitat areas and acid sulfate soils risk. The map and model indicates there are some areas of potential habitat in the Study Area, particularly along mapped watercourses and areas of intact wetland vegetation. Accordingly, targeted surveys should be

considered to determine the presence or absence of Green and Golden Bell Frogs within suitable habitat proposed for clearance or undertaken voluntarily for conservation areas.

The area of suitable habitat (Species Polygons) for the Green and Golden Bell Frog is mapped in **Figure 26**. The species polygons have been based on each of the candidate species polygon parameters outlined within the Threatened Biodiversity Data Collection (TBDC). Species polygons buffers were then limited to the areas with multiple stratum layers of native vegetation within the Study Area.

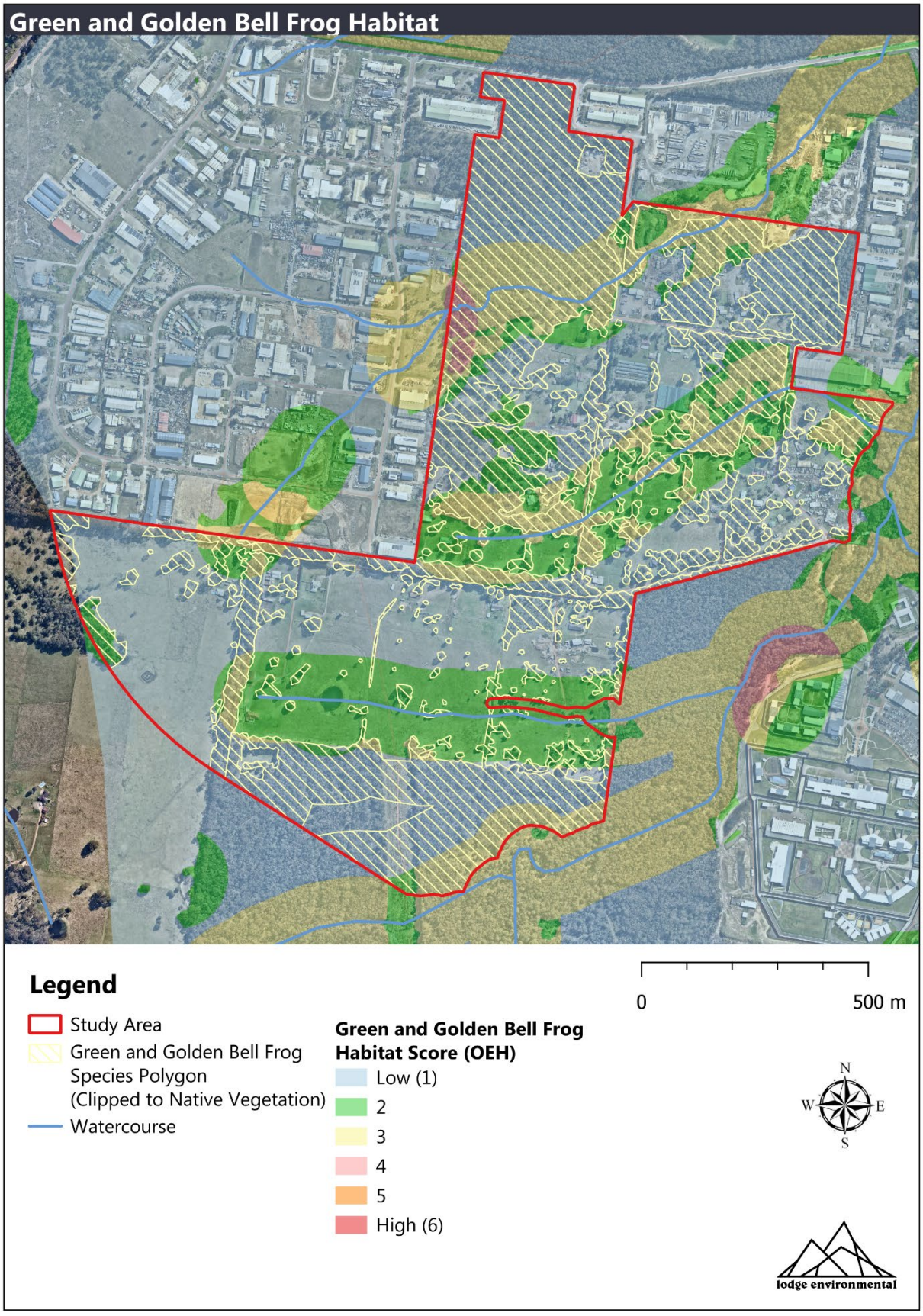


Figure 26: Green and Golden Bell Frog records and habitat score

5.8 SERIOUS AND IRREVERSIBLE IMPACTS

One Threatened Ecological Community is listed as a Serious and Irreversible Impact (SAII) entity, being:

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Five threatened fauna species are listed as SAII entities, being:

- Regent Honeyeater (*Anthochaera phrygia*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Swift Parrot (*Lathamus discolor*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- *Pterostylis vernalis*
- *Rhodamnia rubescens* (Scrub Turpentine)

Out of the six SAII entities, only Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion (ILGW) is considered to have a moderate to high potential of occurring within the Study Area. ILGW is listed as an SAII due to Principles 1, 2 and 3 set out in cl6.7(2) of the Biodiversity Conservation Regulation (2017):

- Principle 1 - It will cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
- Principle 2 - It will further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size.
- Principle 3 - It is an impact on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.

Council may determine further species than those entities listed above as being at threat of a SAII based on the principles listed above. If it is considered impacts of a proposal equate to a SAII, the consent authority must refuse the application.

6.0 ECOLOGICAL CONSTRAINTS

Ecological values identified through the literature review and field survey were ranked on a scale of high, moderate, and low based on the level of ecological value and legislative protection. The constraint levels and relevant attributes recorded within the Study Area are shown in **Figure 27** and detailed in **Table 14**.

Table 14: Ecological Constraints within the Study Area

Constraint Level	Description/Activity
High	• Clearance of native vegetation in exceedance of the BOS threshold • Impact to threatened flora or fauna and their habitat • Impact to habitat connectivity • Riparian corridor with good condition native vegetation
Moderate	• Impact to native flora fauna habitat • Impact to riparian land • Impact to isolated or fragmented native vegetation • Riparian condition with moderate condition native vegetation
Low	• Cleared / Exotic and pasture grasses • Existing artificial structures and hardstand areas

High Constraints

Designing and planning any future development within the Study Area should limit or avoid the impacts to areas considered as 'High' ecological constraint. Impact within these areas is likely to require entry into the Biodiversity Offset Scheme (BOS), taken to represent a significant impact, and the preparation of a Biodiversity Development Assessment Report (BDAR). The design and planning for any future development is required to consider the hierarchical approach outlined within the BC Act of avoidance, minimise and then offsets to mitigate impacts.

The Study Area contains multiple habitat features that are likely to be utilised or inhabited by locally occurring threatened species. These areas are considered a 'High' ecological constraint. To protect threatened flora within the Study Area, it is recommended that any recorded threatened flora individuals are retained and afforded a vegetation buffer of 20 metres, in accordance with the Department of Environment and Energy threatened flora guidelines. Any unavoidable impact to threatened flora or fauna and their respective habitat will require consideration through the preparation of a BDAR.

The Study Area is located in a unique pocket within the local landscape as it is situated on the outskirts of Nowra town centre with rural and rural residential land in close proximity whilst also offering habitat connectivity through wildlife corridors to several protected areas, including:

- Nowra State Forest
- Currambene State Forest
- Worrigee Nature Reserve
- Brundee Swamp Nature Reserve

- Shoalhaven State Forest
- Triplarina Nature Reserve
- Colymea State Conservation Area

This allows the Study Area to serve as a 'stepping stone' for fauna movement between coastal areas to the east and the escarpment to the west. When designing and planning future developments it is essential to consider the wildlife corridors currently within and adjacent to the Study Area with the intention of retaining, maintaining and improving them.

Impacts to the Category 2 riparian corridor in areas with good condition vegetation is considered a high constraint. Ongoing general management, including removal of exotic species and rubbish, of the high constraint areas will maintain the biodiversity values of the riparian corridor.

Moderate Constraints

Impacts to native vegetation below the BOS clearance threshold is considered as a 'Moderate' constraint. Future development design and planning should focus on areas where previous disturbance has been recorded while avoiding intact and well-connected vegetation areas.

The Study Area contains hydrolines which require riparian corridor buffer zones. Any future development design and planning must consider impacts to riparian zones. Where avoidance of riparian zones is not possible, mitigation measures such as Vegetation Management Plans should be prepared.

Despite historical disturbance and impact to fragmented or isolated native vegetation, these pockets of vegetation can still provide safe refuge to native fauna moving through the wider locality. The importance of these areas should not be discounted. These areas would also benefit from assisted regeneration.

Impacts to the Category 2 riparian corridor in areas with moderate condition vegetation is considered a moderate constraint. Ongoing general management, including removal of exotic species and rubbish, and assisted revegetation where required of the moderate constraint areas will maintain and improve the biodiversity values of the riparian corridor.

Low Constraints

Exotic species, pasture grasses and existing artificial structures are considered a low constraint. The exotic vegetation provides lower habitat value compared to native vegetation. Impacts to and removal of the exotic species and pasture grasses will not present a considerable impact on native fauna species. Areas of currently cleared vegetation and pasture grasses remain the preferred location for any future development.

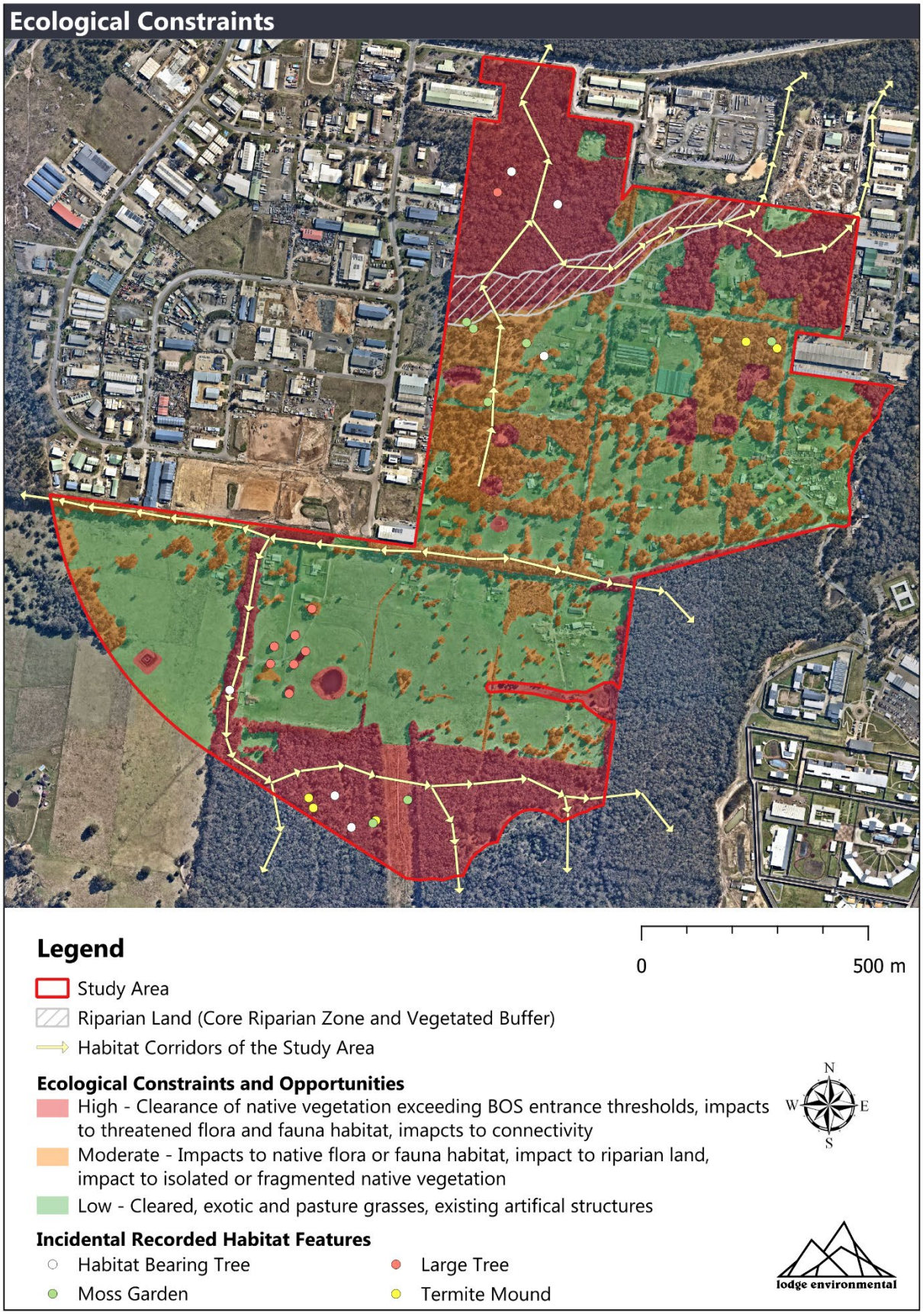


Figure 27: Ecological constraints within the Study Area

7.0 BIODIVERSITY STEWARDSHIP AGREEMENT

The NSW Biodiversity Conservation Act (BC Act) aims to slow the decline of threatened species, populations and communities listed under the Act. One of the mechanisms facilitated under the BC Act is the process of establishing a Biodiversity Stewardship Agreement (BSA) which are in-perpetuity agreements and are registered on the property title. These sites generate 'biodiversity credits' which can be sold to developers, government bodies or philanthropic organisations. Landholders receive ongoing annual management payments and a potential profit from credit sales, once the credits are sold. The assessment required to establish a Stewardship Site is a Biodiversity Stewardship Assessment Report (BSSAR) and will allow for the creation of credits and place a perpetual bind on the land between the owner and the state government under a BSA.

The BSA will outline the specific management actions that will result in a gain in biodiversity value on the land. When it comes to managing the agreement site, the landowner can choose to undertake the biodiversity management actions, or use contracted bush regenerators. Either way, annual payments will be supplied out of a trust fund established on sale of any credits generated which should cover costs. The Biodiversity Offset Scheme (BOS) allows for a diversification of the income generated from the land and will often result in the price of credit sales exceeding the costs of land management.

The results of this preliminary assessment indicate that the vegetation adjacent to the northern and southern boundaries has a strong potential to form a viable stewardship site (**Figure 28**). The biodiversity credits generated from entering the suggested land into a BSA could then be utilized as offset credits required for future development on the remainder of land within the Study Area.

The Study Area's strong viability is due to good condition, well-connected and large areas of native vegetation, as well as several potentially occurring threatened candidate species.

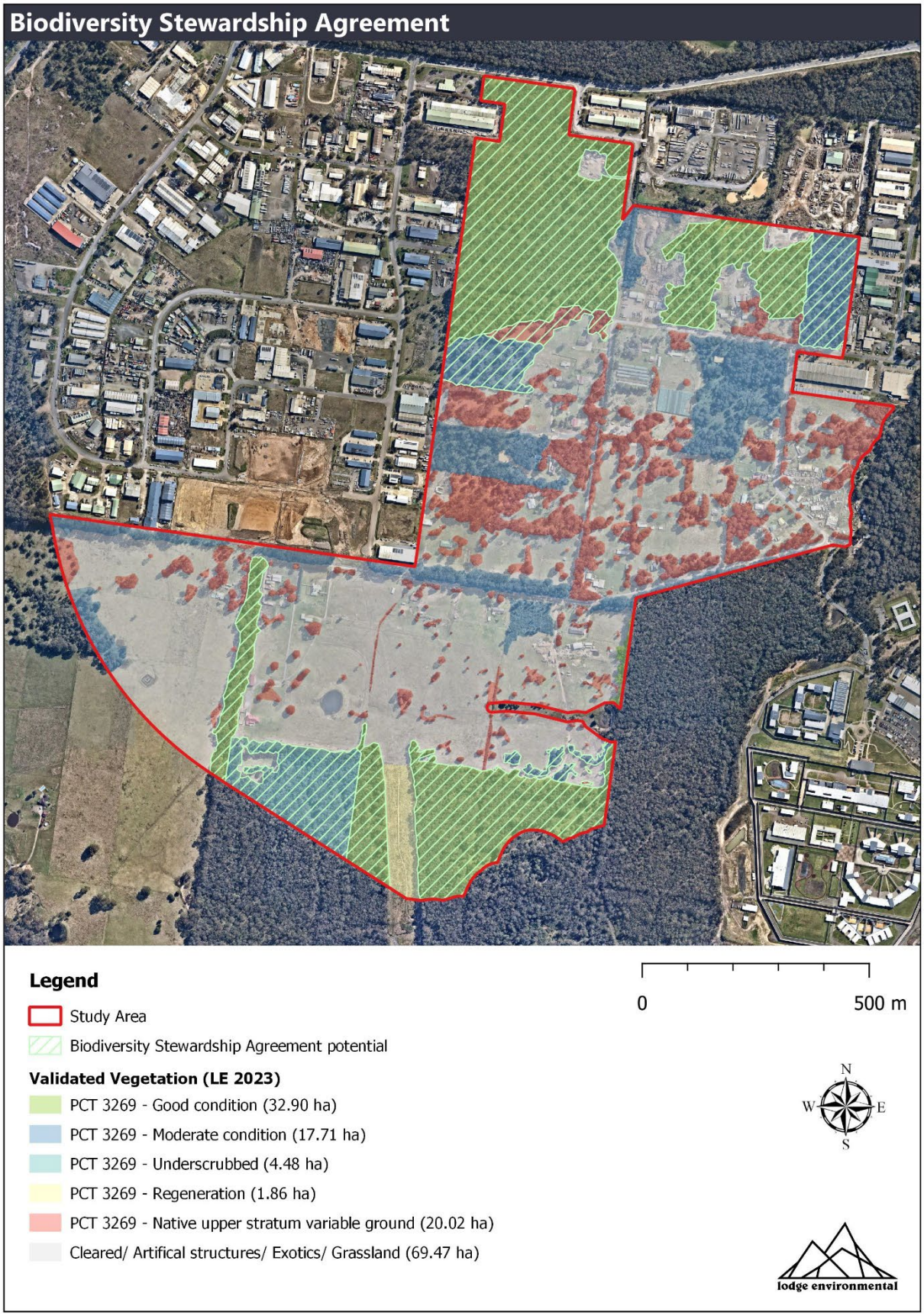


Figure 28: Preliminary BSA potential vegetation

8.0 BIODIVERISTY CERTIFICATION

Biodiversity Certification is a biodiversity assessment process for large areas of land that are proposed for development after being certified and measures to offset future development are established. Where land has completed a Biodiversity Certification, development may proceed without the usual requirement for site by site biodiversity assessments.

Biodiversity Certification is particularly useful when strategic land use planning at a landscape scale is proposed. Biodiversity Certification aims to result in better biodiversity outcomes than site by site assessments and upfront certainty for developers and landowners about the development and conservation outcomes for an area.

As Biodiversity Certification addresses the potential impacts of a development on biodiversity during the early stages of planning and design, there is a greater scope available for planning authorities or landholders to design their development in a way that avoids and minimises impacts to biodiversity. Protected biodiversity can then be entered into conservation agreements, such as Biodiversity Stewardship Sites, further protecting and improving the biodiversity values of the land.

The Study Area contains multiple lots under various ownerships, many of which contain well-connected vegetation. Biodiversity Certification should be considered as a potential assessment process for the Study Area. This approach would enable current and potential landowners to understand the development potential of their land, whilst allowing for positive and favourable outcomes for the biodiversity values of the Study Area.

8.1 BIODIVERSITY CERTIFICATION PROCESS

There are 6 main steps in the Biodiversity Certification process:

1. Plan and design the project before applying.
2. Apply the Biodiversity Assessment Method and prepare a Biodiversity Certification Assessment Report. Further assessment for species highlighted in **Table 11** and **Table 13** would be conducted during this step.
3. Formal consultation with Council.
4. Submit the application to the Department of Planning and Environment and notify the public.
5. The Minister for the Environment considers and determines the application.
6. Ongoing review and compliance checks.

9.0 BIODIVERSITY OFFSET ESTIMATION

This Section fulfils the requirements of Stage 2 Biodiversity Offset Estimation (BOE). A desktop study was conducted to review the landscape features required as inputs into the BAM-C. All plot data input into the BAM-C was collected during the field survey completed by Lodge Environmental as part of Stage 1 works, unless otherwise stated.

The objective of the BOE is to provide an estimation of the maximum indicative biodiversity credits needed for each Development Impact Scenario (DIS). This section includes a breakdown of ecosystem credits and species credits likely to be required and, where data is available, the estimated price required for retiring each credit.

9.1 DEVELOPMENT IMPACT SCENARIOS

The concept plan for the South Nowra Industrial Lands has been designed by SCC and details four Development Impact Scenarios (DIS), being:

- Low Development (**Figure 29**) – Development within predominantly areas of low ecological constraints and a sewer main.
- Moderate Development (**Figure 30**) – Development within areas of low and moderate ecological constraints, sewer main and road connection.
- High Development 1 (**Figure 31**) – Development of all areas excluding riparian buffers and large high constraint vegetation patches, sewer main and road connection.
- High Development 2 (**Figure 32**) – Development of all areas and a sewer main.

The DIS have been designed in a way in which they have an increasing level of impact to the ecological values of the Study Area. DIS High Development 2 is not considered to represent a likely scenario, however, it is included to allow for a comparison to the lesser impact scenarios, highlighting the financial benefits of pursuing a lesser impact compared to full a impact outcome.

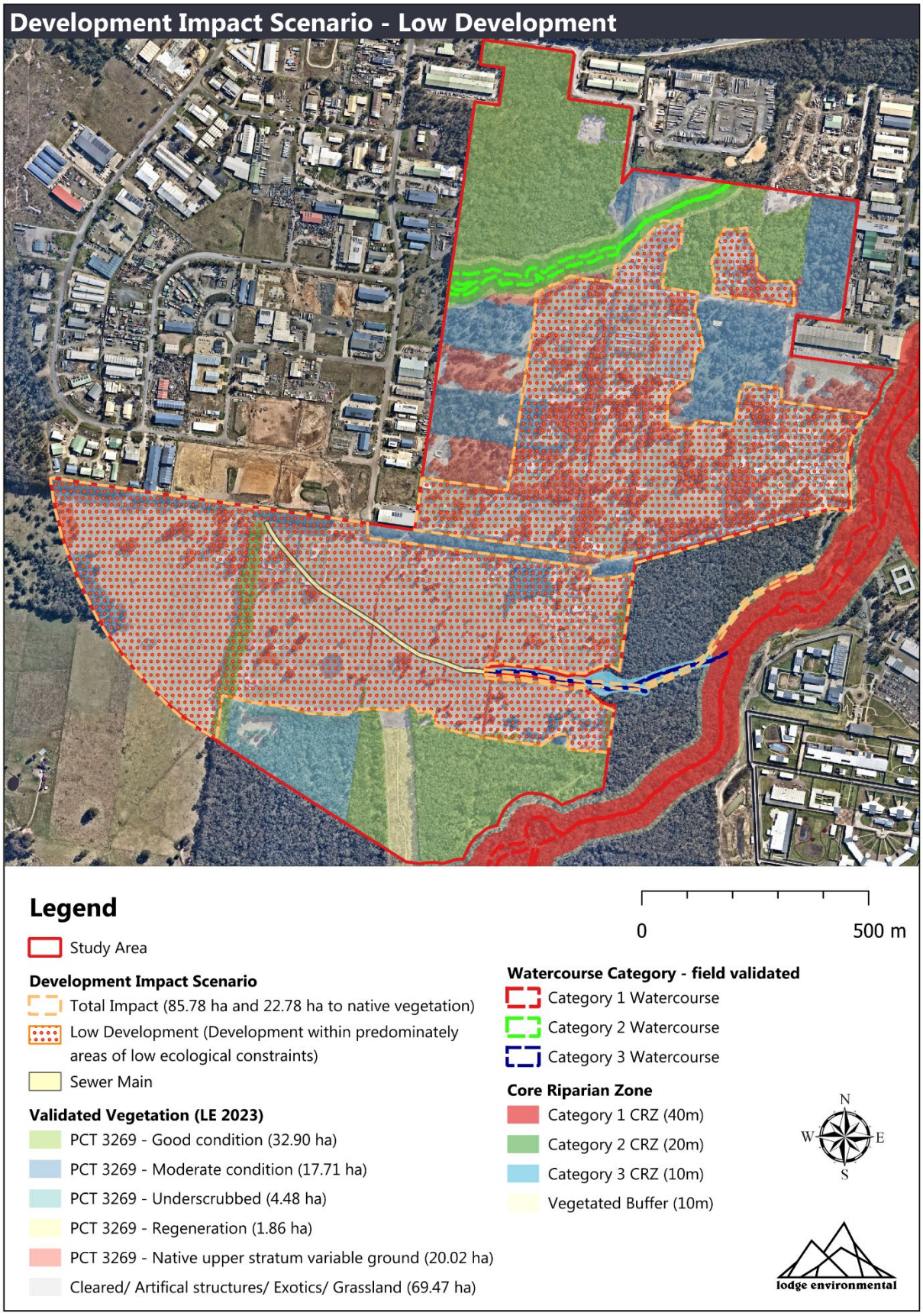


Figure 29: Low Development

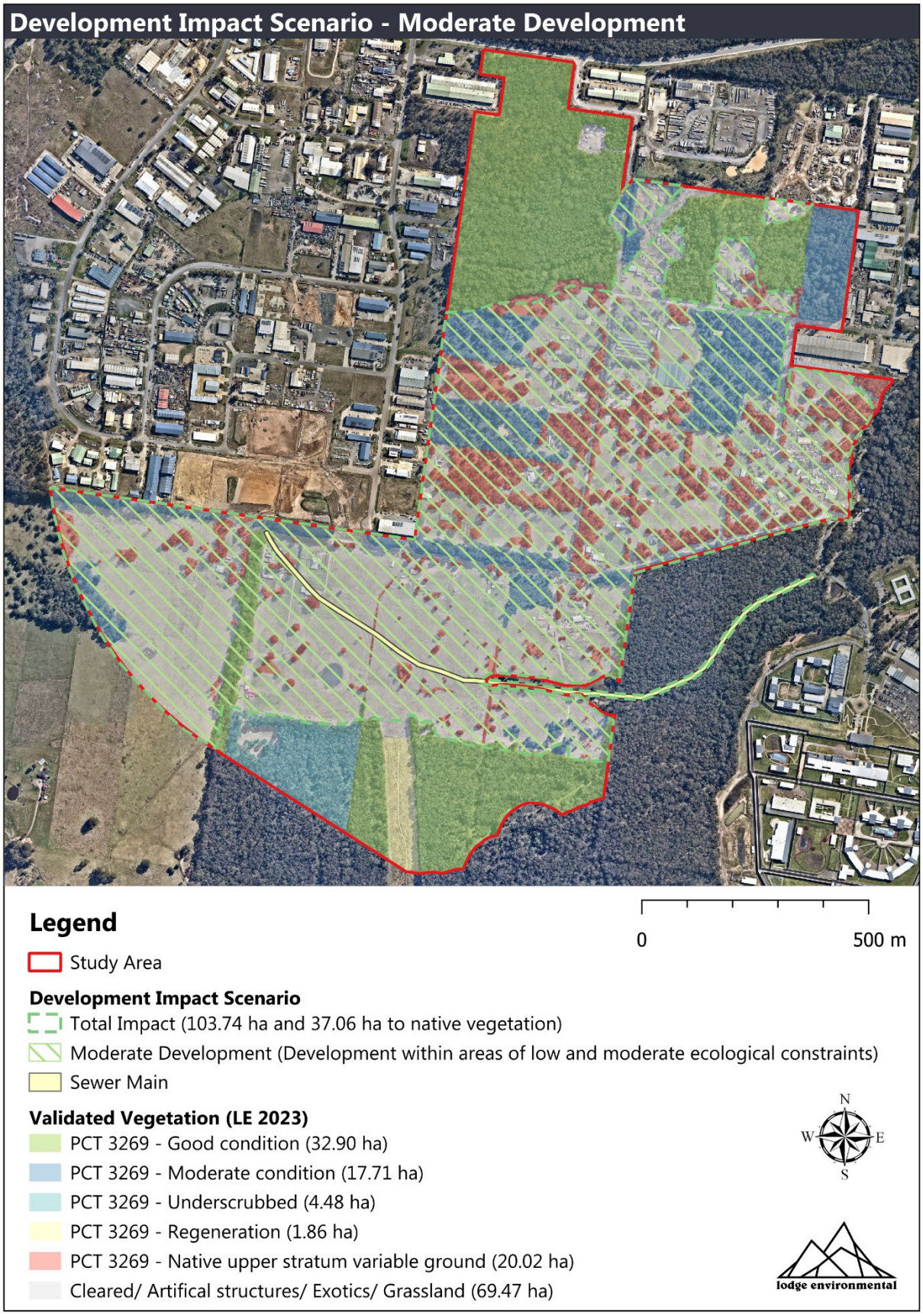


Figure 30: Moderate Development

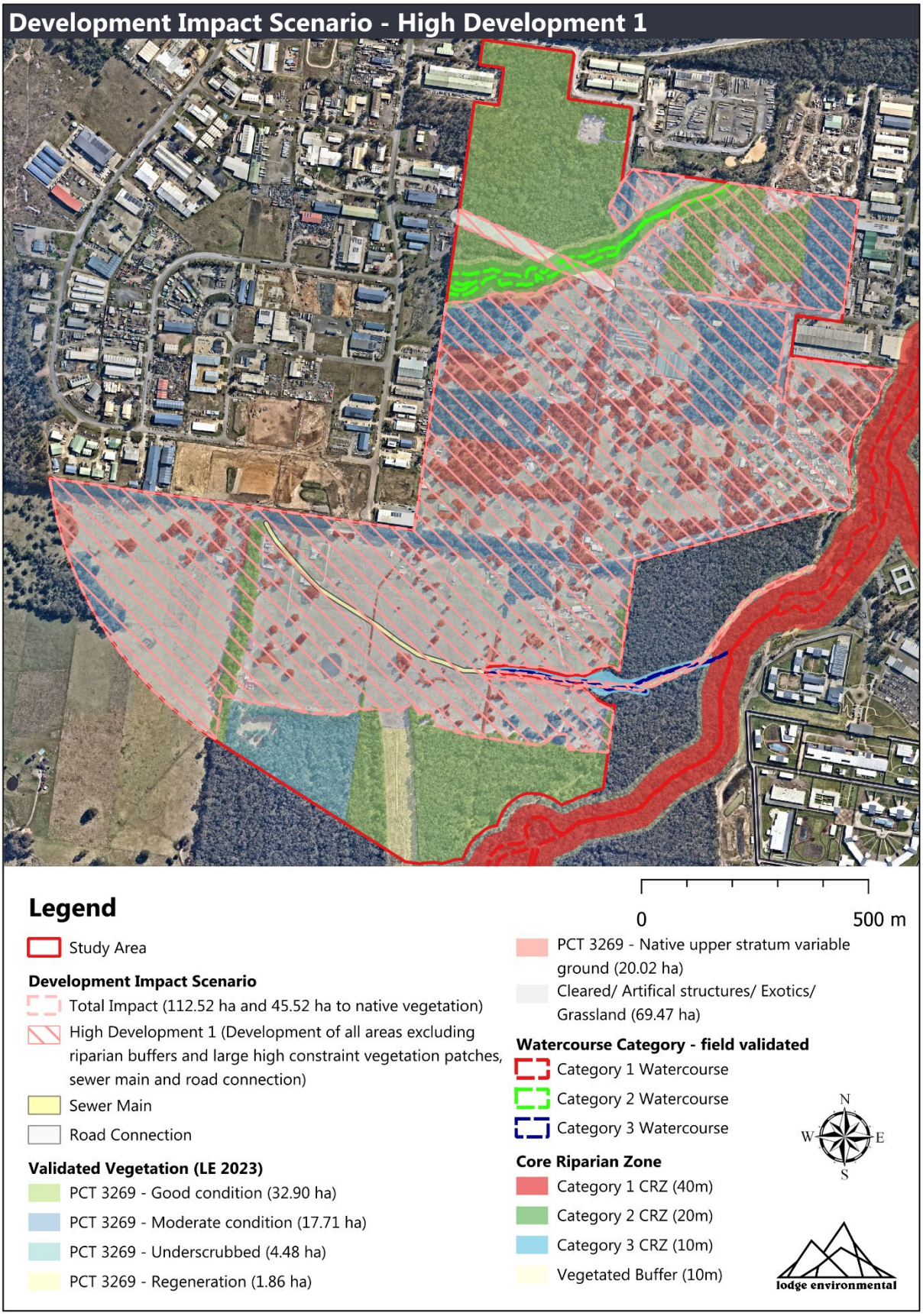


Figure 31: High Development 1

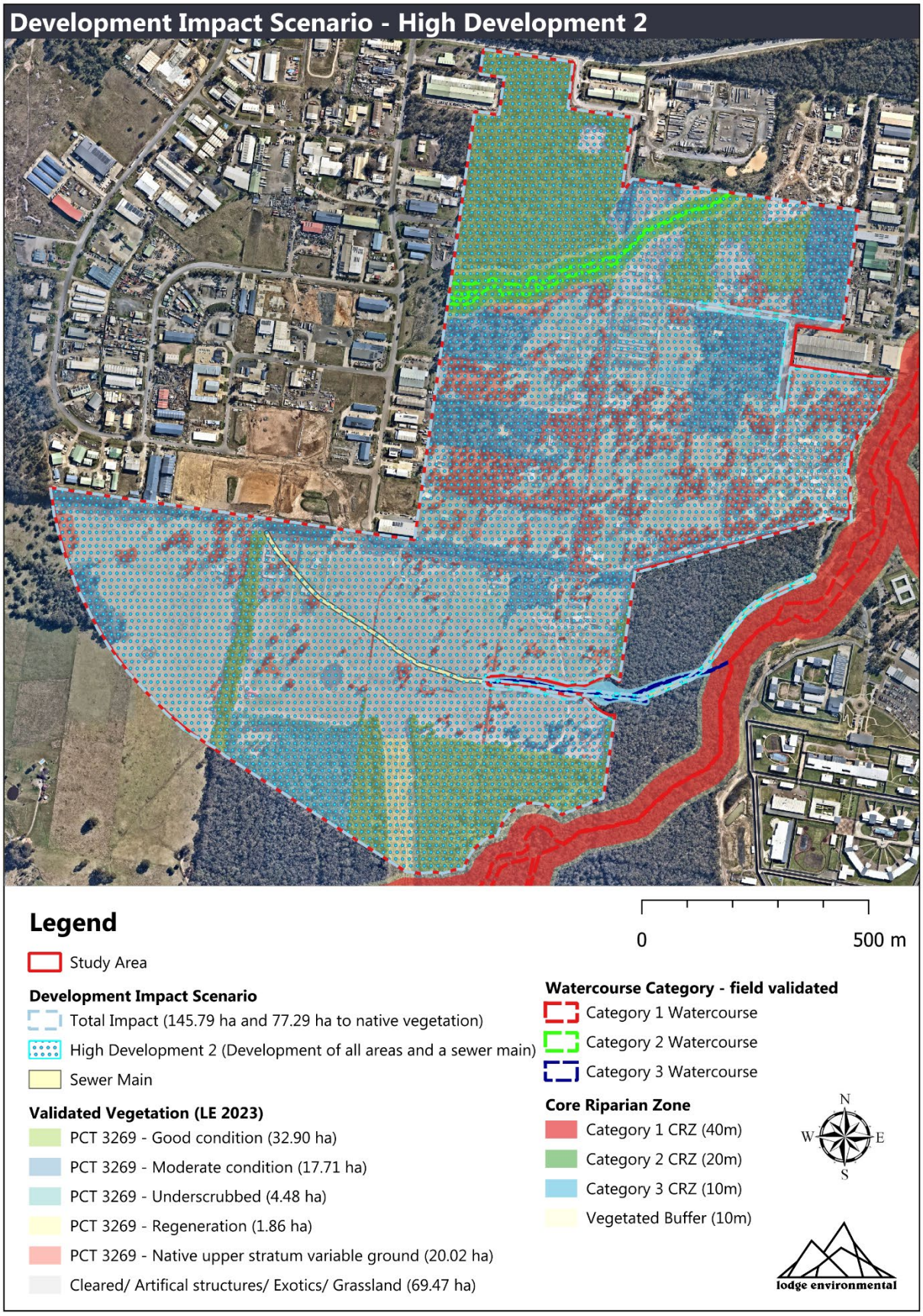


Figure 32: High Development 2

9.2 LANDSCAPE CONTEXT

9.2.1 Landscape Features

In accordance with Chapter 3 of the BAM, a range of landscape features must be identified where they occur on the Study Area. These features may contain biodiversity values that are important for the site context, or for informing the likely habitat suitability for locally occurring threatened species. The below subsections and **Figure 33** detail these features, including Interim Biogeographic Regionalisation Australia (IBRA) regions and landscape regions (Mitchell Landscapes).

9.2.1.1 IBRA Bioregions and IBRA Subregions

Interim Biogeographic Regionalisation for Australia (IBRA) regions is a nationally endorsed classification system for mapping large, geographically distinct bioregions based on climate, geology, landform, native vegetation and species information.

The Subject Land occurs within the Jervis IBRA subregions (version 7) (**Figure 33**) and within the Sydney Basin IBRA region (version 7). The Sydney Basin region is characterised by mesozoic sandstones and shales; dissected plateaus; forests, woodlands and heaths; skeletal soils, sands and podzolics.

9.2.1.2 Mitchell Landscapes

Mitchell Landscapes are areas of land with relatively homogenous geomorphology, soils and broad vegetation. The Subject Land occurs on the 'Nowra – Durras Coastal Slopes 'landscape (Mitchell Landscapes version 3.1) (**Figure 33**). Nowra – Durras Coastal Slopes is characterised Permian lithic sandstone and pebbly siltstone with yellow and yellow-red texture-contrast soils. General elevation 20 to 80 m, local relief 30 m. Open forest of Spotted Gum (*Corymbia maculata*) with extensive *Macrozamia* sp., and Blady Grass (*Imperata cylindrica*) understorey. Freshwater Reed (*Phragmites australis*) swamps on wider valley floors, merging down valley with Swamp Oak (*Casuarina glauca*) communities. Nowra – Durras Coastal Slopes Landscape was input into the BAM calculator.

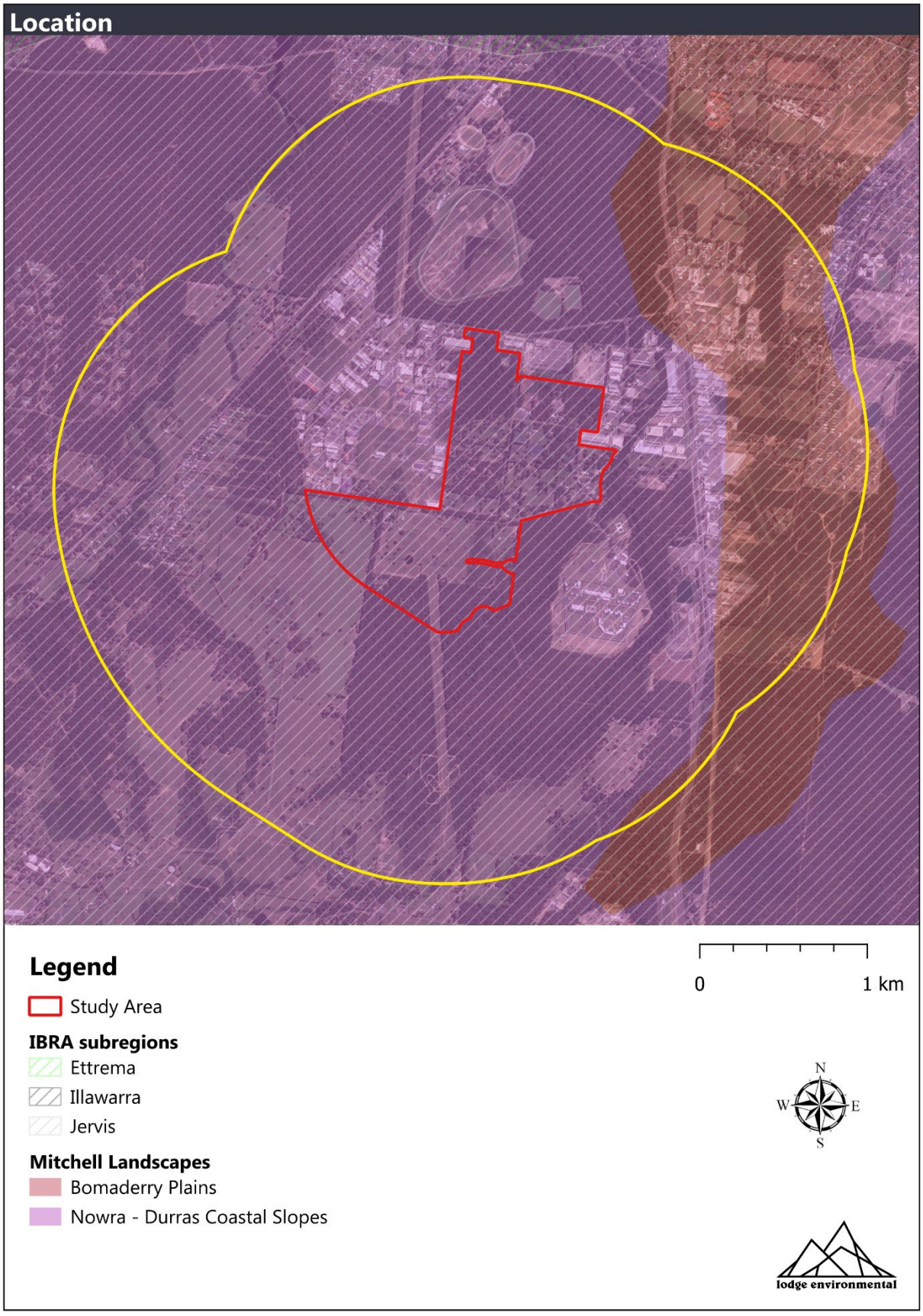


Figure 33: Landscape Features

9.2.2 Site Context

9.2.2.1 Native Vegetation Cover

To determine the site context of the Study Area, the Department of Planning and Environment State Vegetation Type Map (SVTM) (DPE 2022) was used within a 1,500 m radius (**Figure 34**). Edits were made where necessary based on current aerial imagery to reflect any relevant changes in vegetation extent. The presence of remnant canopy trees, understanding of garden landscaping and agricultural patterns and differentiation between groundcover colour were considered during the aerial image interpretation.

Table 15 displays the relevant site context values. The native vegetation cover class used in the BAM-C is 53%.

Table 15: Native Vegetation Cover

1,500 m buffer area	Native Vegetation Cover	Percent Vegetation Cover
1731 ha	910 ha	52.57%

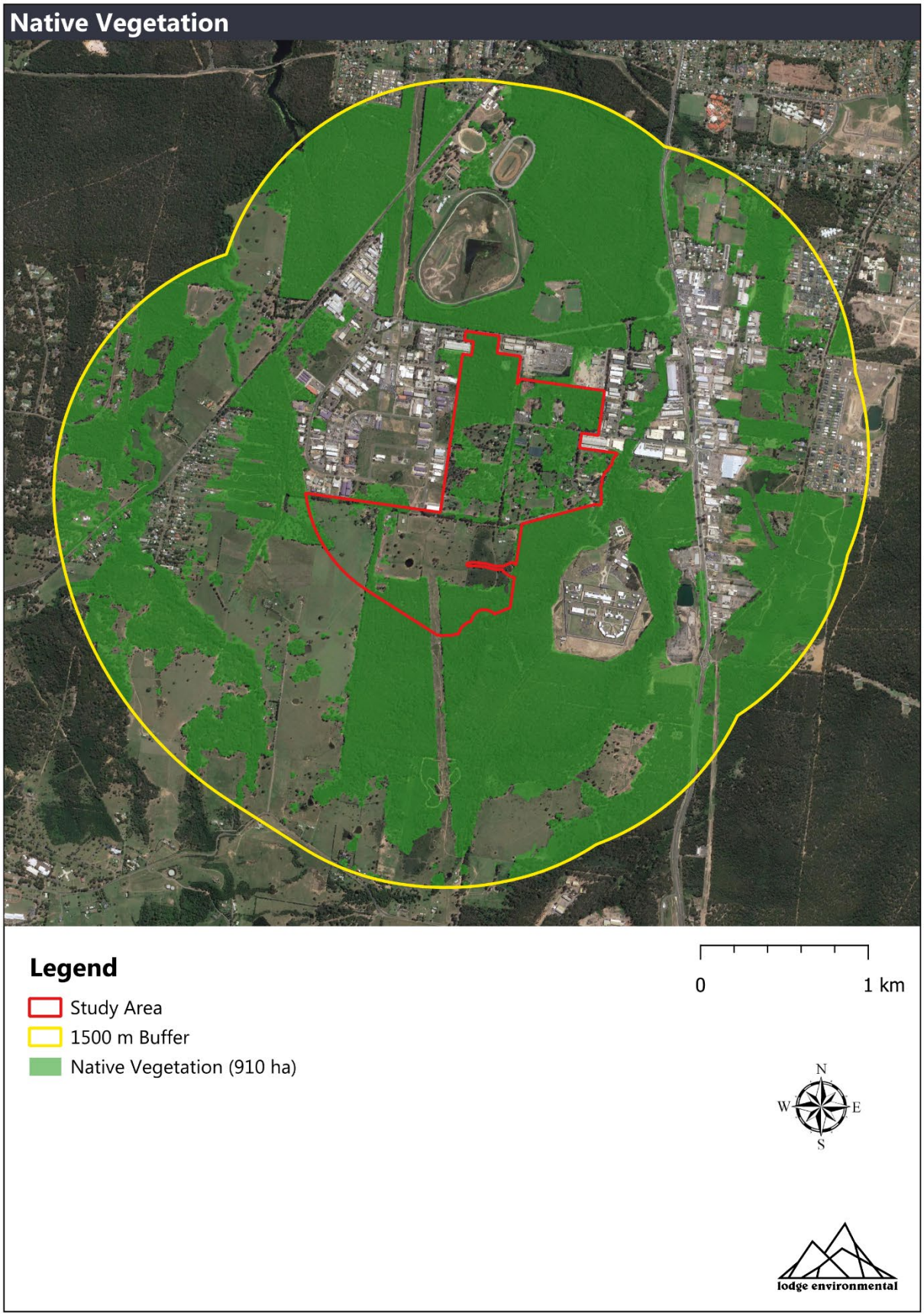


Figure 34: Native Vegetation Cover within 1,500 m of the Study Area

9.2.2.2 Patch Size

Patch size for each vegetation zone within the Study Area was calculated and assigned to a vegetation class, being either <5ha, 5-24 ha, 25-100 ha or ≥100 ha.

Patch size is defined within the BAM as an area of intact vegetation that:

a) occurs on the development site or biodiversity stewardship site, and
b) includes native vegetation that has a gap of less than 100 m from the next area of moderate to good condition native vegetation (or ≤30 m from non-woody ecosystems).

Intact vegetation is defined as "vegetation where all tree, shrub, grass and/or forb structural growth form groups expected for a plant community type are present".

Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site.

The patch size class used to assess the habitat suitability for all native vegetation patches within the Subject Land is **≥100 ha** as there is well connected vegetation within the Subject Land and beyond to the north.

The patch size class is used to assess the habitat suitability of the Subject Land for threatened species. **100 ha** was input into the BAM-C.

9.3 IMPACTS REQUIRING OFFSETTING

9.3.1 Ecosystem Credits

A key outcome of the BOS and application of the BAM is the quantification of the required amount of biodiversity offsets which the proponent will need to purchase or retire from their own Stewardship Sites as a result of direct impact on native vegetation.

Impacts on native vegetation require offsetting if they are associated with either:

- A vegetation zone that has a vegetation integrity score ≥15 where the PCT is representative of an endangered or critically endangered ecological community, or
- A vegetation zone that has a vegetation integrity score of ≥17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits) or is a vulnerable ecological community, or
- A vegetation zone that has a vegetation integrity score ≥20 where the PCT is not representative of a TEC or associated with threatened species habitat.

The impact of each DIS on the validated vegetation of the Study Area is detailed in **Table 16**.

It is important to note, the sewer main requires impact to unvalidated vegetation outside of the Study Area. Following discussions with SCC, it was decided that for the purpose of the BOE this vegetation is to be assigned the benchmark values for PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest as it is mapped on the SVTM (DPIE 2022).

Table 16: Areas of vegetation required offsetting via ecosystem credits

Development Impact Scenario	Vegetation Zone	Total impact (ha)	Current VI score	VI score after development	Offset Obligation
Low Development (Impact to native vegetation = 22.78 ha)	Good	2.39	87.8	0	Yes
	Moderate	4.93	76.5	0	Yes
	Underscrubbed	0.03	52.1	0	Yes
	Native upper stratum variable ground	14.66	36.8	0	Yes
	Cleared/ Artificial structures/ Exotics/ Grassland	62.74	16.1[1]	0	No
	Benchmark	0.77	100	0	Yes
Moderate Development (Impact to native vegetation = 38.17 ha)	Good	3.43	87.8	0	Yes
	Moderate	14.79	76.5	0	Yes
	Underscrubbed	0.03	52.1	0	Yes
	Native upper stratum variable ground	19.15	36.8	0	Yes
	Cleared/ Artificial structures/ Exotics/ Grassland	66.42	16.1[1]	0	No
	Benchmark	0.77	100	0	Yes

High Development 1 (Impact to native vegetation = 45.52 ha)	Good	7.86	87.8	0	Yes
	Moderate	17.31	76.5	0	Yes
	Underscrubbed	0.03	52.1	0	Yes
	Native upper stratum variable ground	19.55	36.8	0	Yes
	Cleared/ Artificial structures/ Exotics/ Grassland	66.68	16.1[1]	0	No
	Benchmark	0.77	100	0	Yes
High Development 2 (Impact to native vegetation = 77.29 ha)	Good	32.83	87.8	0	Yes
	Moderate	17.62	76.5	0	Yes
	Underscrubbed	4.47	52.1	0	Yes
	Regeneration	1.86	49.8	0	Yes
	Native upper stratum variable ground	19.74	36.8	0	No
	Cleared/ Artificial structures/ Exotics/ Grassland	68.50	16.1[1]	0	Yes
	Benchmark	0.77	100	0	Yes

[1]Calculated off two VI plots. See **Section 5.2.8** for further discussion.

9.3.2 Species Credits

The area of suitable habitat (Species Polygons) for species credit species within the Study Area, assuming total impact, is outlined in **Table 17** and as mapped in **Figure 35**, **Figure 36** and **Figure 37**. The species polygons have been based on each candidate species polygon parameters outlined within the Threated Biodiversity Data Collection (TBDC) or the relevant threatened species survey guidelines. Area calculations for the specific species polygons under each DIS are listed in **Appendix D**.

Table 17: Species Polygons assuming total impact

Candidate Species	Description of suitable habitat	Threatened Biodiversity Data Collection or Survey guideline recommendations	Study Area Species Polygon	Species Polygon (Total area)
Acacia pubescens (Downy Wattle)	Occurs in open woodland and forest, in a variety of plant communities. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone.	As outlined in the Department of Planning, Industry & Environment 'Surveying threatened plants and their habitats' NSW Survey guide for the BAM, if the unit of measure is area of suitable habitat, the assessor must consider the following when defining the species polygon: • The land-use history and disturbance on the Study Area, including fire history • Recent rainfall events, and how it compares to long-term averages • Previous surveys for the species at or near the Study Area • Reference populations in the local area • Life history characteristics of the species, and Habitat constraints, growth form, any other relevant ecological information (e.g. hydrology, aspect, soil type, underlying lithology and vegetation community).	Without targeted surveys conducted during the recommended survey period for this species, it is uncertain if this species is present within the Study Area. A conservative approach has been applied and all areas containing PCT 3269 within the Study Area are considered to represent the species polygon for this species.	Species Polygon 1 (77.74 ha)
Callocephalon fimbriatum (Gang-gang Cockatoo) (Breeding)	Dependent on hollow-bearing eucalypts for nest sites.	Species polygon should be circular in shape and must include a buffer radius of 200 m around each actual nest tree.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all vegetation zones with suitable eucalypts within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)

Calyptorhynchus lathami (Glossy Black-Cockatoo) (Breeding)	Dependent on hollow-bearing eucalypts for nest sites.	Species polygon should be circular in shape and must include a buffer radius of 200 m around each actual nest tree.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all vegetation zones with suitable eucalypts within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)
Cercartetus nanus (Eastern Pygmy-possum)	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath. This species prefers habitat with a rich shrub understory, they are known to occur in grassy woodlands and the presence of Eucalypts alone is sufficient to support populations in low densities.	No buffers or general comments relating to this species is provided within the TBDC or survey guides.	This species prefers habitat with a rich understorey. Good and Moderate condition vegetation zones within the Study Area are considered to represent the species polygon for this species.	Species Polygon 3 (51.39 ha)
Cryptostylis hunteriana (Leafless Tongue Orchid)	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. ppears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*).	As outlined in the Department of Planning, Industry & Environment 'Surveying threatened plants and their habitats' NSW Survey guide for the BAM, if the unit of measure is area of suitable habitat, the assessor must consider the following when defining the species polygon: • The land-use history and disturbance on the Study Area, including fire history • Recent rainfall events, and how it compares to long-term averages • Previous surveys for the species at or near the Study Area	Without targeted surveys conducted during the survey period for this species, it is uncertain if this species is present within the Study Area. A conservative approach has been applied and all areas identified as 'Potential Orchid Habitat' in **Figure 12** within the Study Area are considered to represent the species polygon for this species.	Species Polygon 4 (77.74 ha)

		• Reference populations in the local area • Life history characteristics of the species, and Habitat constraints, growth form, any other relevant ecological information (e.g. hydrology, aspect, soil type, underlying lithology and vegetation community).		
Hieraaetus morphnoides (Little Eagle) (Breeding)	Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	Species polygon should be established by providing a circular polygon with a 300 m radius around the nest tree.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all areas that containing suitable nest trees within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)
Litoria aurea (Green and Golden Bell Frog)	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.).	Species polygon incorporates all the PCTs with which this species is associated, within a 200 m radius from the top of bank. The polygon should include a minimum 50 m wide corridor of native and non-native vegetated areas linking available waterbodies, where relevant.		Species Polygon 5 (50.50 ha)
Lophoictinia isura (Square-tailed Kite) (Breeding)	Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	Species polygon should be established by providing a circular polygon with a 300 m radius around the nest tree and incorporate all woody and non-woody native vegetation within the radius.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all areas that containsuitable nest trees within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)
Myotis Macropus (Southern Myotis)	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water	Species polygon to include the range of PCTs associated with this species within 200 m of any medium to large permanent		Species Polygon 5 (50.50 ha)

	channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3m or wider.		
Ninox strenua (Powerful Owl) (Breeding)	Nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	Species Polygon providing a circular buffer with a 100 m radius should be drawn around the known nest tree.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all vegetation zones with suitable eucalypts within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)
Petauroides volans Greater Glider	Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. Shelter during the day in tree hollows and will use up to 18 hollows in their home range.	No buffers or general comments relating to this species is provided within the TBDC or survey guides.	Without targeted surveys conducted during the survey period for this species, it is uncertain if this species is present within the Study Area. A conservative approach has been applied and all vegetation zones with suitable eucalypts within the Study Area are considered to represent the species polygon for this species	Species Polygon 2 (75.88 ha)
Pterostylis gibbosa Illawarra Greenhood	All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. Near Nowra, the species grows in an open forest of Spotted Gum, Forest Red Gum and Grey Ironbark.	As outlined in the Department of Planning, Industry & Environment 'Surveying threatened plants and their habitats' NSW Survey guide for the BAM, if the unit of measure is area of suitable habitat, the assessor must consider the following when defining the species polygon: • The land-use history and disturbance on the Study Area, including fire history • Recent rainfall events, and how it compares to long-term averages	Without targeted surveys conducted during the survey period for this species, it is uncertain if this species is present within the Study Area. A conservative approach has been applied and all areas identified as 'Potential Orchid Habitat' in **Figure 12** within the Study Area are considered to represent the species polygon for this species.	Species Polygon 4 (77.74 ha)

		• Previous surveys for the species at or near the Study Area • Reference populations in the local area • Life history characteristics of the species, and Habitat constraints, growth form, any other relevant ecological information (e.g. hydrology, aspect, soil type, underlying lithology and vegetation community).		
Pterostylis vernalis	Grows in open sites around moss gardens in shallow soil over sandstone sheets or moss gardens on heavy laterite associated soils, in heath and dry heathy forest/woodland.	As outlined in the Department of Planning, Industry & Environment 'Surveying threatened plants and their habitats' NSW Survey guide for the BAM, if the unit of measure is area of suitable habitat, the assessor must consider the following when defining the species polygon: • The land-use history and disturbance on the Study Area, including fire history • Recent rainfall events, and how it compares to long-term averages • Previous surveys for the species at or near the Study Area • Reference populations in the local area • Life history characteristics of the species, and Habitat constraints, growth form, any other relevant ecological information (e.g. hydrology, aspect, soil type, underlying lithology and vegetation community).	Without targeted surveys conducted during the survey period for this species, it is uncertain if this species is present within the Study Area. A conservative approach has been applied and all areas identified as 'Potential Orchid Habitat' in **Figure 12** within the Study Area are considered to represent the species polygon for this species.	Species Polygon 4 (77.74 ha)

Rhodamnia rubescens (Scrub Turpentine)	Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	No buffers or general comments relating to this species is provided within the TBDC or survey guides.	The unit of measure listed by the TBDC for this species is 'Count'. Without targeted surveys conducted during the survey period for this species the number of individuals is uncertain.	-
Triplarina nowraensis (Nowra Heath Myrtle)	Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone.	No buffers or general comments relating to this species is provided within the TBDC or survey guides.	The unit of measure listed by the TBDC for this species is 'Count'. Without targeted surveys conducted during the survey period for this species the number of individuals is uncertain.	-
Tyto novaehollandiae (Masked Owl) (Breeding)	Masked Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	Species polygon should be established by providing a circular buffer with a 100 m radius around the nest tree.	Without targeted surveys conducted during the survey period for this species, it is uncertain how many actual nest trees are present within the Study Area. A conservative approach has been applied and all vegetation zones with suitable eucalypts within the Study Area are considered to represent the species polygon for this species.	Species Polygon 2 (75.88 ha)

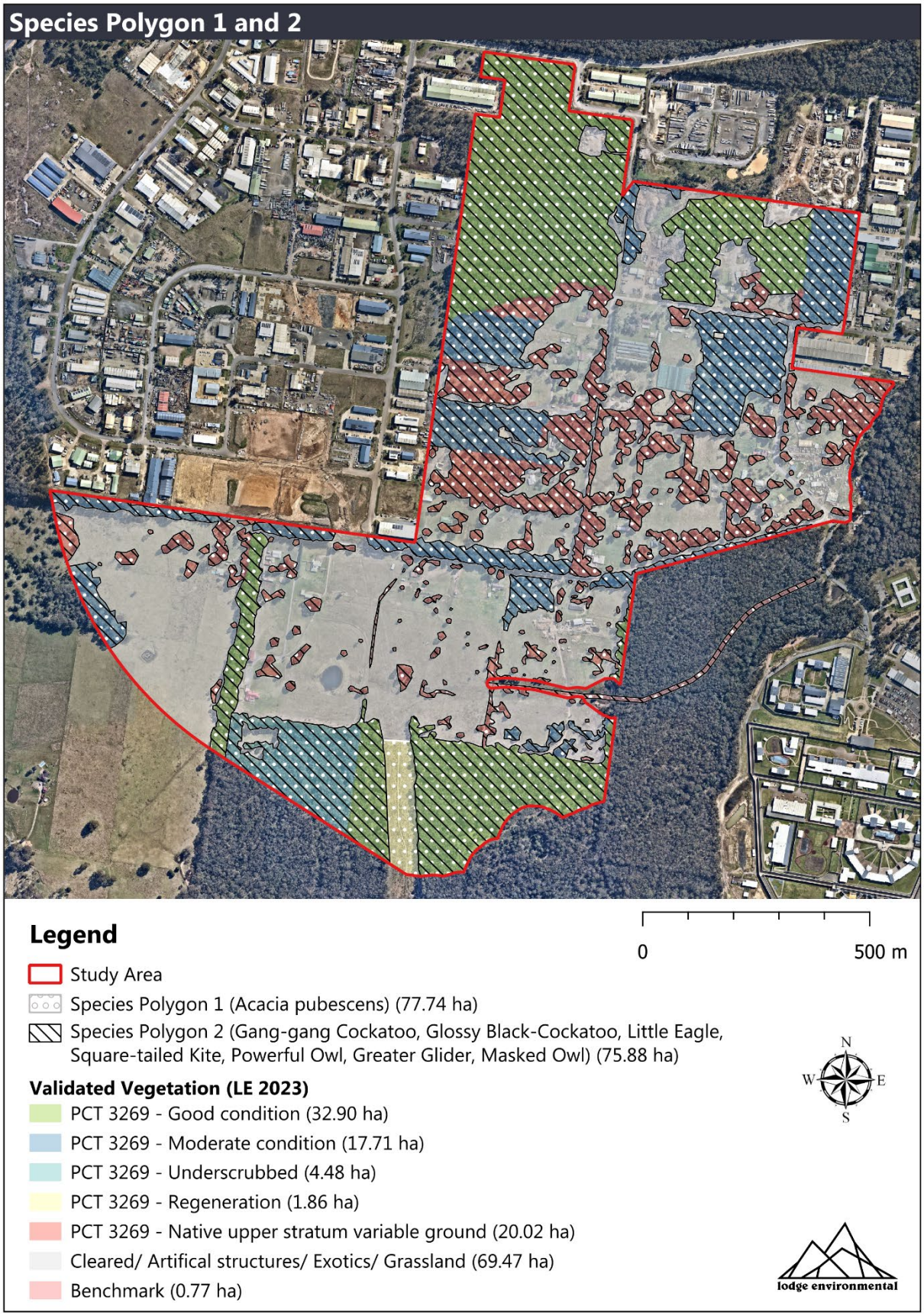


Figure 35: Species Polygon 1 and Species Polygon 2 assuming total impact

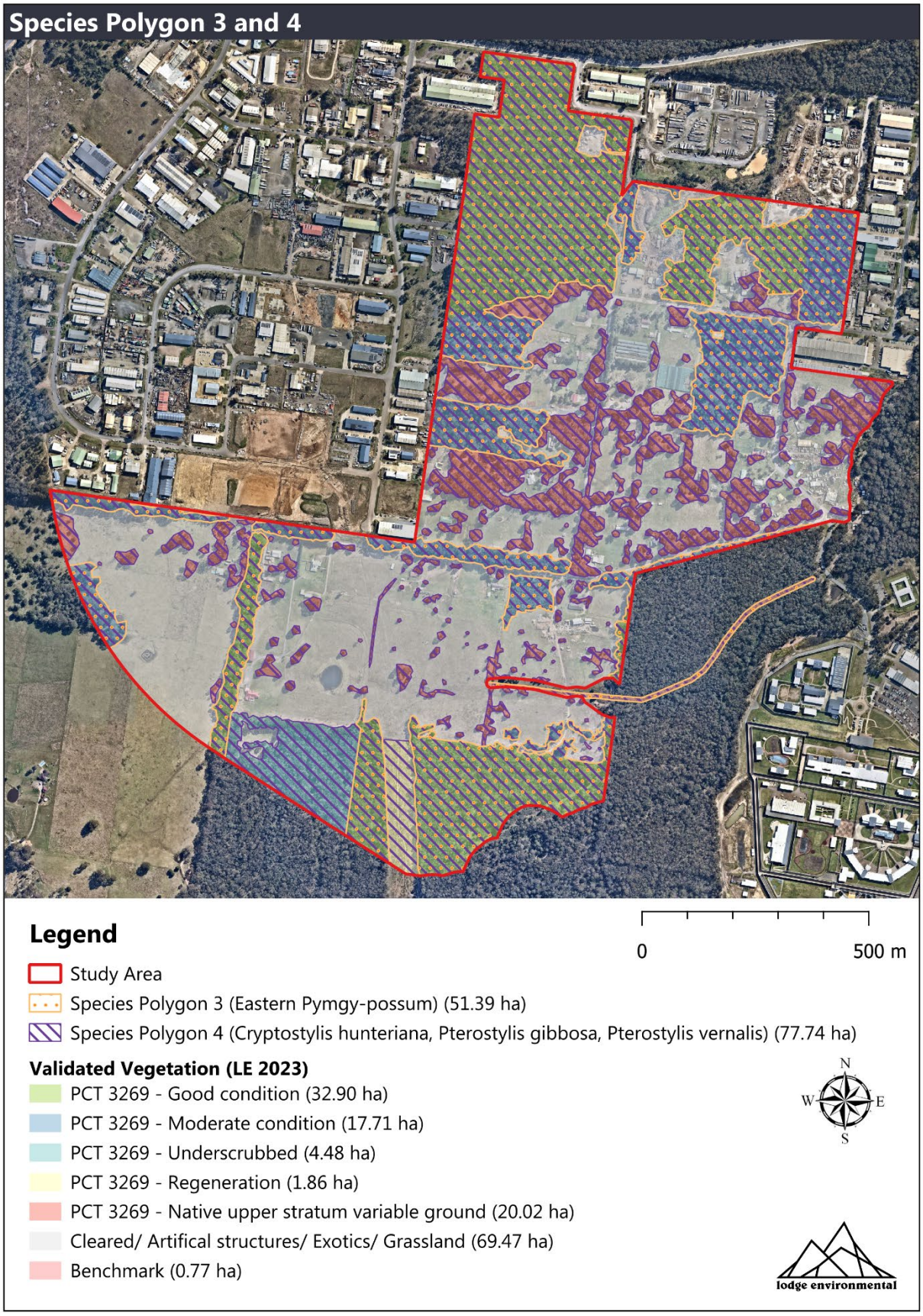


Figure 36: Species Polygon 3 and Species Polygon 4 assuming total impact

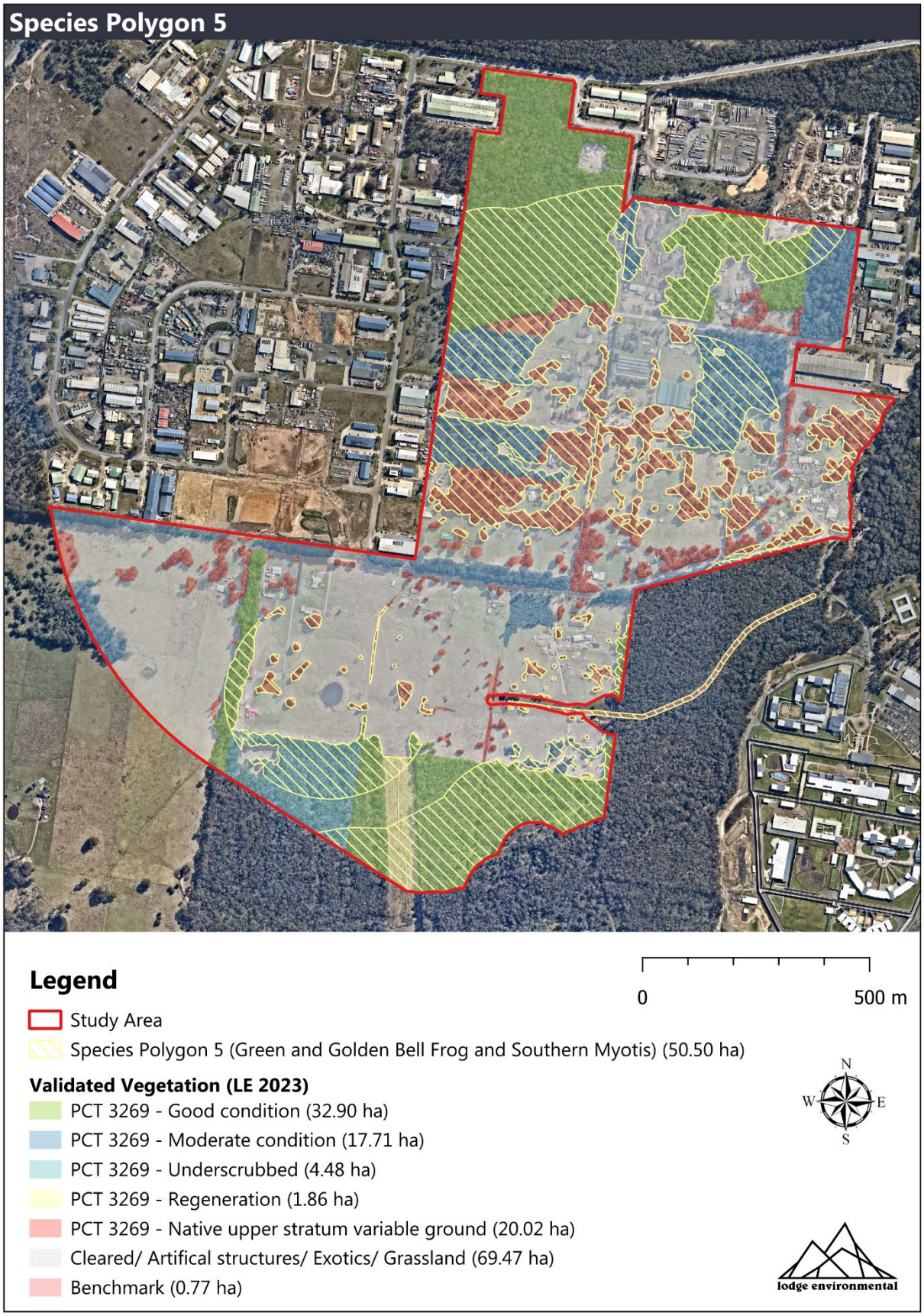


Figure 37: Species Polygon 5 assuming total impact

9.4 OFFSET ESTIMATION

9.4.1 Ecosystem Credits

The ecosystem credits calculated as a requirement for each DIS is outlined in **Table 18**. In total:

- 604 ecosystem credits are required for the Low Development scenario,
- 1,109 ecosystem credits are required for the Moderate Development scenario,
- 1,406 ecosystem credits are required for the High Development 1 scenario, and
- 2,679 ecosystem credits are required for the High Development 2 scenario.

Areas within the Study Area that do not contain native vegetation do not need to be assessed for ecosystem credits. However, non-native vegetation must still be assessed for species credits in accordance with Chapter 5 of the BAM.

Table 18: Ecosystem credit requirement

Development Impact Scenario	Vegetation Zone	Total impact (ha)	Ecosystem Credit Requirement
Low Development	Good	2.39	105
	Moderate	4.93	189
	Underscrubbed	0.03	1
	Native upper stratum variable ground	14.66	270
	Cleared/ Artificial structures/ Exotics/ Grassland	62.74	-
	Benchmark	0.77	39
		Total:	**604**
Moderate Development	Good	3.43	151
	Moderate	14.79	566
	Underscrubbed	0.03	1
	Native upper stratum variable ground	19.15	352
	Cleared/ Artificial structures/ Exotics/ Grassland	66.42	-
	Benchmark	0.77	39
		Total:	**1,109**
High Development 1	Good	7.86	345
	Moderate	17.31	662
	Underscrubbed	0.03	1
	Native upper stratum variable ground	19.55	359
	Cleared/ Artificial structures/ Exotics/ Grassland	66.68	-
	Benchmark	0.77	39
		Total:	**1,406**

High Development 2	Good	32.83	1,441
	Moderate	17.62	674
	Underscrubbed	4.47	116
	Regeneration	1.86	46
	Native upper stratum variable ground	19.74	363
	Cleared/ Artificial structures/ Exotics/ Grassland	68.50	-
	Benchmark	0.77	39
		Total:	**2,679**

9.4.2 Species Credits

As detailed in **Section 5.6** and **Section 5.7**, further site surveys in accordance with the BAM is required to determine presence or absence of candidate species with moderate to high potential of utilising the habitat within the Study Area. In lieu of conducting targeted surveys, the BOE has assumed that all species with a moderate to high potential for utilising the Study Area (**Section 5.6** and **Section 5.7**) are present.

The species credits calculated as a requirement for each DIS is outlined in **Table 19**. In total:

- 7,929 species credits are required for the Low Development scenario,
- 14,615 species credits are required for the Moderate Development scenario,
- 19,582 species credits are required for the High Development 1 scenario, and
- 34,634 species credits are required for the High Development 2 scenario.

Table 19: Species credit requirement

Species/Species Polygon	Development Impact Scenario	Total impact (ha)	Species Credit Requirement
Acacia pubescens (Downy Wattle) Species Polygon 1	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	77.29	2,679
Callocephalon fimbriatum (Gang-gang Cockatoo) (Breeding) Species Polygon 2	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	75.43	2,633
Calyptorhynchus lathami (Glossy Black-Cockatoo) (Breeding) Species Polygon 2	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	75.43	2,633
Cercartetus nanus	Low Development	8.09	333

(Eastern Pygmy-possum) Species Polygon 3	Moderate Development	18.98	756
	High Development 1	25.94	1,046
	High Development 2	51.22	2,154
Cryptostylis hunteriana (Leafless Tongue Orchid) Species Polygon 4	Low Development	40.54	559
	Moderate Development	56.77	943
	High Development 1	64.25	1,169
	High Development 2	98.49	2,126
Hieraaetus morphnoides (Little Eagle) (Breeding) Species Polygon 2	Low Development	22.78	452
	Moderate Development	38.17	831
	High Development 1	45.52	1,056
	High Development 2	75.43	1,975
Litoria aurea (Green and Golden Bell Frog) Species Polygon 5	Low Development	12.78	323
	Moderate Development	25.39	728
	High Development 1	29.74	910
	High Development 2	50.36	1,737
Lophoictinia isura (Square-tailed Kite) (Breeding) Species Polygon 2	Low Development	22.78	452
	Moderate Development	38.17	831
	High Development 1	45.52	1,056
	High Development 2	75.43	1,975
Myotis macropus (Southern Myotis) Species Polygon 5	Low Development	12.78	323
	Moderate Development	25.39	728
	High Development 1	29.74	910
	High Development 2	50.36	1,737
Ninox strenua (Powerful Owl) (Breeding) Species Polygon 2	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	75.43	2,633
Petauroides volans Greater Glider Species Polygon 2	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	75.43	2,633
Pterostylis gibbosa Illawarra Greenhood Species Polygon 4	Low Development	40.54	746
	Moderate Development	56.77	1,258
	High Development 1	64.25	1,556

	High Development 2	98.49	2,834
Pterostylis vernalis Species Polygon 41056	Low Development	40.54	1,117
	Moderate Development	56.77	1,886
	High Development 1	64.25	2,335
	High Development 2	98.49	4,252
Rhodamnia rubescens (Scrub Turpentine)	Low Development	-	-
	Moderate Development		
	High Development 1		
	High Development 2		
Triplarina nowraensis (Nowra Heath Myrtle)	Low Development	-	-
	Moderate Development		
	High Development 1		
	High Development 2		
Tyto novaehollandiae (Masked Owl) (Breeding) Species Polygon 2	Low Development	22.78	604
	Moderate Development	38.17	1,109
	High Development 1	45.52	1,406
	High Development 2	75.43	2,633

9.5 CREDIT COSTS

The Biodiversity Offsets Payment Calculator (BOPC) was replaced by the Biodiversity Charge Fund (BCF) Charge System on the 17th of October 2022. The new BCF Charge System will now be used to determine the amount a proponent may pay into the BCF to meet a biodiversity offset obligation.

The Biodiversity Conservation Trust (BCT) is responsible for administering the new charge system. More information about the new charge system, including how to request a quote from the BCT, is available on the BCT website, available through https://www.bct.nsw.gov.au/info/biodiversity-conservation-fund-charge-system.

Table 20 provides an estimation of credit prices for the ecosystem and species credits listed in **Table 18** and **Table 19**. These prices have been sourced from the NSW DPE Market Sales Dashboard and the BCF Quarterly Charge Report and Biodiversity Offsets Payment Calculator.

It is important to note that the prices contained within **Table 20** are an estimation and should serve as a guide only and not be considered the actual market price.

Table 20: Biodiversity credit price estimation

PCT or Species	Charge price per credit	Development Impact Scenario	Maximum Credit Requirement	Final Estimated Credit Price (excluding GST)
PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest (OTG: TEC Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion)	$23,743.04	Low Development	604	$14,340,796.16
		Moderate Development	1,109	$26,331,031.36
		High Development 1	1,406	$33,382,714.24
		High Development 2	2,679	$63,607,604.16
Acacia pubescens (Downy Wattle)	$1,070.00	Low Development	604	$646,280.00
		Moderate Development	1,109	$1,186,630.00
		High Development 1	1,406	$1,504,420.00
		High Development 2	2,679	$2,866,530.00
Callocephalon fimbriatum (Gang-gang Cockatoo) (Breeding)	$3,220.00	Low Development	604	$1,944,880.00
		Moderate Development	1,109	$3,570,980.00
		High Development 1	1,406	$4,527,320.00
		High Development 2	2,633	$8,478,260.00
Calyptorhynchus lathami (Glossy Black-Cockatoo) (Breeding)	$3,220.00	Low Development	604	$1,944,880.00
		Moderate Development	1,109	$3,570,980.00
		High Development 1	1,406	$4,527,320.00
		High Development 2	2,633	$8,478,260.00
Cercartetus nanus (Eastern Pygmy-possum)	$1,070.00	Low Development	333	$356,310.00
		Moderate Development	756	$808,920.00
		High Development 1	1,046	$1,119,220.00
		High Development 2	2,154	$2,304,780.00
Cryptostylis hunteriana (Leafless Tongue Orchid)	$3,220.00	Low Development	559	$1,799,980.00
		Moderate Development	943	$3,036,460.00
		High Development 1	1,169	$3,764,180.00
		High Development 2	2,126	$6,845,720.00
Hieraaetus morphnoides (Little Eagle) (Breeding)	$1,610.00	Low Development	452	$727,720.00
		Moderate Development	831	$1,337,910.00
		High Development 1	1,056	$1,700,160.00
		High Development 2	1,975	$3,179,750.00

Litoria aurea (Green and Golden Bell Frog)	$2,150.00	Low Development	323	$694,450.00
		Moderate Development	728	$1,565,200.00
		High Development 1	910	$1,956,500.00
		High Development 2	1,737	$3,734,550.00
Lophoictinia isura (Square-tailed Kite) (Breeding)	$1,610.00	Low Development	452	$727,720.00
		Moderate Development	831	$1,337,910.00
		High Development 1	1,056	$1,700,160.00
		High Development 2	1,975	$3,179,750.00
Myotis macropus (Southern Myotis)	$1,070.00	Low Development	323	$345,610.00
		Moderate Development	728	$778,960.00
		High Development 1	910	$973,700.00
		High Development 2	1,737	$1,858,590.00
Ninox strenua (Powerful Owl) (Breeding)	$4,300.00	Low Development	604	$2,597,200.00
		Moderate Development	1,109	$4,768,700.00
		High Development 1	1,406	$6,045,800.00
		High Development 2	2,633	$11,321,900.00
Petauroides volans Greater Glider	$540.00	Low Development	604	$326,160.00
		Moderate Development	1,109	$598,860.00
		High Development 1	1,406	$759,240.00
		High Development 2	2,633	$1,421,820.00
Pterostylis gibbosa Illawarra Greenhood	$8,600.00	Low Development	746	$6,415,600.00
		Moderate Development	1,258	$10,818,800.00
		High Development 1	1,556	$13,381,600.00
		High Development 2	2,834	$24,372,400.00
Pterostylis vernalis	$8,600.00	Low Development	1,117	$9,606,200.00
		Moderate Development	1,886	$16,219,600.00
		High Development 1	2,335	$20,081,000.00
		High Development 2	4,252	$36,567,200.00
Rhodamnia rubescens (Scrub Turpentine)	Unknown	Low Development	-	-
		Moderate Development		
		High Development 1		
		High Development 2		
Triplarina nowraensis (Nowra Heath Myrtle)	Unknown	Low Development	-	-
		Moderate Development		

		High Development 1		
		High Development 2		
Tyto novaehollandiae (Masked Owl) (Breeding)	$4,300.00	Low Development	604	$2,597,200.00
		Moderate Development	1,109	$4,768,700.00
		High Development 1	1,406	$6,045,800.00
		High Development 2	2,633	$11,321,900.00

9.5.1 Total Estimated Credit Costs

The Total Estimated Credit Costs for each DIS is detailed in **Table 21**.

Please note that prices of credits are subject to change. The amount payable to discharge an offset obligation will be determined at the time of payment.

Table 21: Total Estimated Credit Costs

Development Impact Scenario	Biodiversity Credit	Estimated credit total	Final Estimated Credit Price (excluding GST)
Low Development (Impact to native vegetation = 22.78 ha)	Ecosystem Credit	604	$14,340,796.16
	Species Credit[2]	7,929	$30,730,190.00
	Total[2]	**8,533**	**$45,070,986.16**
Moderate Development (Impact to native vegetation = 38.17 ha)	Ecosystem Credit	1,109	$26,331,031.36
	Species Credit[2]	14,615	$54,368,610.00
	Total[2]	**15,724**	**$80,699,641.36**
High Development 1 (Impact to native vegetation = 45.52 ha)	Ecosystem Credit	1,406	$33,382,714.24
	Species Credit[2]	19,582	$68,086,420.00
	Total[2]	**20,988**	**$101,469,134.24**
High Development 2 (Impact to native vegetation = 77.29 ha)	Ecosystem Credit	2,679	$63,607,604.16
	Species Credit[2]	34,634	$125,931,410.00
	Total[2]	**37,313**	**$189,539,014.16**

[2]Excluding the estimated prices for species where the charge price per credit is unknown.

10.0 CONCLUSION

Lodge Environmental has conducted a preliminary assessment of the biodiversity values present at the South Nowra Industrial Land to determine notable ecological constraints in the context of future development and conservation opportunities.

Vegetation within the Study Area aligns with PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest and occurs as five different vegetation zones, being:

- Good condition
- Moderate condition
- Under scrubbed
- Regeneration
- Native upper stratum with variable ground stratum

PCT 3269 – Shoalhaven Lowland Spotted Gum-Paperbark Forest can be associated with the Threatened Ecological Community Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion. The occurrence within the Study Area is considered to represent the Threatened Ecological Community.

A total of 176 flora species, consisting of 134 native and 42 exotic species, and 20 fauna species were recorded during the site surveys. No threatened flora or fauna were recorded, however, no targeted surveys were conducted. Target surveys, as per the BAM 2020, will be required to determine presence or absence of candidate species. These surveys must be conducted following the NSW survey guidelines for threatened species and during the survey period for the species as outline by BioNet.

Core Riparian Zones for field validated watercourses identified in **Figure 22** should be considered for restoration works in any future planning for the Study Area.

Future development design and planning should be completed with consideration to the Biodiversity Offset Scheme entrance thresholds of:

- Clearance of native vegetation over the relevant native vegetation clearance threshold.
- Significant impacts to matters listed under the BC Act as assessed using s7.3 of the BC Act.

High, moderate and low ecological constraints have been identified as part of this report and should be considered for all future development plans.

The results of this preliminary assessment indicate that the vegetation adjacent to the northern and southern boundaries has a strong potential to form a viable stewardship site. The biodiversity credits generated from entering the suggested land into a BSA would provide a portion of offset credits required for future development on the remainder of land within the Study Area. Further site assessments in accordance with the BAM is required to gain a better understanding of the Study Area' s suitability and viability for a BSA.

Four Development Impact Scenarios were reviewed, and areas of impact ran through the BAM-C. The total Biodiversity Offset Estimation for the four Development Impact Scenarios proposed by Shoalhaven City Council are:

- Low Development requires 8,533 biodiversity credits estimated to cost $45,070,986.16.
- Moderate Development requires 15,724 biodiversity credits estimated to cost $80,699,641.36.
- High Development 1 requires 20,988 biodiversity credits estimated to cost $101,469,134.24.
- High Development 2 requires 37,313 biodiversity credits estimated to cost $189,539,014.16.

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12.0 LIMITATIONS

This report and the associated services performed by Lodge Environmental are in accordance with the scope of services set out in the contract between Lodge Environmental and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to Site.

Lodge Environmental derived the data in this report primarily from visual inspections, and, limited survey and analysis made on the dates indicated. In preparing this report, Lodge Environmental has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while Lodge Environmental believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

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It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

Appendices

Appendix A: Flora Species List

Scientific name	Common name	Native	Exotic
Acacia falcata	Hickory Wattle	X	
Acacia irrorata	Green Wattle	X	
Acacia longifolia	-	X	
Acacia maidenii	Maiden's wattle	X	
Acacia mearnsii	Black Wattle	X	
Acacia obtusifolia	Blunt Leaf Wattke	X	
Acacia stricta	Straight Wattle	X	
Acacia ulicifolia	Prickly Moses	X	
Ageratina sp.	Crofton Weed		X
Allocasuarina littoralis	Black She-oak	X	
Allocasuarina sp. (Juvenile)	-	X	
Anthoaxnthum odoratum	Sweet Vernal Grass		X
Anthosachne scabra	Wheatgrass	X	
Araujia sericifera	Moth Vine		X
Aristida vagans	Threeawn Speargrass	X	
Asparagus aethiopicus	Ground Asparagus		X
Avena fatua	Wild Oats		X
Axonpus compresus	Broadleaf Carpet Grass		X
Bidens pilosa	Cobbler's Peg		X
Billardiera scandens	Hairy Apple Berry	X	
Bothriochloa macra	Red Grass	X	
Briza maxima	Quaking Grass		X
Brunoniella australis	Blue Trumpet	X	
Brunoniella pumilio	Dwarf Brunoniella	X	
Bryophyllum delagoense	Mother-of-millions		X
Bursaria spinosa	Boxthorn	X	
Caesia parviflora	Pale Grass-lily	X	
Calochlaena dubia	Rainbow Fern	X	
Cassinia aculeata	Dolly Bush	X	
Cassinia uncata	Sticky Cassinia	X	

Scientific name	Common name	Native	Exotic
Cassytha pubescens	Devils Twine	X	
Cenchrus clandestinus	Kikuyu Grass		X
Centaurium erythraea	Common Centaury		X
Centella asiatica	Indian Pennywort	X	
Cheilanthes sieberi	-	X	
Chloris gayana	Rhodes Grass		X
Chlorophytum comosum	Spider Plant		X
Cinnamomum camphora	Camphor Laurel		X
Commelina cyanea	-	X	
Conyza bonariensis	Flaxleaf fleabane		X
Corymbia maculata	Spotted Gum	X	
Cyanthillium cinereum	Iron Weed	X	
Cyclospermum leptophyllum	Slender Celery		X
Cymbopogon refractus	Barbed Wire Grass	X	
Cyperus brevifolius	Mullumbimby Couch		X
Cyperus eragrostis	Umbrella Sedge		X
Cyperus haspan	-	X	
Cyperus polystachyos	-	X	
Cyperus sanguinolentus	-	X	
Daviesia ulicifolia	Gorse Bitter Pea	X	
Desmodium sp.		X	
Dianella caerulea	Blue Flax-lily	X	
Dianella longifolia	Blueberry Lily	X	
Dichelachne micrantha	Shorthair Plumegrass	X	
Dichondra repens	Kidney Weed	X	
Digitaria didactyla	Queensland Blue Couch	X	
Digitaria sanguinalis	Summer Grass		X
Echinopogon caespitosus	Bushy Hedgehog-grass	X	
Ehrharta erecta	Panic Veldtgrass		X
Einadia hastata	Berry Saltbush	X	
Einadia nutans	Climbing Saltbush	X	
Entolasia marginata	Bordered Panic	X	

Scientific name	Common name	Native	Exotic
Entolasia stricta	Wiry Panic	X	
Eragrostis brownii	Brown's Lovegrass	X	
Eragrostis leptostachya	Paddock Lovegrass	X	
Eragrostis pilosa	Soft Lovegrass		X
Eucalyptus eugenioides	Thin-leaved Stringybark	X	
Eucalyptus longifolia	Woollybutt	X	
Eucalyptus paniculata	Grey Ironbark	X	
Eucalyptus punctata	Grey Gum	X	
Eucalyptus tereticornis	Forest Red Gum	x	
Eucalyptus sp. (regrowth/juvenile)	-	X	
Euchiton sphaericus	-	X	
Exocarpos cupressiformis	Native Cherry	X	
Fimbristylis dichotoma	Common Fringe-sedge	X	
Gahnia clarkei	Tall Saw-sedge	X	
Geranium homeanum	-	X	
Glochidion ferdinandi	Cheese Tree	X	
Glycine clandestina	-	X	
Glycine microphylla	Small-leaf Glycine	X	
Glycine tabacina	-	X	
Gnaphalium sp.	Cudweed		X
Gonocarpus tetragynus	-	X	
Gonocarpus teucrioides	Raspwort	X	
Goodenia hederacea	Forest Goodenia	X	
Goodenia paniculata	Branched Goodenia	X	
Grona varians	Slender Tick-trefoil		X
Hakea dactyloides	Finger Hakea	X	
Hakea sericea	Needlebush	X	
Hardenbergia violacea	Purple Coral Pea	X	
Homalanthus populifolius	Bleeding Heart	X	
Hydrocotyle peduncularis	-	X	
Hypericum gramineum	Small St. John's Wort	X	
Hypochaeris radicata	Catsear		X

Scientific name	Common name	Native	Exotic
Hypoxis hygrometrica	Golden Weather-grass	X	
Imperata cylindrica	Blady Grass	X	
Juncus pallidus	-	X	
Juncus pauciflorus	-	X	
Juncus usitatus	-	X	
Kunzea ambigua	Tick Bush	X	
Lagenophora stipitata	Blue Bottle-daisy	X	
Lantana camara	Lantana	X	
Lepidosperma gunnii	-	X	
Lepidosperma laterale	-	X	
Leptospermum continentale	Prickly Tea-tree	X	
Leptospermum polygalifolium	Tantoon	X	
Leucopogon juniperinus	Prickly Beard-heath	X	
Ligustrum lucidum	Large-leaved Privet		X
Ligustrum sinense	Small-leved Privet		X
Linum marginale	Native Flax	X	
Lissanthe strigosa	Peach Heath	X	
Lomandra confertifolia	Mat-rush	X	
Lomandra filiformis	Wattle Mat-rush	X	
Lomandra gracilis	-	X	
Lomandra longifolia	Spiny-headed Mat-rush	X	
Lomandra multiflora	Many-flowered Mat-rush	X	
Macrozamia communis	Burrawang	X	
Marsdenia rostrata	Milk Vine	X	
Melaleuca decora	-	X	
Melaleuca diosmatifolia	Rosy Honey-myrtle	X	
Melaleuca ericifolia	Swamp Paperbark	X	
Melaleuca linariifolia	Flax-leaved Paperbark	X	
Melaleuca styphelioides	Prickly-leaved Tea Tree	X	
Microlaena stipoides	Weeping Grass	X	
Modiola caroliniana	Red-flowered Mallow		
Notelaea venosa	Veined Mock-olive	X	

Scientific name	Common name	Native	Exotic
Olearia viscidula	Wallaby Weed	X	
Onopordum acanthium	Scoth Thistle		X
Opercularia aspera	Coarse Stinkweed	X	
Oplismenus aemulus	Australian Basket Grass	X	
Oplismenus imbecillis	Creeping Beard Grass	X	
Ozothamnus diosmifolius	Rice Flower	X	
Pandorea pandorana	Wonga Wonga Vine	X	
Panicum effusum	Hairy Panic	X	
Panicum repens	Torpedo Grass		X
Panicum simile	Two-colour Panic	X	
Parsonsia straminea	Common Silkpod	X	
Paspalidium distans	-	X	
Paspalum dilatatum	Paspalum		X
Paspalum distichum	Water Couch	X	
Paspalum orbiculare	Ditch Millet	X	
Persicaria decipiens	Slender Knotweed	X	
Phyllanthus hirtellus	Thyme Spurge	X	
Phytolacca octandra	Inkweed		X
Pimelea linifolia	Slender Rice Flower	X	
Pittosporum undulatum	Native Daphne	X	
Plantago lanceolata	Lamb's Tongues		X
Plantago linearis	-		X
Poa sieberiana	-	X	
Pomax umbellata	-	X	
Pratia purpurascens	Whiteroot	X	
Pultenaea retusa	Blunt Bush-pea	X	
Pultenaea villosa	Bronze Bush-pea	X	
Rubus parvifolius	Native Raspberry	X	
Rubus sp.	Blackberry		X
Rumex brownii	Swamp Dock	X	
Rytidosperma sp.	Wallaby Grass	X	
Rytidosperma racemosum	-	X	

Scientific name	Common name	Native	Exotic
Schoenus apogon	Common Bog-rush	X	
Senecio madagascariensis	Fireweed		X
Setaria parviflora	Pigeon Grass		X
Sida rhomifolia	Paddy's Lucerne		X
Solanum mauritianum	Tabacco Bush		X
Solanum prinophyllum	Forest Nightshade	X	
Sphaeromorphaea australis	Spreading Nut-heads	X	
Sporobolus africanus	Parramatta Grass		X
Stylidium sp.	-	X	
Taraxacum officinale	Dandelion		X
Themeda australis	Kangaroo Grass	X	
Tricoryne elatior	Yellow Autumn-lily	X	
Trifolium arvense	Haresfoot Clover		X
Verbena bonariensis	Purpletop		X
Veronica plebeia	Trailing Speedwell	X	
Vittadinia sulcata	-	X	
Wahlenbergia communis	Tufted Bluebell	X	
Wahlenbergia gracilis	Sprawling Bluebell	X	
Zieria smithii	SANDFLY ZIERIA	X	

Appendix B: Fauna Species List

Class Name	Scientific Name	Common Name
Aves	*Cacatua sanguinea*	Little Corella
	Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo
	Chenonetta jubata	Australian Wood Duck
	Coracina novaehollandiae	Black-faced Cuckoo-shrike
	Corvus coronoides	Australian Raven
	Cracticus tibicen	Magpie
	Dacelo novaeguineae	Laughing Kookaburra
	Egretta novaehollandiae	White-faced Heron
	Eolophus roseicapillus	Galah
	Manorina melanocephala	Noisy Miner
	Ocyphaps lophotes	Crested Pigeon
	Phaps chalcoptera	Common bronzewing
	Platycerus eximius	Eastern Rosella
	Todiramphus sanctus	Sacred Kingfisher
	Vanellus miles	Masked Lapwing
Mammal	*Macropus giganteus*	Eastern Grey Kangaroo
	Oryctolagus cuniculus	European Rabbit
Amphibian	*Crinia signifera*	Common Eastern Toadlet
Reptile	*Pseudechis porphyriacus*	Red-bellied Black Snake
	Varanus varius	Lace Monitor

Appendix C: Vegetation Plot Data

Plot ID	Count of Native Richness						Sum of Cover (%)						
	Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	HTE
1	3	6	5	5	0	3	40.0	7.2	2.3	0.9	0.0	0.3	0.0
2	4	6	5	6	0	7	80.0	2.9	4.7	41.4	0.0	7.6	0.1
3	5	10	13	11	1	1	26.6	32.2	25.8	1.9	0.1	0.1	0.0
4	2	6	6	8	1	2	0.2	7.2	56.5	5.7	0.1	0.2	0.0
5	3	6	5	8	0	2	2.2	6.4	15.4	5.7	0.0	0.2	0.1
6	0	5	4	4	0	0	0.0	6.2	10.3	5.3	0.0	0.0	0.1
7	2	2	4	6	0	1	41.0	5.0	1.3	9.4	0.1	0.1	0.2
8	3	2	6	11	1	0	17.1	0.2	21.3	3.2	0.1	0.0	1.1
9	3	10	14	10	1	1	42.5	13.5	39.8	1.2	0.5	0.2	0.1
10	3	3	5	6	0	1	7.1	0.3	15.8	2.4	0.0	0.1	0.5
11	3	9	10	9	0	5	20.0	16.0	6.8	1.2	0.0	1.4	1.2
12	2	10	11	10	0	0	45.0	5.3	11.4	1.0	0.0	0.0	2.3
13	0	3	5	4	0	0	0.0	0.3	27.0	20.6	0.0	0.0	0.0
14	4	6	16	7	0	3	26.2	2.9	5.3	2.7	0.0	0.7	0.0
15	4	6	8	7	0	3	40.5	6.1	1.2	2.3	0.0	1.6	21.1
16	3	12	16	9	1	3	25.2	8.7	46.0	3.1	0.1	0.3	0.2
17	3	13	15	9	0	3	27.0	19.7	43.3	1.0	0.0	0.7	0.0
18	4	15	10	9	0	4	37.2	34.6	38.5	0.9	0.0	0.9	0.0

Plot ID	Function										
	Hollow trees	Litter cover	Tree stem <5	Tree stem 5-9	Tree stem 10-19	Tree stem 20-29	Tree stem 30-49	Tree stem 50-79	Large trees >80 cm	Tree regen	Length of logs (m)
1	0	72	12	9	22	15	12	2	0	Yes	8
2	1	50	31	21	22	12	7	4	3	Yes	2
3	0	84	29	34	31	20	2	0	0	Yes	3
4	0	46	0	0	0	0	0	0	0	No	58
5	0	13	0	0	2	1	2	1	0	No	0
6	0	32	0	0	0	0	0	0	0	No	0
7	0	37	0	0	1	2	1	3	2	No	0
8	3	39	0	0	2	0	4	3	1	No	1.3

9	0	78	1	18	6	19	6	1	1	Yes	0
10	0	11	7	0	0	0	2	0	0	Yes	6
11	0	87	25	12	25	12	5	1	2	Yes	38
12	0	35	28	7	16	4	8	1	0	Yes	1
13	0	8	0	0	0	0	0	0	0	No	0
14	0	81	11	7	46	21	4	0	0	Yes	7
15	0	68	19	18	16	16	8	4	2	Yes	33
16	0	18	1	2	5	4	2	4	1	Yes	7
17	0	45	40	19	26	16	3	0	0	Yes	113
18	0	77	3	13	33	25	2	2	1	Yes	38

Appendix D: Species Polygon Area Calculations

Development Impact Scenario	Species Polygon	Vegetation Zone	Total impact (ha)
Low Development	Species Polygon 1	Good	2.39
		Moderate	4.93
		Underscrubbed	0.03
		Native upper stratum variable ground	14.66
		Benchmark	0.77
		Total:	**22.78**
	Species Polygon 2	Good	2.39
		Moderate	4.93
		Underscrubbed	0.03
		Native upper stratum variable ground	14.66
		Benchmark	0.77
		Total:	**22.78**
	Species Polygon 3	Good	2.39
		Moderate	4.93
		Benchmark	0.77
		Total:	**8.09**
	Species Polygon 4	Good	2.39
		Moderate	4.93
		Underscrubbed	0.03
		Native upper stratum variable ground	14.66
		Cleared/ Artificial structures/ Exotics/ Grassland	17.75
		Benchmark	0.77
		Total:	**40.53**
	Species Polygon 5	Good	1.43
		Moderate	1.37
		Underscrubbed	0.03
		Native upper stratum variable ground	9.22
		Benchmark	0.73
		Total:	**12.78**

Moderate Development	Species Polygon 1	Good	3.43
		Moderate	14.79
		Underscrubbed	0.03
		Native upper stratum variable ground	19.15
		Benchmark	0.77
		Total:	**38.17**
	Species Polygon 2	Good	3.43
		Moderate	14.79
		Underscrubbed	0.03
		Native upper stratum variable ground	19.15
		Benchmark	0.77
		Total:	**38.17**
	Species Polygon 3	Good	3.43
		Moderate	14.79
		Benchmark	0.77
		Total:	**18.98**
	Species Polygon 4	Good	3.43
		Moderate	14.79
		Underscrubbed	0.03
		Native upper stratum variable ground	19.15
		Cleared/ Artificial structures/ Exotics/ Grassland	18.61
		Benchmark	0.77
		Total:	**56.78**
	Species Polygon 5	Good	2.47
		Moderate	8.78
		Underscrubbed	0.03
		Native upper stratum variable ground	13.38
		Benchmark	0.73
		Total:	**24.66**
High Development 1	Species Polygon 1	Good	7.86
		Moderate	17.31
		Underscrubbed	0.03
		Native upper stratum variable ground	19.55
		Benchmark	0.77

		Total:	**45.52**
	Species Polygon 2	Good	7.86
		Moderate	17.31
		Underscrubbed	0.03
		Native upper stratum variable ground	19.55
		Benchmark	0.77
		Total:	**45.52**
	Species Polygon 3	Good	7.86
		Moderate	17.31
		Benchmark	0.77
		Total:	**25.94**
	Species Polygon 4	Good	7.86
		Moderate	17.31
		Underscrubbed	0.03
		Native upper stratum variable ground	19.55
		Cleared/ Artificial structures/ Exotics/ Grassland	18.74
		Benchmark	0.77
		Total:	**64.26**
	Species Polygon 5	Good	6.09
		Moderate	9.24
		Underscrubbed	0.03
		Native upper stratum variable ground	13.65
		Benchmark	0.73
		Total:	**29.74**
High Development 2	Species Polygon 1	Good	32.83
		Moderate	17.62
		Underscrubbed	4.47
		Regeneration	1.86
		Native upper stratum variable ground	19.74
		Benchmark	0.77
		Total:	**77.29**
	Species Polygon 2	Good	32.83
		Moderate	17.62
		Underscrubbed	4.47

		Native upper stratum variable ground	19.74
		Benchmark	0.77
		Total:	**75.43**
	Species Polygon 3	Good	32.83
		Moderate	17.62
		Benchmark	0.77
		Total:	**51.22**
	Species Polygon 4	Good	32.83
		Moderate	17.62
		Underscrubbed	4.47
		Regeneration	1.86
		Native upper stratum variable ground	19.74
		Cleared/ Artificial structures/ Exotics/ Grassland	19.33
		Benchmark	0.77
		Total:	**96.62**
	Species Polygon 5	Good	22.30
		Moderate	9.55
		Underscrubbed	2.75
		Regeneration	1.18
		Native upper stratum variable ground	13.85
		Benchmark	0.73
		Total:	**50.36**