Moss Vale Road North Urban Release Area Riparian Assessment

Shoalhaven City Council

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Template 2.8.1

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Abbreviations

Abbreviation	Description
ELA	Eco Logical Australia Pty Ltd
FM Act	*Fisheries Management Act 1994*
GPS	Global Positioning System
KFH	Key Fish Habitat
NRAR	Natural Resources Access Regulator
RC	Riparian Corridor (channel plus VRZ on each side)
SLEP	Shoalhaven Local Environmental Plan 2014
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WM Act	*Water Management Act 2000*

1. Introduction

1.1 Scope and aims of report

Eco Logical Australia (ELA) was engaged by Shoalhaven City Council (SCC) to provide a peer review of the riparian corridors proposed in the draft Planning Proposal and associated Indicative Layout Plan (ILP) for the Moss Vale Road North Urban Release Area (Figure 1, Figure 2, Figure 3).

To provide robust advice, ELA undertook a field-based assessment of riparian condition. This report provides the following information and recommendations for consideration by SCC:

- higher-resolution top of bank mapping to enable accurate riparian zone mapping
- identification of native and threatened vegetation communities, and habitat trees for protection
- recommendations for riparian zone protection based on the Guidelines for Riparian Corridors on Waterfront Land (2012), including:
    - the use of the averaging rule to achieve a more practical riparian/urban zone boundary
    - locations for waterway crossings and stormwater basin
    - improved connectivity of terrestrial and aquatic habitats
    - recommended extent (conceptual) of riparian corridors to be zoned as C2 Environmental Conservation.

Other background information regarding existing site conditions and planning legislation is provided by others in Rhealm 2018, ELA 2018, Allen Price & Scarratts 2019, ELA 2021a and ELA 2021b.

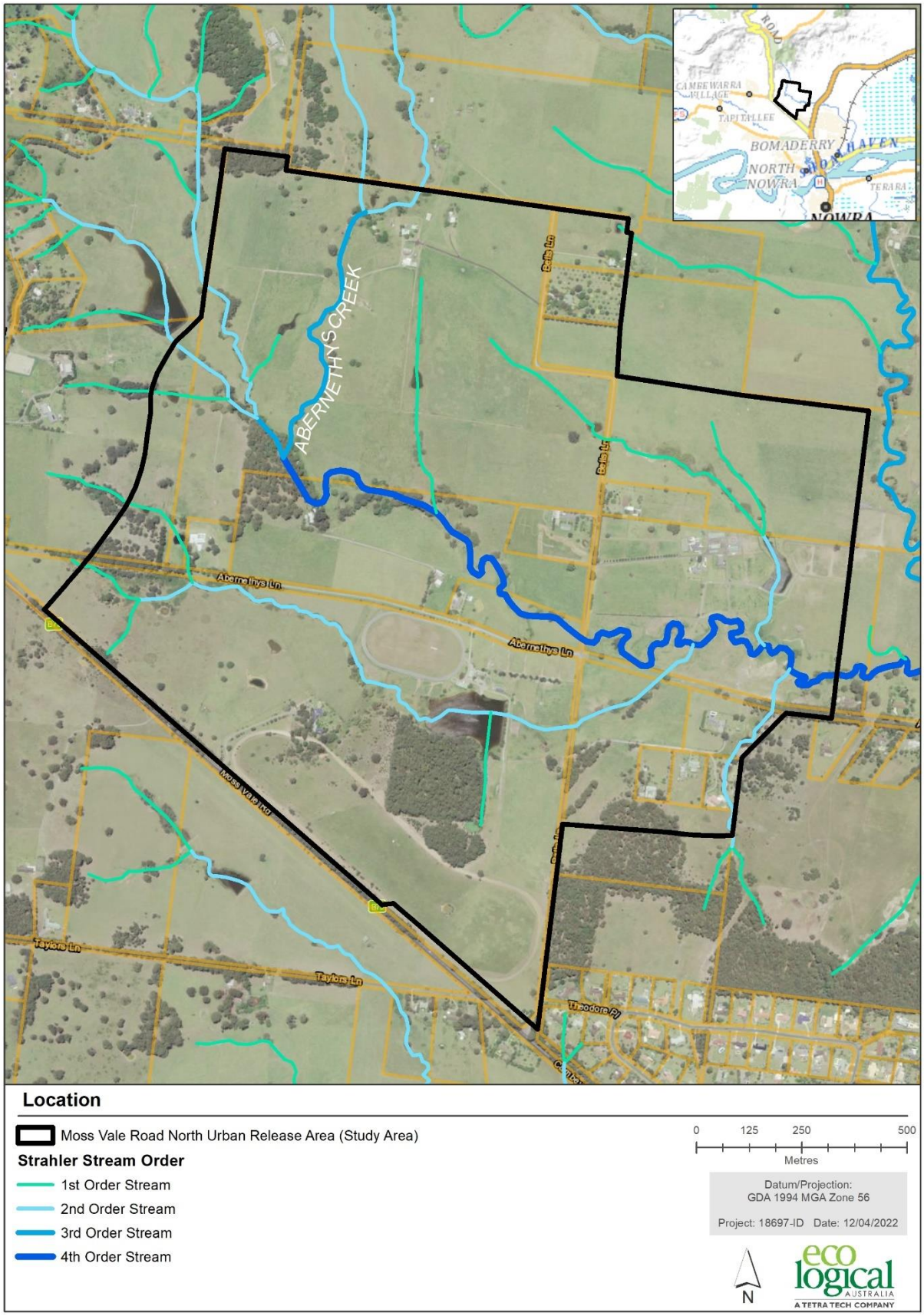

Figure 1: Location of the Moss Vale Road North Urban Release Area (study area)

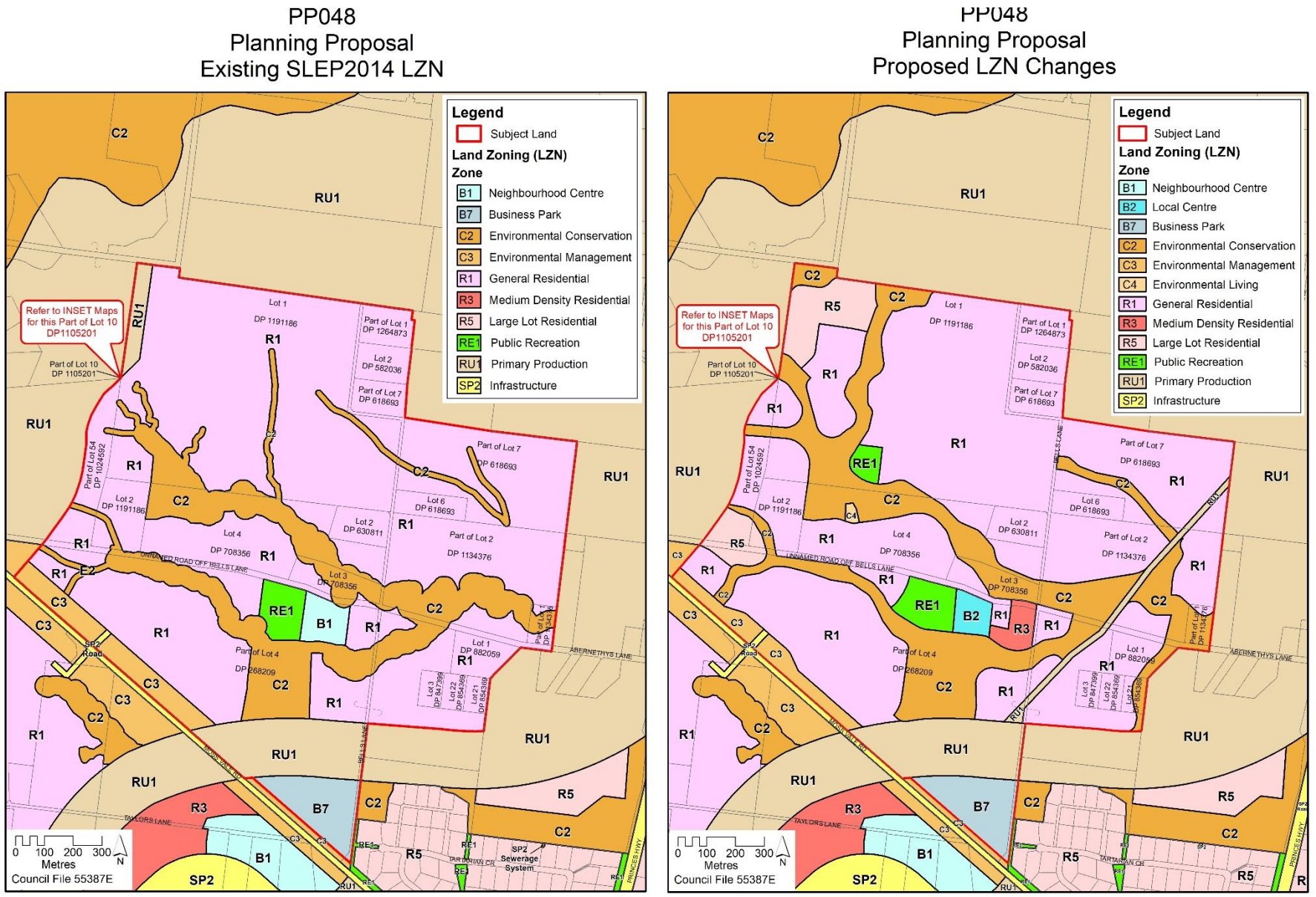

Figure 2: Existing land zoning introduced in 2014 (left) and proposed land zoning changes (right)

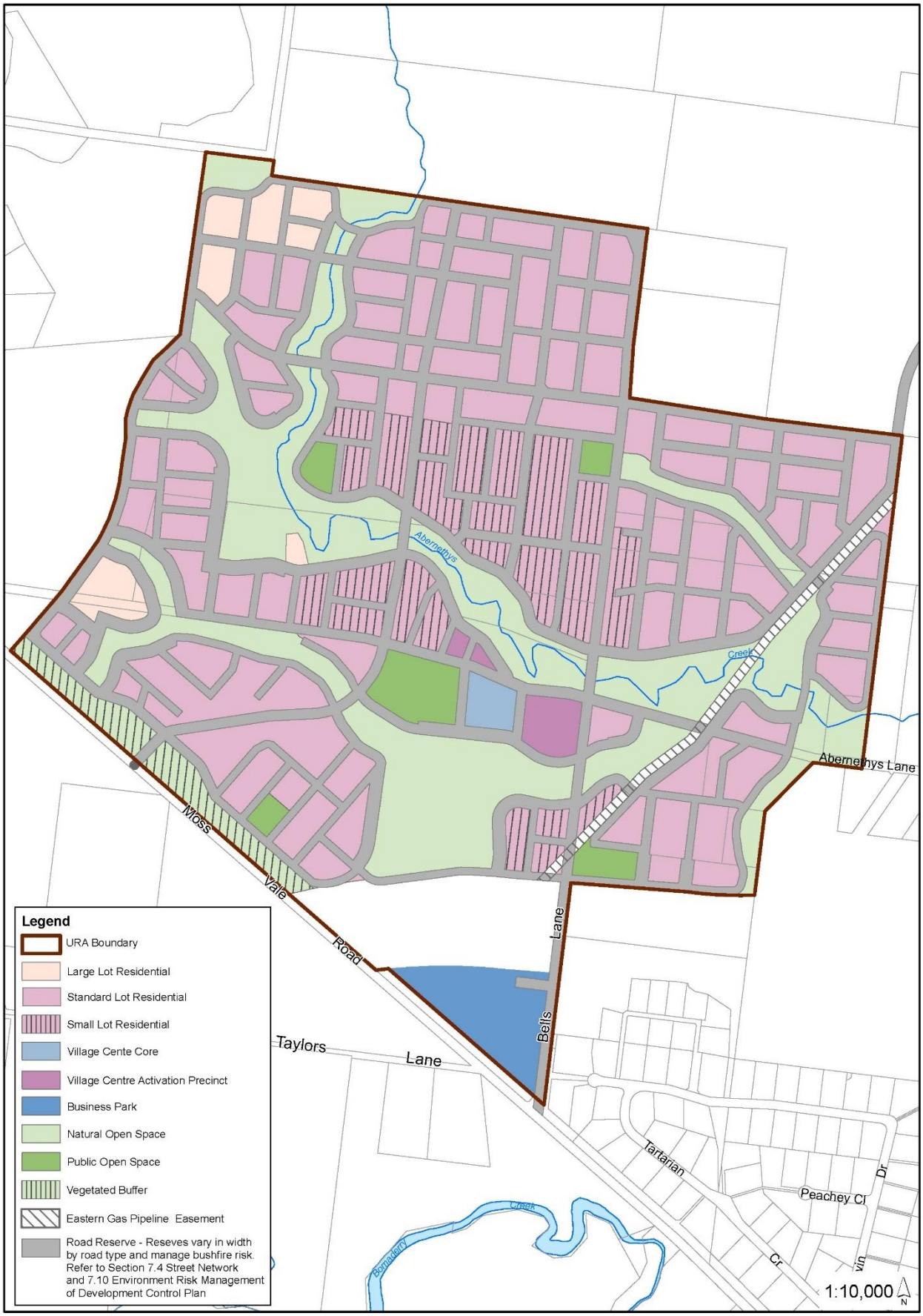

Figure 3: Draft Indicative Layout Plan (ILP) updated February 2022

2. Riparian and aquatic guidelines

2.1 Wetlands Management Policy 2010

The NSW Wetlands Management Policy (DECCW 2010) aims to provide for the protection, ecologically sustainable use and management of NSW wetlands. Wetlands include lakes, lagoons, estuaries, rivers, floodplains, swamps, bogs, billabongs, marshes, coral reefs and seagrass beds. Wetlands within the study area occur within the riparian corridor.

2.2 Water Management Act 2000

The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs. The WM Act is administered by the NRAR and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary.

The relevant objects and principles of the WM Act are set out clause 3 and 5 of the WM Act.

3 Objects

The objects of this Act are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular—

a. to apply the principles of ecologically sustainable development, and
b. to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality
c. to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:
    i. benefits to the environment
    ii. benefits to urban communities, agriculture, fisheries, industry and recreation
    iii. benefits to culture and heritage
    iv. benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water
d. to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,
e. to provide for the orderly, efficient and equitable sharing of water from water sources,
f. to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,
g. to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,
h. to encourage best practice in the management and use of water.

5 Water management principles

(2) Generally—

a. water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and
b. habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and

c. the water quality of all water sources should be protected and, wherever possible, enhanced, and
d. the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and
e. geographical and other features of Aboriginal significance should be protected, and
f. geographical and other features of major cultural, heritage or spiritual significance should be protected, and
g. the social and economic benefits to the community should be maximised, and
h. the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.

Under WM Act framework, activities and works proposed on waterfront land are regulated. These activities include:

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

The NRAR *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR 2018) outlines the need for a Vegetated Riparian Zone (VRZ) adjacent to the channel to provide a transition zone between the terrestrial environment and watercourse. This vegetated zone helps maintain and improve the ecological functions of a watercourse whilst providing habitat for terrestrial flora and fauna. The VRZ plus the channel (bed and banks of the watercourse to the highest bank) constitute the 'riparian corridor' (Figure 4). To be consistent with the guidelines, VRZ widths should be based on watercourse order as classified under the Strahler system of ordering watercourses and using Hydroline Spatial Data which is published on the department's website (Table 1).

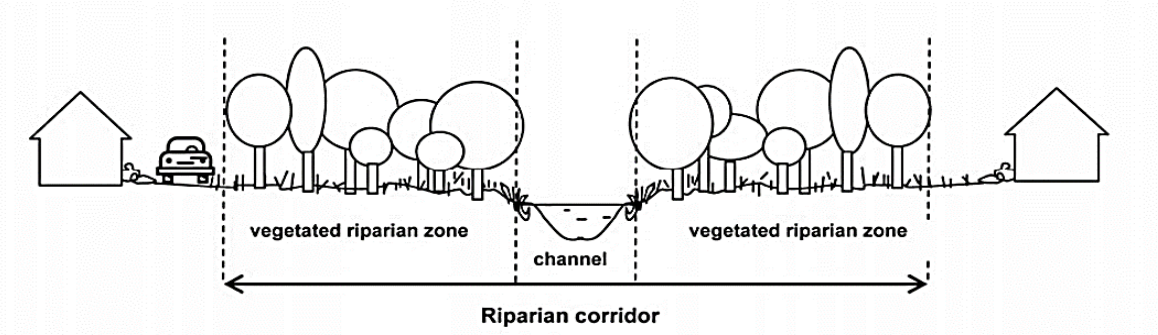

Figure 4: Vegetated riparian zone and watercourse channel comprising the riparian corridor (NRAR 2018).

Table 1: Recommended riparian corridor widths relative to Strahler stream order (NRAR 2018).

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

Certain works are permissible within the riparian zone if specific design criteria are met (Table 2 and key). Non-riparian uses in the outer 50% of the VRZ are permitted as long as compensation (1:1 offset) is achieved within the site using the 'averaging rule' (Figure 5).

Table 2: Riparian corridor (RC) matrix of permissible use with key (NRAR 2018).

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	•	•	•		•			•	•

Key to riparian corridor matrix

Stream order: The watercourse order as classified under the Strahlers based on Hydroline Spatial Data published on the Department's website[1]

Vegetated riparian zone (VRZ): The required width of the VRZ measured from the top of the high bank on each side of the watercourse.

Riparian corridor (RC) off-setting for non RC uses: Non-riparian uses, such as bushfire Asset Protection Zones, roads and urban development are allowed within the outer 50% of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 5.

Cycleways and paths: Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50% of the VRZ.

[1] https://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data

Detention basins: Detention basins can be built in the outer 50% of the VRZ or online where indicated. Online basins must:

- be dry and vegetated
- be for temporary flood detention only with no permanent water holding
- have an equivalent VRZ for the corresponding watercourse order
- not be used for water quality treatment purposes.

Stormwater outlet structures and essential services: Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings.

Stream realignment: Indicates that a watercourse may be realigned.

Road crossings: Indicates permitted road crossing methods. Also refer to DPI Fisheries policy and guidelines for fish friendly waterway crossings (Fairfull 2013, discussed below in section 2.3).

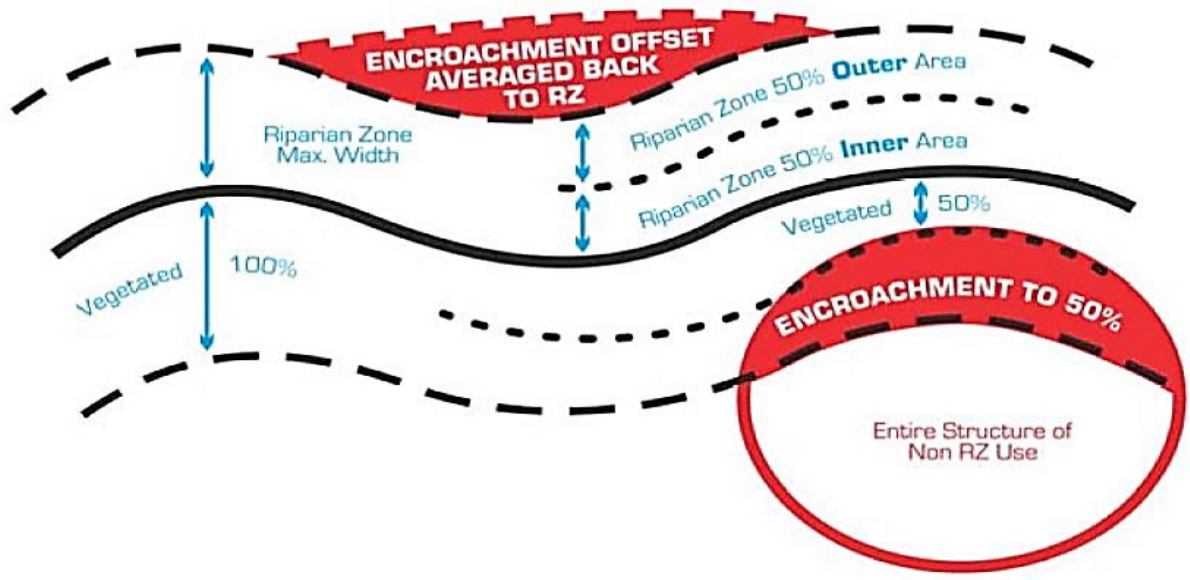

Figure 5: Riparian 'averaging rule' for offsetting encroachment into the outer 50% of the VRZ (NRAR 2018)

2.3 Policy and guidelines for fish habitat conservation and management

The *Policy and guidelines for fish habitat conservation and management* (Fairfull 2013) is a supplementary document that outlines the requirements and obligations under the FM Act and the *Fisheries Management (General) Regulation 2010* and were developed to maintain and enhance fish habitat and assist in the protection of threatened species. The Policy provides a definition of key fish habitat and provides guidance for assigning a classification of waterways for fish passage, which informs the types of infrastructure suitable for the creekline (Table 3) and sensitivity of the key fish habitat present, which determines the potential disturbance and offsetting required for development (Table 4).

Table 3: Classification of waterways for fish passage and crossing type (Fairfull 2013)

Classification	Characteristics of waterway class and preferred crossing type
CLASS 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'. Bridge, arch structure or tunnel. Bridges are preferred to arch structures.
CLASS 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pool or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present. Bridge, arch structure, culvert[1] or ford. Bridges are preferred to arch structures, box culverts and fords (in that order).
CLASS 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats. Culvert[2] or ford. Box culverts are preferred to fords and pipe culverts (in that order).
CLASS 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present). Culvert[3], causeway or ford. Culverts and fords are preferred to causeways (in that order).

[1] High priority given to the 'High Flow Design' procedures presented for the design of these culverts—refer to the "Design Considerations" section of Fairfull and Witheridge 2003.
[2] Minimum culvert design using the 'Low Flow Design' procedures; however, 'High Flow Design' and 'Medium Flow Design' should be given priority where affordable—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).
[3] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with NSW DPI.
As noted in Fairfull and Witheridge 2003, there are additional factors that must be taken into consideration by those involved in waterway crossing design and construction, including public safety, social and budgetary constraints. Each crossing is therefore assessed by NSW DPI on a case-by-case basis.

Table 4: Key fish habitat types (Fairfull 2013)

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)
TYPE 1 – Highly sensitive key fish habitat:
Posidonia australis (strapweed)
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds >5 m^2 in area
Coastal saltmarsh >5 m^2 in area
Coral communities
Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings)
Marine park, an aquatic reserve or intertidal protected area
SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia
Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants
Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
Mound springs
TYPE 2 – Moderately sensitive key fish habitat:
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds <5 m^2 in area
Mangroves
Coastal saltmarsh <5 m^2 in area
Marine macroalgae such as *Ecklonia* and *Sargassum* species
Estuarine and marine rocky reefs
Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management program)
Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area
Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1
Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 – Minimally sensitive key fish habitat may include:
Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna
Coastal and freshwater habitats not included in TYPES 1 or 2
Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

3. Methods

3.1 Literature review and desktop assessment

A review of the following studies was undertaken to identify data gaps and accuracy of information for use in defining the riparian corridor within the study area:

- Mapping of Riparian Lands (GHD 2008)
- Flood Study and Riparian Lands Concept Design and Assessment (Rhelm 2018)
- Flora and Fauna Assessment (ELA 2018) and targeted orchid surveys (in progress)
- Targeted Fauna Surveys (JB Enviro 2019)
- Planning Proposal Background Report (Allen Price & Scarratts 2019)
- Bushfire Opportunities and Constraints Advice (ELA 2021a)
- Riparian Restoration Planning (ELA 2021b).

Where gaps or inconsistencies in previous top of bank mapping occurred, linework was adjusted on ArcMap as much as practical using high resolution aerial photograph (Nearmap 14 Dec 2021) and 1 m contours (Lidar). The accuracy of digitising top of bank using a Nearmap image was tested against existing surveyed points (fence posts) along a proposed wastewater pipe supplied by SCC. ELA estimate the desktop method has an accuracy of <0.3 m in areas of no canopy, and <1 m in areas of dense canopy. Areas with dense canopy or complex topography were marked for ground-truthing, along with a subset of representative reaches to maximise accuracy.

3.2 Field inspection

Field work was conducted by Ian Dixon, Claire Wheeler, Nial Roder and James King on 17 May 2021, 15 Feb 2022 and 15 March 2022. The aim of the field work was to validate watercourses against the definition of a 'river' used in the WM Act and the NRAR riparian guidelines, and to ground-truth/adjust top of bank mapping. For watercourses that the draft ILP shows a need for realignment or complete removal, a rapid assessment of aquatic and riparian condition was used to describe the value of those watercourse. Other vegetation surveys, waterway descriptions and a riparian vegetation management strategy can be found in ELA 2018 and ELA 2021b.

3.2.1 River validation

A 'river', as termed in the WM Act, is a watercourse shown on the state hydroline map and one that has a defined bed, bank and evidence of geomorphic processes (erosion and deposition). A river may generally have some aquatic habitat features, either ephemeral or permanent, and may be discontinuous along its length. A watercourse may have portions of its length that do not display evidence of a river but if there are defining features upstream of that reach, then it must be classed as a river for its full length (as measured down from the uppermost part that has defining characteristics). Under the NRAR riparian guidelines, should a watercourse not be defined as a river, then the downstream Strahler stream order cannot be altered. That is, the Strahler stream order is a fixed calculation from the state hydroline map, regardless of whether the river exists, or has been engineered, or is proposed to be engineered (i.e. piped or filled for development).

3.2.2 Top of bank mapping

Target areas were walked and mapped using a GPS-enable tablet loaded with aerial imagery, Lidar contours and desktop mapping. Linework was adjusted based on site observations, then corrected in ArcMap following field work.

3.2.3 Habitat assessment

For reaches proposed to be removed or potentially realigned, notes on its condition were taken to describe riparian vegetation, aquatic habitat and erosion.

3.3 Riparian averaging for the ILP

Once linework was finalised, riparian buffers (VRZ widths) were applied to each stream order in accordance with the NRAR riparian guidelines (Table 1). The draft C2 zone (riparian) was then adjusted to protect existing stands of native vegetation and hollow-bearing trees, and improve habitat connectivity along or immediately adjacent to the riparian zone. The draft ILP was overlaid to review waterway crossing locations, basins and perimeter roads. The riparian boundary was then adjusted to resemble the intent of the ILP, but using the NRAR riparian guidelines to ensure protection of the inner 50% VRZ and that crossings were in suitable locations. The allocation of riparian lands also ensures there is adequate offsets available to achieve the averaging rule.

4. Results

4.1 Review of previous studies

Previous studies did not provide sufficient information to apply the riparian corridor assessment across the full study area, because they:

- did not consistently apply the definition of a river under the WM Act
- did not include all streams shown on the state hydroline map
- used an older version of the study area boundary
- used coarse top of bank mapping that was intended for flood modelling and at times did not match the geomorphic riverbank
- used rough centrelines and average channel widths for large lengths of river, rather than mapping a top of bank
- did not identify a 50% VRZ protection zone (many elements of the draft ILP were placed inside the protection zone).

ELA filled these data gaps by validating the streams, creating a new top of bank map and applying the averaging rule at a scale suitable for further design of the ILP.

4.2 River validation

The study area consists of 1st, 2nd, 3rd and 4th order streams (Figure 7). Of these, three complete 1st order streams and a significant portion of two 1st order streams did not meet the definition of a river under the WM Act. These are marked as red dotted lines in Figure 7, and do not trigger riparian offsets if they are removed. Of the streams that meet the definition of a river, there is a combined length of approximately 8 km, and a required riparian corridor area of 41.93 ha (channel width plus VRZ). Statistics per stream order are shown in Table 5 and mapped in Figure 7. See rules below for dams and unmapped tributaries.

Table 5: Length and area of existing riparian corridors

Stream order	Number	Combined length	VRZ width required on each side under the WM Act	Riparian corridor area required under the WM Act (channel width plus VRZ on each side)
1st	7	1.7 km	10 m	4.3 ha
2nd	7	3.2 km	20 m	14.31 ha
3rd	2	0.9 km	30 m	5.54 ha
4th	1	2.3 km	40 m	17.77 ha
Not a river	6 (parts)	1.2 km	NA	NA
Total River	**17**	**8 km**	**10-40 m**	**41.93 ha**

4.3 Top of bank mapping

Final top of bank mapping is shown in Figure 7. Mapping rules were applied for the whole site:

- All dams were excluded, assuming they will be dewatered, reshaped and restored as riparian vegetation or basins in the future. An indicative channel width was drawn through the likely thalweg (lowest point of a river cross section) for large dams or as a direct path through small dams.
- All drainage lines/gullies not on the state hydroline map were excluded and clipped out at their confluence with a defined river.
- Mapping extended beyond the study area boundary where those streams potentially had riparian corridors buffering into the study area. All VRZ requirements were clipped within the study area boundary.

4.4 Riparian and aquatic condition

No threatened species of fish or aquatic plants are known to occur, or expected to occur in the study area, or upstream of the study area (ELA 2018). Abernethys Creek is identified by DPI Fisheries as key fish habitat (KFH), along with its 3rd order tributary (Figure 8). The large dam on the southern 2nd order stream is also identified as KFH, but there is poor connectivity with other KFH.

The portion of Abernethys Creek that flows west to east and its 3rd order tributary (Figure 8) meet the DPI Fisheries definition of a Class 2 waterway (due to intermittent flows and freshwater habitat). The remainder of Abernethys Creek flowing north to south is meets the definition of a Class 3 waterway (due to intermittent flows and sporadic refuge, breeding or feeding areas).

Streams that met the definition of a river under the WM Act and that are proposed to be removed were in poor condition, as demonstrated by field observations and photographs in Table 6 and Figure 6: Representative photos of streams requiring alteration. They provide low aquatic and riparian value in their current state, and their loss will be offset elsewhere within the study area to provide better riparian outcomes in more important areas.

Streams, or portions of streams that do not meet the definition of a river are documented in Table 6 and Figure 6: Representative photos of streams requiring alteration. These streams were grassy depressions, some with online dams. They lacked evidence of a bed, bank or geomorphic processes (erosion and deposition). These reaches do not need to be treated as waterfront land and are suitable for engineered alternatives if necessary.

Table 6: Riparian and aquatic condition for streams requiring alteration

Reach label (Figure 8)	Stream order	WM Act status	Condition (photos in Figure 6)
1A	1st	Not a river.	**Poor condition** • Small online dam. • No defined channel downstream for at least 40 m outside of the study area.
1B	1st	Not a river.	**Poor condition** • No woody riparian vegetation.

Reach label (Figure 8)	Stream order	WM Act status	Condition (photos in Figure 6)
			• Grassy depression conveying dam spills. • No defined bed, bank, erosion or deposition. • No fish habitat except one small online dam.

1C	1st	Upper 380 m is not a river.
		Lower 200 m is a river.
			Poor condition
			• Upper 380 m is a grassy depression conveying dam spills from two small online dams, with no defined bed, bank, erosion or deposition.
			• River starts approximately 200 m upstream of confluence with Abernethys Creek.
			  ○ Sparse woody riparian vegetation, dominated by weedy understorey (*Rubus fruticosus*) and pasture.
			  ○ Defined channel typically 1-3 m wide, gentle to steep banks <1m high.
			  ○ Small disconnected pools <0.3 m deep.
			  ○ Uniformly silty, sandy substrate until midway, then some patches of exposed gravel and pebble.
			  ○ Sparse aquatic vegetation and no valuable fish habitat.

1D	1st	Not a river upstream of Bells Lane. River downstream of Bells Lane.	**Poor condition** • Upper 380 m from Bells Lane is a grassy depression with no defined bed, bank, erosion or deposition. • Downstream of Bells Lane is heavily eroded with sparse woody weeds (*Salix* sp.) and native macrophytes (*Typha orientalis*).
1E	1st	River.	**Poor condition** • Upper 50 m has no defined channel. The remainder is a river. • Sparse woody weeds (*Salix* sp.) and patches of weedy understorey (*Rubus fruticosus*) dominated by pasture grasses. • Bed vegetated, alternating between waterlogged grasses and macrophytes (*Persicara decipens* and *Typha orientalis*). • Poorly defined gentle banks <0.3 m high within wider gully. • Little to no aquatic habitat due to shallow channel and dense groundcover.
1F	1st	Not a river.	**Poor condition** • No defined bed, bank, erosion or deposition. • Mostly waterlogged pasture grasses. • No aquatic habitat. • Rubble outlet from Moss Vale Road. • No defined channel upstream of Moss Vale Road.
1G	1st	River.	**Moderate condition** • Upper 35 m proposed for removal is a small online dam. • Downstream of dam is a narrow channel through dense native forest (C2 lands), leading to a large dam.
2A	1st	River.	**Poor to moderate condition** • Narrow row of *Melaleuca styphelioides* and grazed pasture. • Channel <1 m wide with steep banks <0.4 m high. • Occasional small turbid pools <0.2 m deep. • Uniformly silty, sandy sediment. • Sparse aquatic vegetation and no fish habitat. • No connectivity to dam upstream, as overflows travel to a different stream north via large spillway.

Reach label (Figure 8)	Stream order	WM Act status	Condition (photos in Figure 6)
			• Due to changed hydrology and diversion of flows due to the dam, this reach functions more like a lowland 1st order stream.
3A	3rd	River (Abernethys Creek)	**Poor to moderate condition** Potential to straighten central 160 m upstream of powerline crossing, where the: • channel is less defined • riparian zone is disturbed from historic tree clearing and grazing • instream habitat is poor • proposed crossing will require bank stabilisation

1A Nearmap aerial photo – not a river

1B facing upstream (left) and downstream (right) – not a river

1C facing upstream (left) and downstream (right) – not a river


1C facing upstream (left) and downstream (right) – river


1D facing upstream (left) and downstream (right) – not a river


1D facing upstream (left) and downstream (right) – not a river


1E facing upstream (left) and downstream (right) – river


1E facing upstream (left) and downstream (right) – river


1F facing upstream (left) and downstream (right) – not a river

1G Nearmap aerial photo – river

2A facing upstream (left) and downstream (right) – river

3A facing across channel to east (left) and downstream (right) – river

Figure 6: Representative photos of streams requiring alteration (see Figure 8 for location)

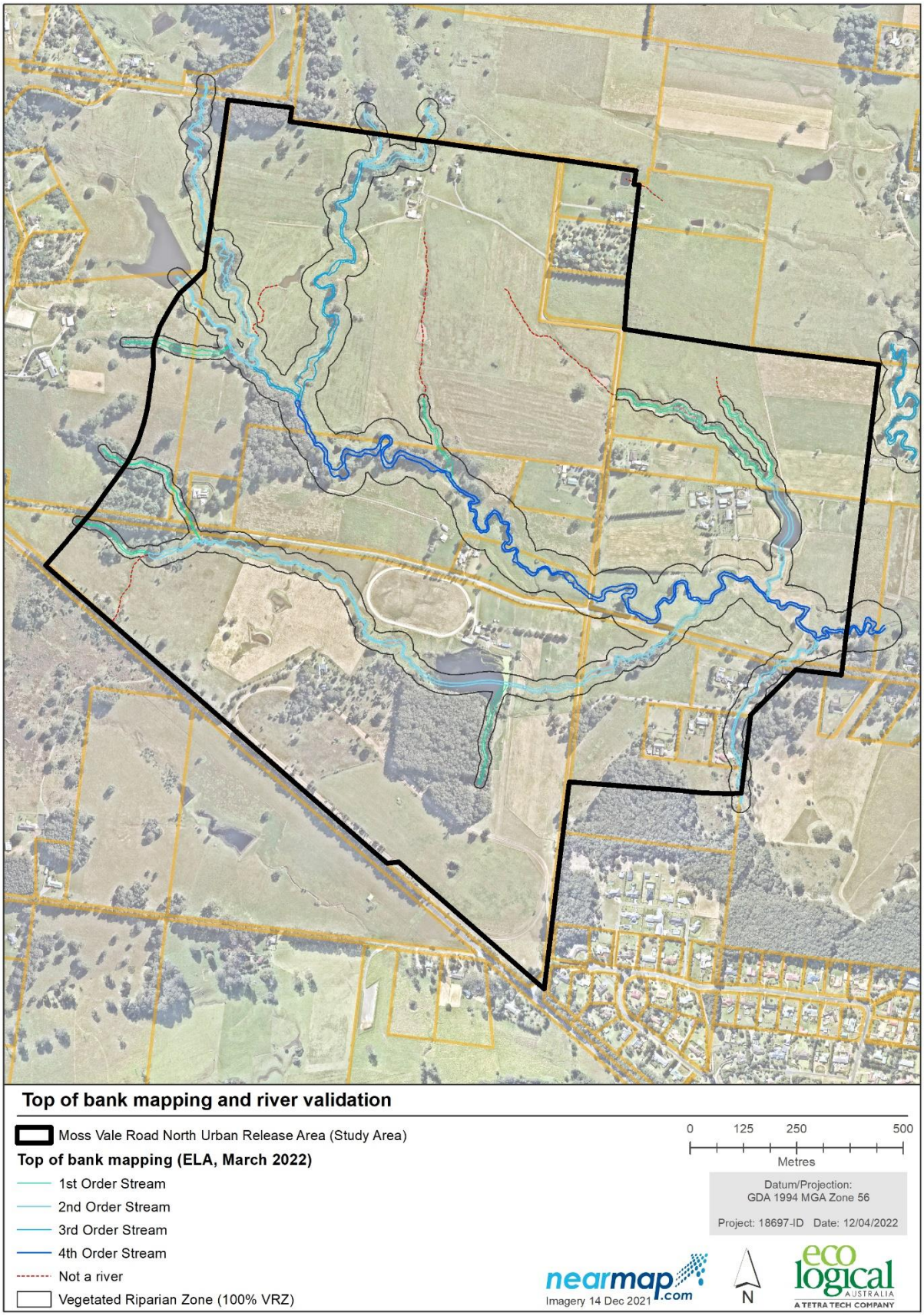

Figure 7: Updated top of bank mapping, river status and vegetated riparian zones required under NRAR riparian guidelines

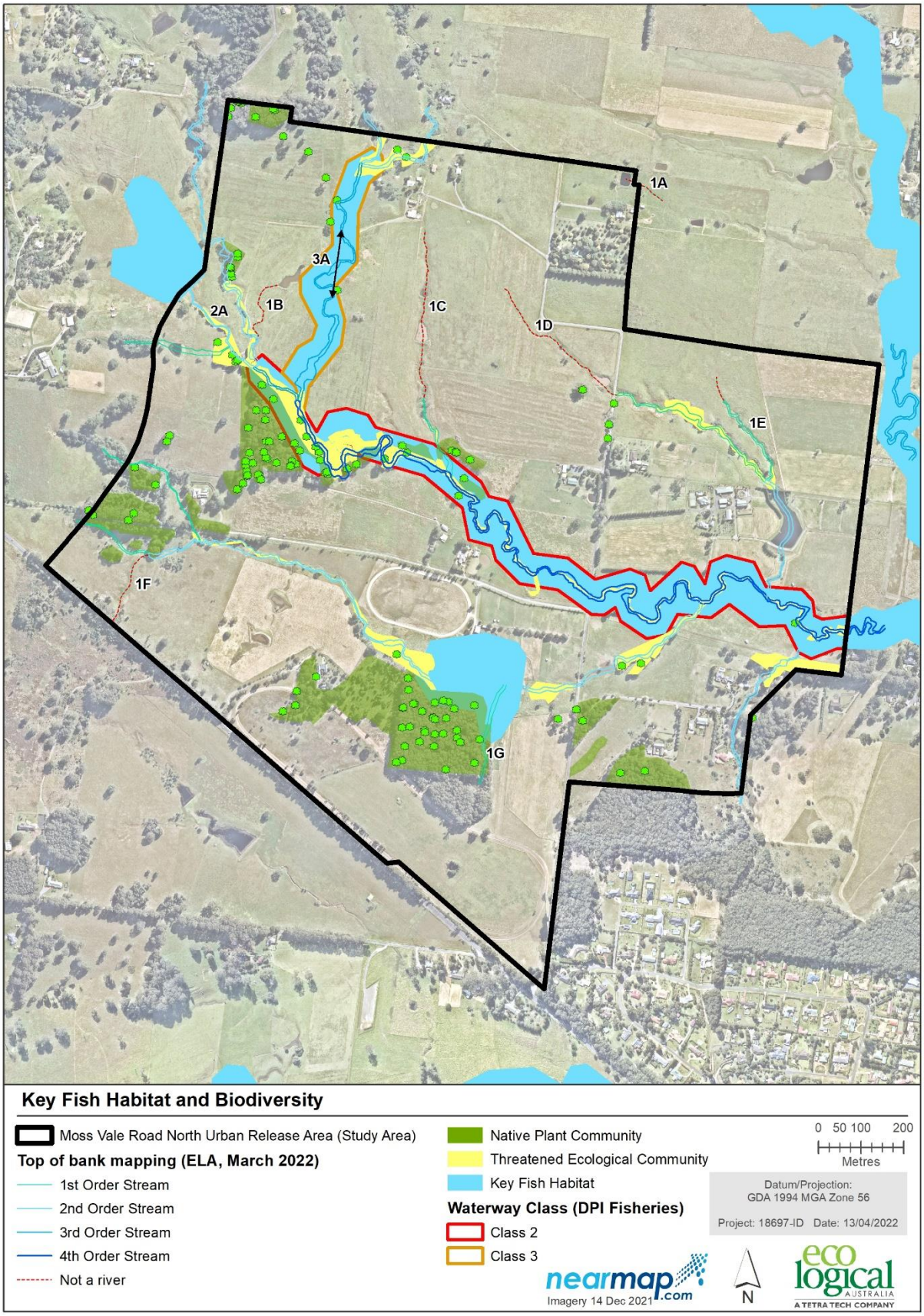

Figure 8: Key fish habitat, waterway class, plant communities and reach labels (discussed in Table 6)

5. Recommendations

Riparian averaging across the study area is possible, as there is sufficient space to offset any non-permissible uses of the riparian corridor. Offsets are to be 1:1 compensation for encroaching the VRZ, with the aim to provide an average width that meets the VRZ widths shown in Table 1. For such a large-scale urban renewal project, offsets may occur on a different watercourse within the study area. The averaging rule was applied using hectares rounded to two decimal places. Large stands of native vegetation (existing C2 zoning) that were considerable distance from a watercourse were not used as offsets.

Mapping rules were applied to meet the NRAR riparian guidelines:

- Non-permissible impacts must stay outside of the 50% VRZ and avoid stands of native riparian vegetation.
- Offsets should be located on cleared areas if possible, with the aim to restore previous disturbed riparian land, rather than offsetting overtop of vegetation protected for other purposes.
- Permissible impacts do not need offsetting, unless they do not meet the design criteria (e.g., online basins require a VRZ around them, but if this is not possible then the basin or reduced VRZ requires offsets, and concurrence from the NRAR is required).
- Watercourses not meeting the definition of a river do not need to be offset or treated as waterfront land.
- Removal of defined rivers require offsets and concurrence from the NRAR.
- Road crossing should be minimised and avoid river bends.

A recommended indicative riparian corridor is shown in Figure 9 and Figure 10, where non-permissible encroachment of the VRZ (red shading) is offset elsewhere (green shading) to adhere to the NRAR riparian averaging rule (Figure 5). Impacts and offsets in this instance are calculated in hectares to achieve a minimum 1:1 compensation. Modification to the ILP, such as resizing or repositioning stormwater basins, will likely alter the amount of offsets applied in Figure 9 and Figure 10, such as around the largest existing dam.

The riparian corridor presented in this report is conceptual, with the aim of achieving endorsement from the NRAR following public exhibition. Further design of the ILP should aim to keep within this concept and recommendations listed below. Departures may require additional review from the NRAR. Recommendations listed below are labelled on Figure 9 as example locations only, and may apply more broadly across the study area.

REALIGNMENT OF A RIVER

A – assumes waterway entering the dam is diverted to spillway if future development occurs on adjacent property.

B – potential to straighten the central bends where no riparian trees occur, from the powerline crossing to 160 m upstream. This may be tied in with road crossings if erosion is a concern.

BASINS

C – keep outside 50% VRZ for 3rd order and greater streams.

D – for online basins, include an average 20 m VRZ around them (or form an impact), avoid harm to existing wetlands and protect existing forests.

CROSSINGS – FISH - CLASS

E – Avoid placing crossings near bends and within the inner 50% VRZ of adjacent parallel streams.

F – minimise the number of crossings and position to avoid native vegetation.

G – Potential crossing, if required, instead of along western boundary.

H – Design bridge and culvert crossings to provide fauna passage beneath roads during high flows, and maximise riparian corridor width around piped culverts and causeway crossings.

I – Design crossings to be fish friendly for 3rd and 4th order streams (Abenerthys Creek and one tributary) (see Figure 8 for key fish habitat class and Table 3 for corresponding crossing design in accordance with DPI Fisheries policy and guidelines).

FOOTPATHS

J – footpaths must be <4 m wide and stay outside the 50% zone. Crossings are to be minimised and tied in with vehicle crossings unless providing an essential linkage between residential areas and services (such as shops, public transport and sporting fields).

ASSET PROTECTION ZONES (APZ)

K – APZs must be outside the proposed C2 land (riparian corridor). Where alternative designs are proposed, the APZ must be outside the 50% VRZ, preferably overlapping the road and footpath network, and offset elsewhere on site by expanding the C2 land.

POWERLINES

L – Existing powerlines may require a modified planting and maintenance type in the riparian corridor so tall trees don't obstruct lines or become a fire hazard to towers.

UNDERGROUND INFRASTRUCTURE

M – Proposed underground services (sewer and water) should be built to allow riparian planting overtop. Crossing of waterways should be tied to road crossings or under bored for 4th order or greater streams.

RIPARIAN VEGETATION

N – See recommendations in Riparian Restoration Planning – Moss Vale Road North Urban Release Area (ELA 2021b) for full site.

URBAN VEGETATION

O – The proposed Development Control Plan for the study area should consider what type of urban vegetation is permitted. Urban design should avoid using deciduous trees within 40 m of a watercourse, or in areas where excessive leaf drop cannot be contained from stormwater runoff (e.g. street trees where stormwater collects and transports leaves into a watercourse). Seasonal leaf drop can have

detrimental effects on the aquatic ecology, such as decreased dissolved oxygen due to leaf decomposition, and irregular food sources for detritivores (some water bugs) that support the aquatic food web. Garden species may become weeds in riparian corridors and their use should be discouraged.

RIPARIAN OFFSETS ON EXISTING BUSHLAND

P – A large patch of bushland (*Spotted Gum – Blackbutt shrubby open forest*) between two 1st order streams (western edge of the study area) has been identified as a riparian offset location. This area was selected for several reasons:

- To utilise an existing habitat patch that will connect to other habitat nodes across the study area via the proposed riparian corridor
- To protect and restore a large patch of native bushland in a development-constrained location (access requires two waterway crossings and potential removal of hollow-bearing trees)
- To reduce edge impacts to the riparian corridor by preventing development adjacent to 500 m of 1st order streams
- To provide offset surplus should the large online basins downstream not be able to accommodate a VRZ around them, and/or if other encroachment elsewhere is greater than mapped in Figure 9
- To compensate loss of threatened ecological communities (wetlands) mapped in Figure 8.

This vegetation patch is 2.79 ha in size (excluding the VRZs). If it was removed from the offset calculation there would be insufficient offset land (-0.06 ha) and no capacity to adjust the development footprint closer to waterways or increase online basin size. The recommended riparian corridor in Figure 9 will most likely require refinement as development design continues. Having a surplus in offset land at this conceptual stage will improve flexibility in designing the final ILP.

OTHER

Other constraints may occur on site that may affect rehabilitation of riparian corridors, such as heritage items, contaminated lands, gas pipes and other items not discussed in this report.

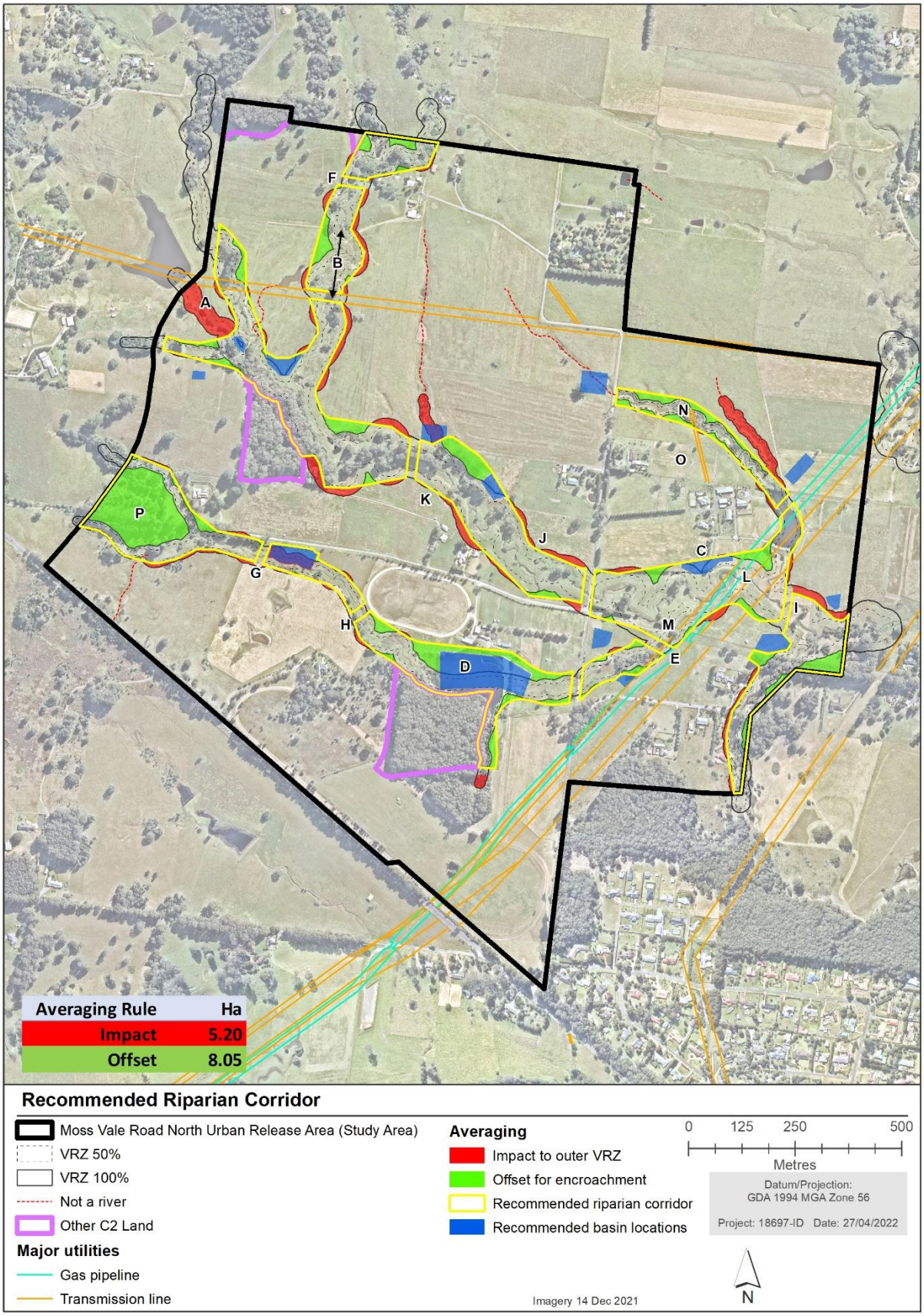

Figure 9: Recommended riparian corridor and averaging rule to meet the NRAR riparian guidelines

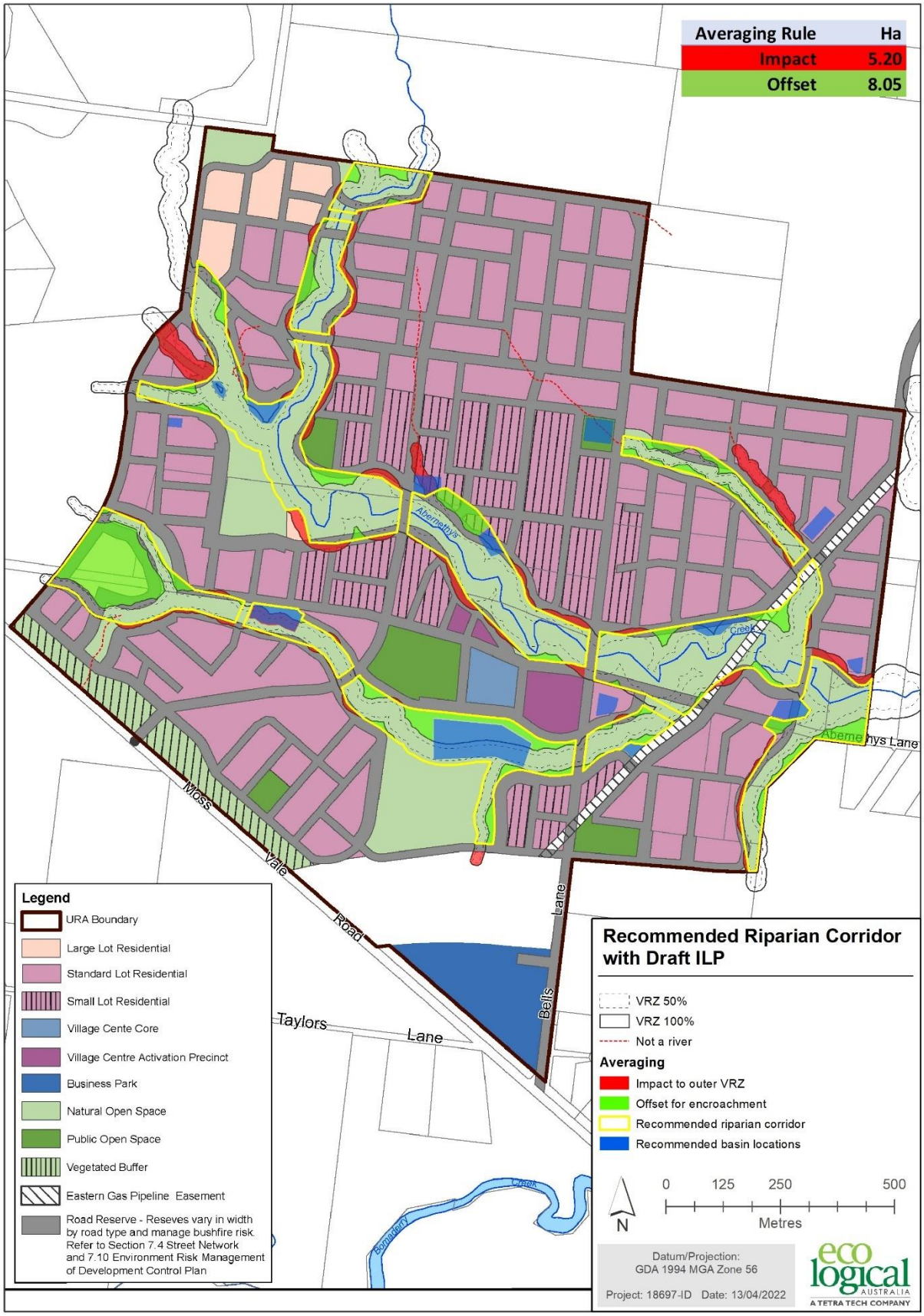

Figure 10: Recommended riparian corridor overlaid draft ILP

6. References

Allen Price & Scarratts 2019. *Planning Proposal Background Report to Support Rezoning – Moss Vale Road North Urban Release Area*.

DECCW 2010. *NSW Wetlands Policy*, NSW Department of Environment, Climate Change and Water, Sydney.

Eco Logical Australia 2018. *Flora and Fauna Assessment for Moss Vale Rd North Urban Release Area Masterplan and Development Control Plan*. Prepared for Allen Price & Scarratts Pty Ltd, 10 May 2018.

Eco Logical Australia 2021a. *Bushfire Opportunities and Constraints Advice, Indicative Layout Plan, Moss Vale Road Urban Release Area*. Prepared for Shoalhaven City Council, 17 May 2021.

Eco Logical Australia 2021b. *Riparian Restoration Planning – Moss Vale Road North Urban Release Area*. Prepared for Shoalhaven City Council, 8 February 2021.

Eco Logical Australia March 2018. *Bushfire Constraints advice for Masterplan and DCP - Moss Vale Road North Urban Release Area (MVRN URA).* Prepared for Allen Price & Scarratts Pty Ltd, 9 March 2018.

Fairfull and Witheridge 2003. *'Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings'.* DPI Fisheries.

Fairfull, S. 2013. *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update*). Available online: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/634694/Policy-and-guidelines-for-fish-habitat.pdf

GHD (2008) *Mapping of Riparian Lands*. Prepared for Shoalhaven City Council.

JB Enviro 2019. *Moss Vale Rd North Urban Release Area Masterplan and Development Control Plan – Spring -Summer Survey Results and Review of Final Concept Plan.* Prepared for Allen Price & Scarratts, 22 February 2019

Natural Resources Access Regulator (NRAR) 2018. *Guidelines for controlled activities on waterfront land – Riparian corridors*. Available online: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/156865/NRAR-Guidelines-for-controlled-activities-on-waterfront-land-Riparian-corridors.pdf

Rhelm 2018. *Moss Vale Road North Urban Land Release Flood Study and Riparian Lands Concept Design and Assessment.* Prepared for Allen Price & Scarratts, 14 December 2018

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