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Marsden Park North Precinct – Aquatic and Riparian Assessment

Marsden Park North Proponent Group (Garfield Pastoral Holdings Pty Ltd (GPH) & Leamac Property Group)

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Abbreviations

Abbreviation	Description
CAA	Controlled Activity Approval
DA	Development Application
DCCEEW (Commonwealth)	Commonwealth Department of Climate Change, Energy, the Environment and Water
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DCP	Development Control Plan
DPE	Former NSW Department of Planning and Environment (now NSW DCCEEW)
DPI – Fisheries	NSW Department of Primary Industries - Fisheries
DPIE	Former NSW Department of Planning, Industry and Environment (now NSW DCCEEW)
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM Act	NSW <i>Fisheries Management Act 1994</i>
GIS	Geographic Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
ILP	Indicative Layout Plan
KFH	Key Fish Habitat
LGA	Local Government Area
LLS	Local Land Service
NSW	New South Wales
PCT	Plant Community Type
RC	Riparian Corridor (channel plus VRZ on each side)
SEPP	State Environmental Planning Policy
TEC	Threatened Ecological Community
TOB	Top of Bank
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WM Act	NSW <i>Water Management Act 2000</i>

Executive Summary

Eco Logical Australia Pty Ltd (ELA) was engaged by the Marsden Park North Proponent Group (Garfield Pastoral Holdings and Leamac Property Group) to assess the aquatic ecology and riparian values of the Marsden Park North Precinct.

A total of 23 watercourses mapped on the *Water Management (General) Regulation 2018* 'hydroline' are present within the subject site. Field validation of these watercourses concluded four 1st order watercourses did not constitute a 'river' for the purposes of the WM Act, and all watercourses within the subject land were in poor aquatic and riparian condition with the exception of Wianamatta-South Creek and Eastern Creek, which were in moderate condition.

The proposed ILP and zoning plan shows all field-validated watercourses within the subject site are to be retained and zoned C2 Environment Conservation. Minor encroachment of the ILP into 1st and 2nd order riparian corridors can be sufficiently offset elsewhere along the riparian corridor, as per the DCCEEW riparian guidelines.

An on-line constructed wetland is proposed on Marsden Creek - a second order stream. The basin will serve water detention and water quality purposes. It will be dry and vegetated most of the time other than following rainfall. The basins / wetland will be subject to merit assessment at the DA stage.

Vegetation Management Plans will be prepared where works occur on waterfront land and submitted with relevant Development Applications.

Two watercourses within the subject site, Wianamatta-South Creek and Eastern Creek, are identified as Type 1, Class 1 key fish habitat. The proposed ILP does not impact on any key fish habitat, and no threatened aquatic species, populations or communities listed under the FM Act or EPBC Act are anticipated to be directly or indirectly impacted by the proposal. As such, the planning proposal is generally consistent with the objectives of the FM Act. Detailed assessment of impacts and of consistency with the DPI Fisheries guidelines would be determined at the DA stage.

1. Introduction

1.1. Subject site

The Marsden Park North Precinct is located within the northern portion of the North West Growth Centre (Figure 1). The precinct lies entirely within the Blacktown City Council Local Government Area.

The subject site include the following lots:

- Lot 700 in DP1215899
- Lot 11 in DP816720
- Lot 99 in DP752061
- Lot 12 in DP816720
- Lot 1 in DP715318
- Lot 115 in DP456717
- Lot 1 in DP912245
- Lot 114 in DP456717
- Lot 1 in DP572249.

Marsden Park North Precinct is one of 16 Precincts which represents part of the North West Growth Area. Marsden Park North is located off Richmond Road in the south-west, South Creek forms the north-western boundary, Eastern Creek runs along the north-eastern boundary and grazing land along the remaining boundaries.

The Precinct is currently comprised largely of rural grazing land, much of which is low lying flood prone land. Scattered patches of vegetation and larger intact tracts of native vegetation feature throughout the grazing lands. The entire subject site has a level of historical disturbance from agricultural activities and clearing of remnant vegetation. The historical disturbance has resulted in the introduction of exotic grasses, weed species and fragmentation of native vegetation patches. Nevertheless, patches of native vegetation persist across the subject site with varying levels of natural regeneration.

The subject site also includes the former Riverstone Meatworks ponds located in the north-east of the precinct (Figure 1). Although the ponds are considered an artificial habitat, they may provide occasional habitat for migratory/threatened birds listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Appendix A). More information regarding the ponds is provided in Marsden Park North Migratory Shorebird Assessment (ELA, 2025).

The subject site is situated within the Hawkesbury-Nepean catchment and contains numerous unnamed watercourses that serve primarily as tributaries to Wianamatta-South Creek and Eastern Creek, mostly via Marsden Creek that flows northward through the centre of the subject site. These middle and lower reaches of the Hawkesbury-Nepean catchment are generally highly impacted and degraded, both directly through waterway modifications and indirectly through adjacent land-use practises. The smaller watercourses, whilst degraded, vary from having well-defined bed and banks to gentle grassy depressions. The majority of waterways have been heavily impacted by grazing practises with expansive tree clearing, exotic groundcovers and unrestricted cattle access. Throughout the subject site, the watercourses have been occasionally dammed to support either domestic or agricultural water use.

The Marsden Park North Precinct subject site is shown in Figure 1 below.

1.2. Proposal

The Proponent group have prepared an Indicative Layout Plan (ILP) and zoning plan – see Figure 2 and Figure 3.

The Proponent-Initiated Planning Proposal (Planning Proposal) has been prepared by Urbis Ltd on behalf of the Marsden Park North (MPN) Proponent Group – comprising of Garfield Pastoral Holdings Pty Ltd (GPH) and Leamac Property Group (Leamac) in support of a proposed amendment to the *State Environmental Planning Policy (Precincts – Central River City) 2021* (SEPP PCRC).

The MPN Precinct was released for precinct planning under the NSW Government's Precinct Acceleration Protocol (PAP) in February 2015. This process was enabled by the execution of a Planning Agreement between the (at the time) Minister for Planning and Infrastructure and the two (2) key landowners within the Precinct identified as Angliss Estate (Garfield) Pty Ltd and MAC 1 MP Pty Ltd (the Proponent Group). This is commonly referred to as Planning Agreement No.1. At the time of preparing this Planning Proposal, Planning Agreement No. 1 is still in place and remains active.

Following extensive precinct planning investigations, the Marsden Park North draft Indicative Layout Plan (ILP) was placed on public exhibition back in September/October 2018, along with all supporting technical studies including the Biodiversity and Riparian Assessment prepared by ELA (2018).

The exhibited land use outcomes and development parameters for MPN, at that time, identified two categories of land on which future dwellings could be located. They were:

- Land generally between the 1 in 100-year Annual Exceedance Probability (AEP) flood extent and Probable Maximum Flood (PMF) levels, and
- Land generally above the Probable Maximum Flood level (circa 2,191 dwellings).

The 2018 exhibition material focused on residential land uses; however, as the preceding information will explain, a residential outcome for the Precinct was subject to extensive review following the exhibition period.

Given MPN's location within the Hawkesbury-Nepean Valley, the NSW Government's commissioning of an independent expert inquiry into the *preparation for, causes of, response to and recovery from the 2022 catastrophic flood event across the State of NSW* (the Flood Inquiry), was and is relevant to land use planning for the MPN Precinct.

Following the completion of the Flood Inquiry, the DPHI established a Flood Advisory Panel (FAP) to provide further advice to DPHI on flood risk, and whether it had been adequately addressed as part of the MPN Precinct planning process.

In July 2023, after the FAP concluded its considerations, DPHI met with the Proponent Group to advise that the FAP findings still raised concerns about the location of residential land uses below the Probable Maximum Flood level. The FAP Report was formally released in August 2023.

In considering the FAP Report and its recommendations, the DPHI in August 2023 made the decision to not proceed with the finalisation of the MPN precinct rezoning.

The DPHI made it clear that whilst it was not proceeding with the rezoning of MPN, this did not preclude future proponent-led planning proposals from being considered on their merit. Albeit any merit assessment must give close consideration to the FAP Report dated May 2023.

Importantly, the MPN Precinct still remains a 'precinct' located within the strategic context of the North West Growth Area.

Consequently, the proponent group have continued to collaborate with DPHI towards unlocking the MPN Precinct from its existing zoning and land use activities. Acknowledging that the MPN Precinct is not suitable for residential uses and the State's 'housing crisis', the proponent group commenced investigations to consider leveraging a portion of the future housing supply that will be delivered in surrounding areas by reviewing the possibility to rezone the MPN Precinct for employment-related uses.

The Proposal will deliver a precinct that:

- Permits a range of employment-related land use activities, supporting the establishment of freight and logistics uses.
- Establishes controls for appropriate employment-related development, including design and environmental considerations.
- Leverages supply and shortage of available zoned serviced employment-related land within the Sydney Metropolitan Region noting current vacancy rates of 1-2%.
- Identifies and provides a plan for the delivery of infrastructure and upgrades that are required to support future development envisaged for the precinct, whilst remaining cognisant of adjoining land to be rezoned in the future.
- Embellishes concerns in relation to land use planning within the Hawkesbury-Nepean Floodplain and does not generate a significant risk to life during emergency flood evacuation scenarios.
- Protects and embellishes significant vegetation.
- Protects Aboriginal Cultural Heritage.

The Proposal seeks to achieve the above vision by amending the SEPP PCRC and creating a new annexure that will include the site; implement precinct-specific controls and ultimately rezone the land in accordance with the proposed Structure Plan. The land use zones proposed are listed as follows:

- E3 Productivity Support
- E4 General Industrial
- RU6 Transition
- C2 Environmental Conservation
- SP2 Infrastructure (Classified Road and Drainage).

The proposed zoning plan (Figure 3) will be supported by the following additional measures that will provide protection for riparian and aquatic values on site:

- Application of controls which require consideration of any works which propose clearing within the riparian zones of South Creek-Wianamatta; Eastern Creek and Marsden Creek. which require preparation and implementation of a Vegetation Management Plan when developing or subdividing land within the C2 Environment Conservation Zone
- Application of controls which requires preparation and implementation of detailed Vegetation Management Plans for:
 - The riparian zones of Marsden Creek and tributaries
 - The on-line basin on Marsden Creek, including restoration of the broader cut areas as shown on the Indicative Layout Plan
 - The migratory bird habitat

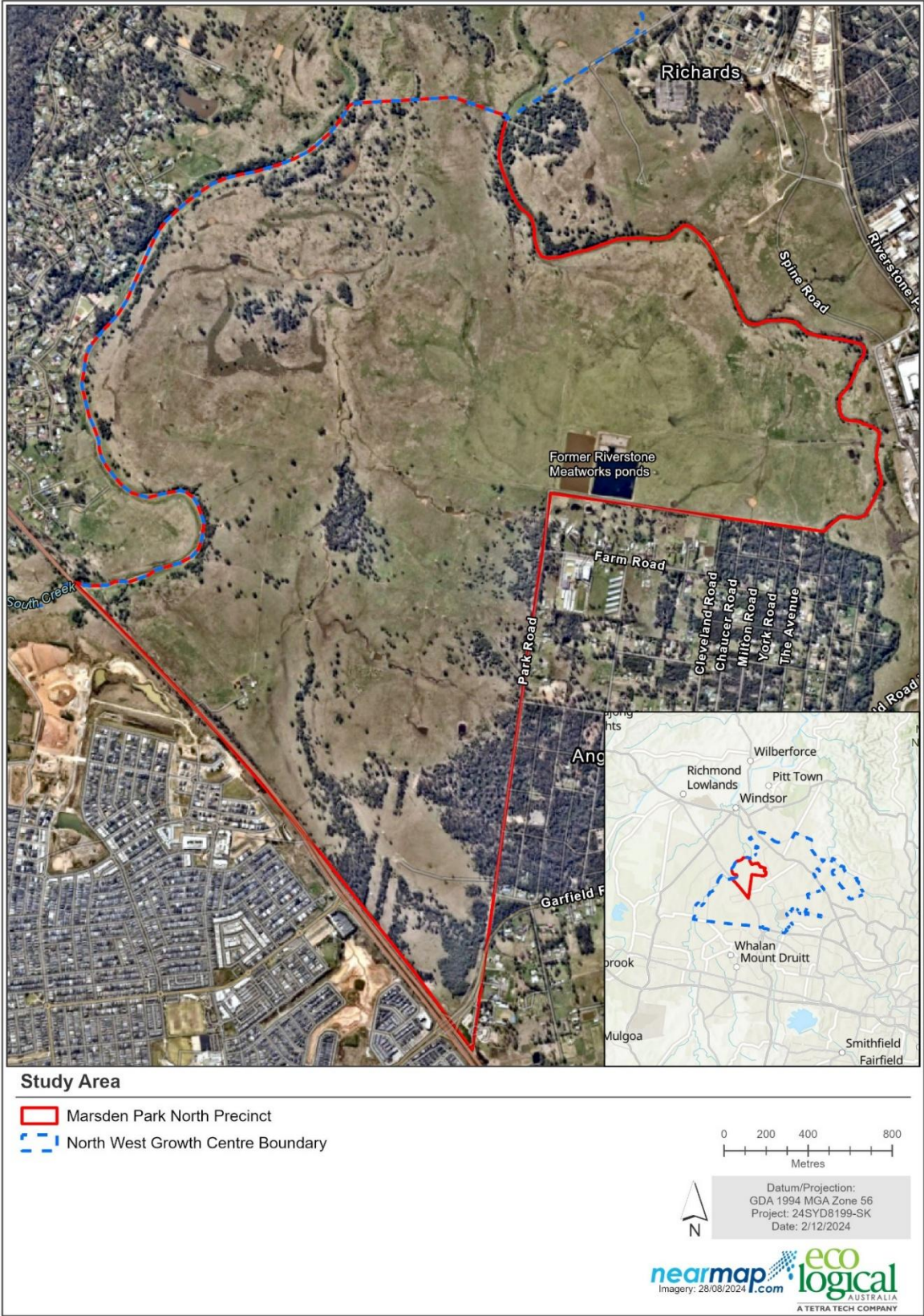
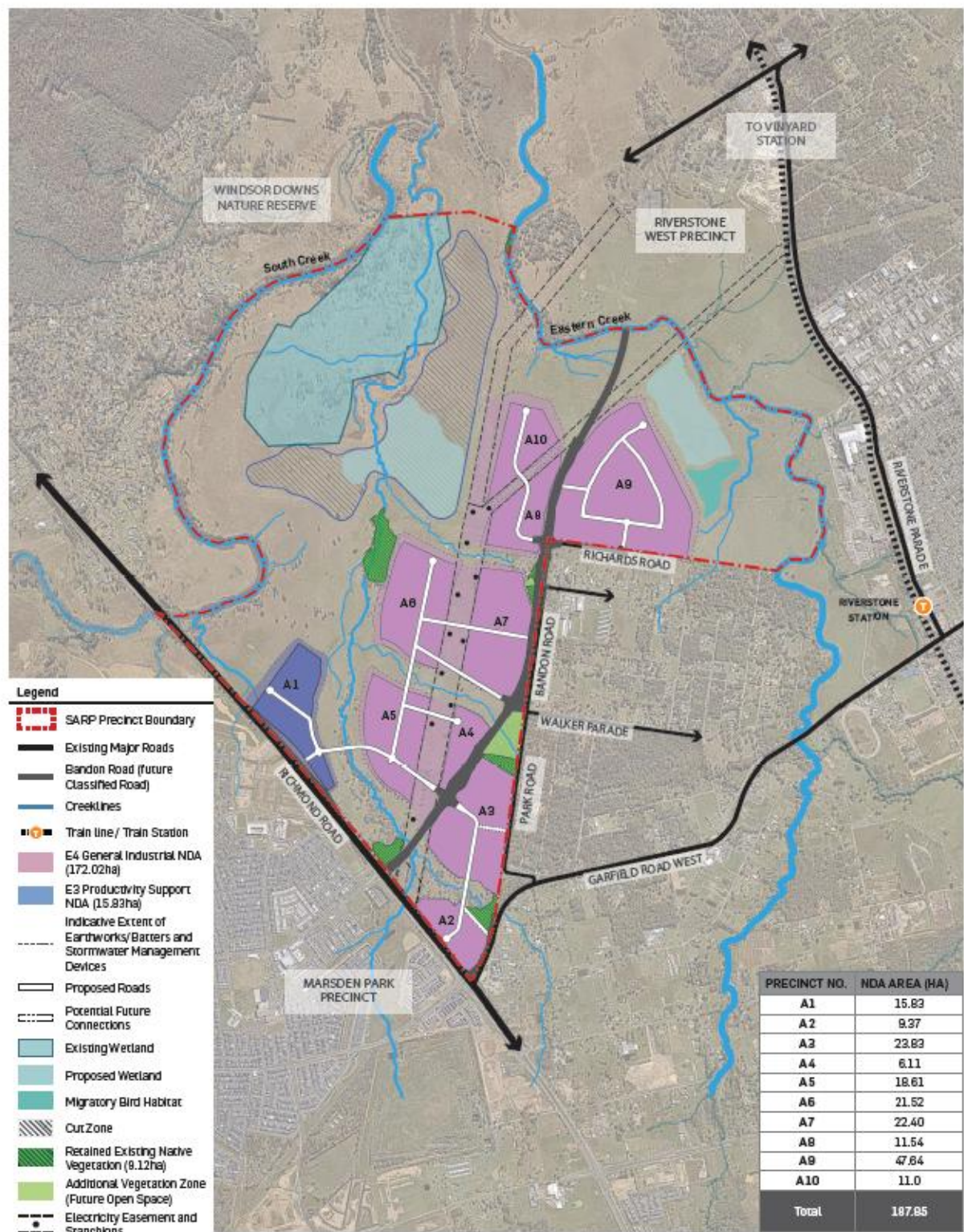


Figure 1: Subject site within the Marsden Park North Precinct



MARSDEN PARK NORTH REZONING - SARP PRECINCT
INDICATIVE LAYOUT PLAN

1:20,000 @ A3
DATE: 28.09.25
JOB NO: P0049367

Figure 2: Indicative Layout Plan

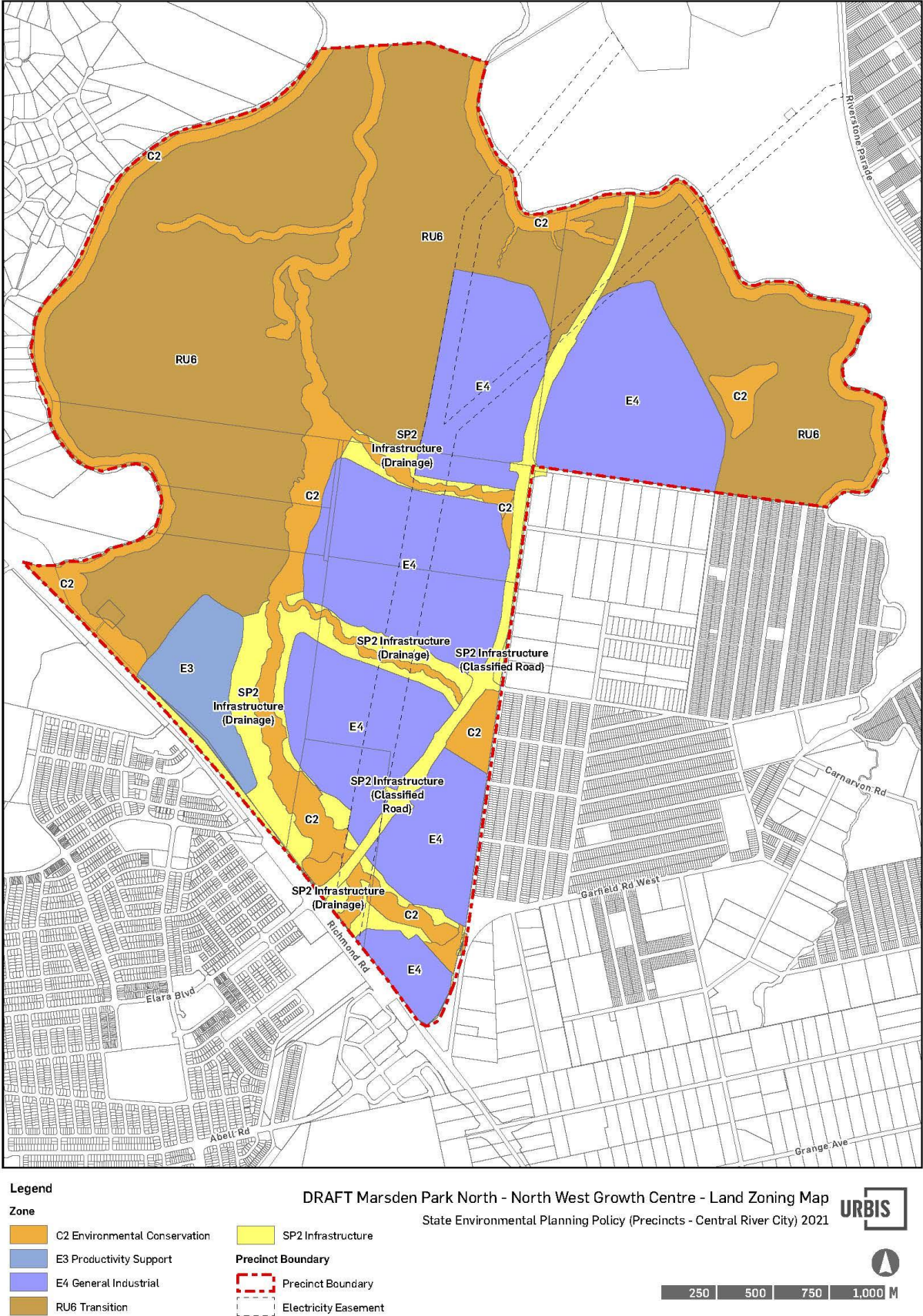


Figure 3: Proposed zoning

2. Statutory Planning Context

2.1. Overview of the legislative context

An array of legislation, policies and guidelines apply to the assessment, planning and management of biodiversity values within the Marsden Park North Precinct. This information was reviewed and used to identify priority issues and approaches for the subject site and are summarised below.

2.2. Statutory Framework

Table 1 summarises the relevant legislation and policies that apply to the subject site, which are required to be considered.

Table 1: Statutory framework and relevance to this study

Name	Relevance to the project
	State
<i>Fisheries Management Act 1994 (FM Act)</i>	The FM Act is the principal piece of legislation protecting aquatic habitat in NSW. The act aims to conserve fish stocks, key fish habitat, aquatic vegetation, and threatened species, populations and communities. Threatened aquatic species, populations and communities are listed under Schedules 4, 4A and 5 of the FM Act, while key threatening processes are listed under Schedule 6. If the proposal involves harm to aquatic habitat, then the proponent is required to demonstrate how the design and works has attempted to avoid, minimise and mitigate direct and indirect harm, plus apply the DPI Fisheries' offset policy to ensure there is no net loss of key fish habitat, as described in Section 3.3.3 of the <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (Fairfull 2013). Key fish habitat exists with the subject site along Wianamatta-South Creek along the western boundary and Eastern Creek along the eastern boundary, as mapped by DPI Fisheries. No FM listed threatened aquatic species, populations or communities are anticipated to be impacted by the proposal.
<i>Water Management Act 2000 (WM Act)</i>	The WM Act aims to protect and use NSW water in a way that is sustainable and holistic, which will help present generations without harming the ability of future generations to satisfy their needs. The NSW Department of Climate Change, Energy, the Environmental and Water (DCCEEW) – Water Group administers licencing and approvals for controlled activities on 'waterfront land', which is defined as the land 40 m from the highest bank of a river, lake or estuary published on the Department's website (Water Management (General) Regulation 2018 hydroline spatial data 1.0), known as the 'hydroline'. Apart from the exceptions stated in Schedule 4, Part 2 of the Water Management (General) Regulation 2018, controlled activities are: - 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. Waterfront land exists within 40 m of the top of bank of each watercourse mapped on the hydroline within the subject site. Development on waterfront land will require controlled activity approval (CAA) at the development application (DA) stage unless the works are exempt under the <i>Water Management (General) Regulation 2018</i> (WM Regulation). Consideration of the DCCEEW riparian guidelines in Appendix B is required by the precinct planning process.
NSW 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 subject site occur within the riparian corridor in addition to the mapped Freshwater Wetlands which are an Endangered Ecological Community under the BC Act. The subject site also

Name	Relevance to the project
	contains proximity area for coastal wetlands listed under the <i>State Environmental Planning Policy (Resilience and Hazards) 2021</i> , and wetland habitat associated with the former Riverstone Meatworks ponds is described in ELA (2018b).

Environmental Planning Instruments and Other Policies

<i>State Environmental Planning Policy (Biodiversity and Conservation) 2021</i> (Biodiversity and Conservation SEPP)	Water Catchments The development site is located within the Hawkesbury-Nepean Catchment in accordance with Chapter 6 of the Biodiversity and Conservation SEPP 2021. Therefore, general development controls under Division 2 (clauses 6.6 – 6.10) may apply at the DA stage: • Water quality and quantity – the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial, and the impact on water flow in a natural waterbody will be minimised. • Aquatic ecology – the development is to have minimal impacts, whether direct, indirect or cumulative, to adjacent and downstream waterbodies and wetlands. • Flooding – the development, if flooded, is not to release pollutants or obstruct natural flows to nearby wetlands and riverine ecosystems. • Recreation and public access – foreshore access is not to cause an adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation. • Total catchment management – the consenting authority must consult with downstream Councils before granting development consent.
<i>State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021</i>	Chapter 2 of the Resilience and Hazards SEPP 2021 aims to manage development within coastal zones and protect the environmental assets of the coast. In accordance with Section 5 of the <i>Coastal Management Act 2016</i> (CM Act), the term coastal zone is defined as any area of land that is comprised of the following coastal management areas: • Coastal wetlands and littoral rainforests • Coastal vulnerability areas • Coastal environment areas • Coastal use areas. The State Environmental Planning Policy (Resilience and Hazards) 2021 maps these four coastal zones, plus a fifth ‘Land in Proximity to Coastal Wetlands’ and provides development controls under Part 2.2. Where zones overlap, the management objectives are resolved in favour of the highest-ranked zone numbered above. The subject site contains land mapped as ‘Proximity Area for Coastal Wetlands’, ‘Coastal Use Area’, and ‘Coastal Environment Area’ in the far north of the precinct. Therefore, the development controls under Part 2.2 may apply to future development applications within this area.

3. Methods

3.1. Literature review

A review of the following data, background literature and relevant planning instruments and strategic documents was undertaken:

- Protected Matters Search Tool for threatened and migratory species, populations and ecological communities listed under the Commonwealth EPBC Act (DCCEEW 2024)
- NSW Threatened Species Profile Database (NSW DCCEEW 2024)
- NSW *Fisheries Management Act 1994*; Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fairfull 2013); key fish habitat mapping; listed protected and threatened species and populations, including species profiles; 'Primefact' publications and expected distribution maps (Riches et al 2016).
- NSW *Water Management Act 2000* and NSW DCCEEW Guidelines for controlled activities on waterfront land – Riparian corridors (DCCEEW 2025) (referred to as 'DCCEEW riparian guidelines')
- Water Management (General) Regulation Hydro Line spatial data, 1:25,000 scale
- NSW Wetlands Management Policy 2010 (DECCW 2010)
- Online Zoological Collections of Australian Museums (OZCAM) and Atlas of Living Australia (ALA) – individual species searches to determine likelihood of occurrence of threatened species
- NSW River styles database (DPE 2023)
- Bureau of Meteorology (BOM) Groundwater Dependent Ecosystem (GDE) Atlas
- Chapter 2 – Coastal Management of the State Environmental Planning Policy (Resilience and Hazards SEPP) 2021
- Chapter 6 – Hawkesbury-Nepean Catchment of the State Environmental Planning Policy (Biodiversity and Conservation SEPP) 2021
- Marsden Park North Precinct Biodiversity and Riparian Corridors Assessment (ELA 2018)
- Top of bank (TOB) mapping, estimated on ArcGIS Pro using a combination of high-resolution aerial imagery and 0.5 m LiDAR-derived contours, informed by previous top of bank mapping (ELA 2018)

3.2. Field survey

Two (2) ELA aquatic ecologists conducted field work via foot on 24 September 2024. The aim of the field work was to validate watercourses on the state hydroline map against the definition of a 'river' under the WM Act, to ground-truth/adjust desktop top of bank (TOB) mapping and conduct rapid assessment of aquatic and riparian condition.

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 DCCEEW riparian guidelines (Appendix B), 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).

Each mapped watercourse within the subject site was observed for evidence of geomorphic processes in the form of a defined channel, bed and banks. Where a watercourse met the definition of a 'river', TOB was mapped using a GPS-enabled tablet loaded with high-resolution aerial imagery, LiDAR-derived 0.5 m contours and desktop TOB mapping. TOB of online dams were included. Desktop TOB mapping and the reach naming convention was adapted from previous TOB mapping (ELA 2018).

Where the channel of a validated watercourse was punctuated by overland flow paths, an indicative TOB was drawn reflective of the existing wetted channel width. In addition, the upstream extent of watercourses outside of the subject site were validated using these methods where access was not constrained. Areas of constrained access were subject to desktop only assessment.

3.3. Riparian corridors

Following fieldwork, desktop TOB linework was adjusted based on site observation and refined in ArcGIS Pro to define the existing, field-validated TOB. A proposed TOB was produced to reflect any proposed realignment of watercourses or removal of online dams as indicated on the ILP (Figure 2). An indicative channel width was provided by the proponent, which assumes realignment of a 1st order watercourse, the removal of two online dams, and reinstatement of a channel in these locations. A 40 m waterfront land buffer and a vegetated riparian zone (VRZ) was applied to the proposed TOB based on corresponding stream order in accordance with the DCCEEW riparian guidelines presented in Appendix B, in addition to a 50% VRZ line to highlight the limit of possible encroachment with offsetting. Any encroachment of the ILP into the VRZ by non-permissible uses (Table 6) was offset along the riparian corridor within the subject site, as per the riparian averaging rule (Figure 12 in Appendix B).

4. Results

4.1. Desktop assessment

The study contains one 6th order watercourse, Wianamatta-South Creek, one 4th order watercourse, Eastern Creek, five 2nd order watercourses, one being Marsden Creek, and sixteen unnamed 1st order watercourses, forming part of the Wianamatta-South Creek sub-catchment within the Hawkesbury-Nepean catchment (Figure 4). The River Style of both Wianamatta-South Creek and Eastern Creek is a laterally unconfined, continuous channel with low sinuosity and a fine-grained bed in moderate geomorphic condition with medium priority for rehabilitation (assessed March 2020) (DPE 2023).

Key fish habitat (KFH) exists within Wianamatta-South Creek along the western subject site boundary, and along Eastern Creek to the east of the subject site (Figure 4). The DPI Fisheries spatial portal identifies Wianamatta-South Creek and Eastern Creek as having 'fair' freshwater fish community status. Approximately 10 km downstream, the Hawkesbury River has 'good' freshwater fish community status. The FM Act listed threatened species with a modelled indicative distribution (Riches et al. 2016) within or near the subject site include:

- *Archaeophya adamsi* (Adam's Emerald Dragonfly) – Endangered
- *Macquaria australasica* (Macquarie Perch) – Endangered

EPBC Act listed threatened aquatic species or aquatic species habitat with an indicative distribution within 10 km of the subject site, as identified on the PMST, include:

- *Epinephelus daemeli* (Black Rockcod) – Vulnerable
- *Macquaria australasica* (Macquarie Perch) – Endangered
- *Prototroctes maraena* (Australian Grayling) – Vulnerable

A search of the Atlas of Living Australia (ALA) database in October 2024 identified the nearest Macquarie Perch record approximately 20 km northwest of the subject site near Kurrajong. The nearest Adam's Emerald Dragonfly record is approximately 21 km east within Berowra Valley National Park. The nearest Australian Grayling records are south of Wollongong, and Black Rockcod records are coastal only. These species are unlikely to occur within the Precinct Plan area – see likelihood of occurrence of FM Act listed threatened aquatic species presented in Appendix A.

Wianamatta-South Creek and Eastern Creek are tidally influenced, up until 190 m downstream of the Richmond Road bridge, and the large old weir 2.9 km upstream from Wianamatta-South Creek confluence, respectively (Manly Hydraulics Laboratory 2006). Along these tidally influenced reaches, Wianamatta-South Creek and Eastern Creek are mapped as 'Coastal Use Area', and 'Coastal Environment Area' under the Resilience and Hazards SEPP (Figure 5). Along the northern boundary, the subject site also contains land mapped as 'Proximity Area for Coastal Wetlands' under the Resilience and Hazards SEPP (Figure 5).

A search of the BOM GDE Atlas highlights a high potential for an aquatic GDE along Wianamatta-South Creek under national assessment (Figure 6). The subject site also contains area mapped as high potential and moderate potential GDE under national assessment (Figure 7), associated with existing wetlands and vegetation.



Figure 4: Hydrological context and key fish habitat within the subject site

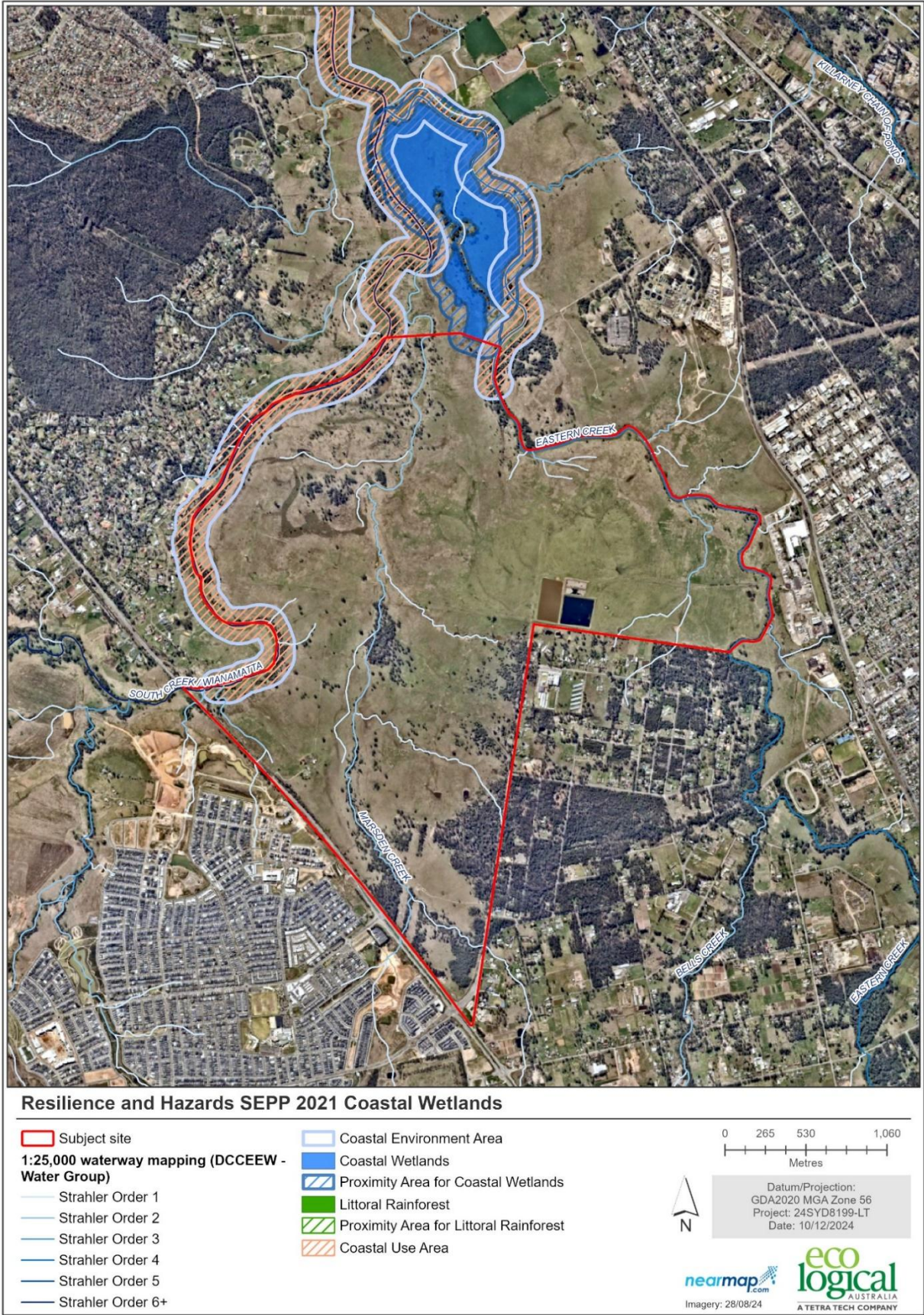


Figure 5: Resilience and Hazards SEPP wetlands

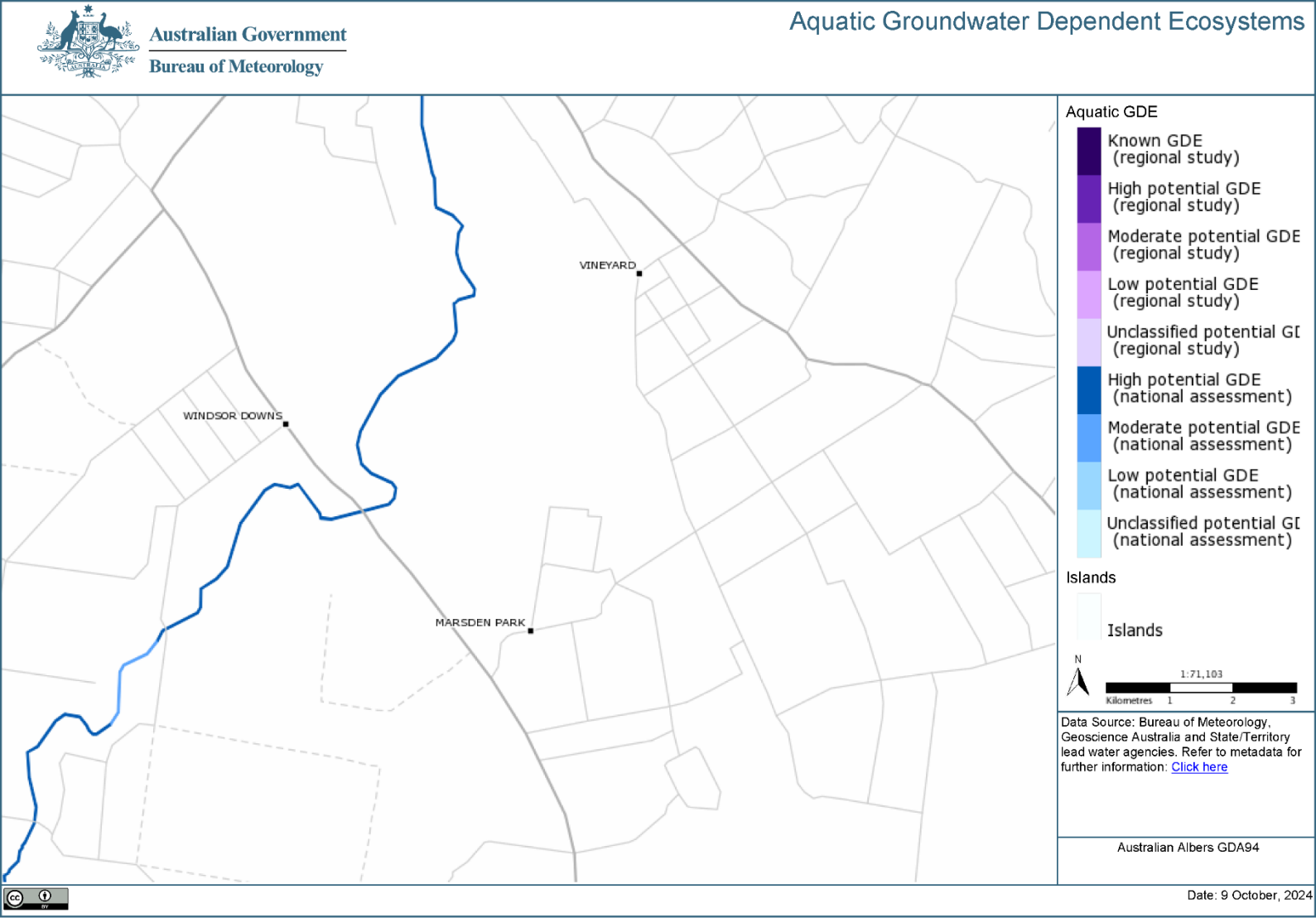


Figure 6: Aquatic groundwater dependent ecosystems within and surrounding the subject site (Bureau of Meteorology, 2024)

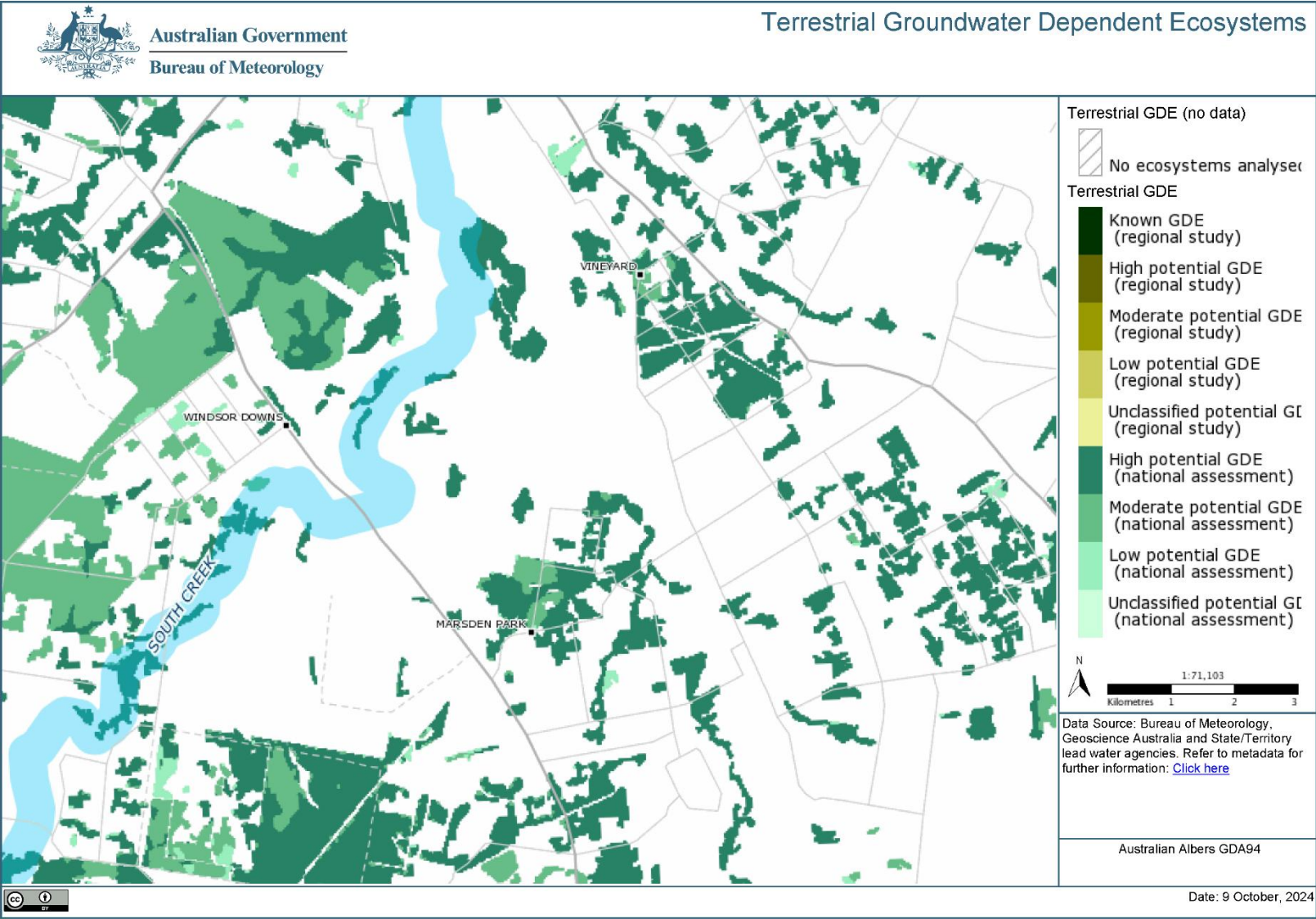


Figure 7: Terrestrial groundwater dependent ecosystems within and surrounding the subject site (Bureau of Meteorology, 2024)

4.2. River validation and top of bank mapping

Field survey concluded that four 1st order watercourses mapped on the state hydroline within the subject site, Reach O, V, X1 and X2, did not meet the definition of a 'river' for the purposes of the WM Act, as they did not exhibit geomorphic features such as a defined channel, bed and banks. Upstream portions of an additional six 1st order streams, Reach I, K, Q, R, T and W, and 2nd order stream Reach F, also did not meet the definition of a river. All field-validated watercourses within the subject land are highlighted in Figure 8. Reaches which do not meet the definition of a river do not need to be treated as waterfront land and are suitable for engineered alternatives if necessary. Reaches D, L, Q, and T had sections of their channel punctuated by overland flow paths with no clear channel, but qualified as 'rivers' where a section of the hydroline upstream had a bed, banks and signs of geomorphic processes. All other hydrolines within the subject site had generally well-defined channels or banks. A desktop-only assessment made for the upper reaches of Reach U and L outside of the subject site concluded that these reaches met the definition of a river, as defined channels could be observed from high-resolution aerial imagery.

Figure 9 highlights the top of bank and appropriate riparian corridors of validated watercourse within the subject site, accounting for the proposed realignment of Reach H and assuming online dams within Reach H and Q would be dewatered with a naturalised channel reinstated.

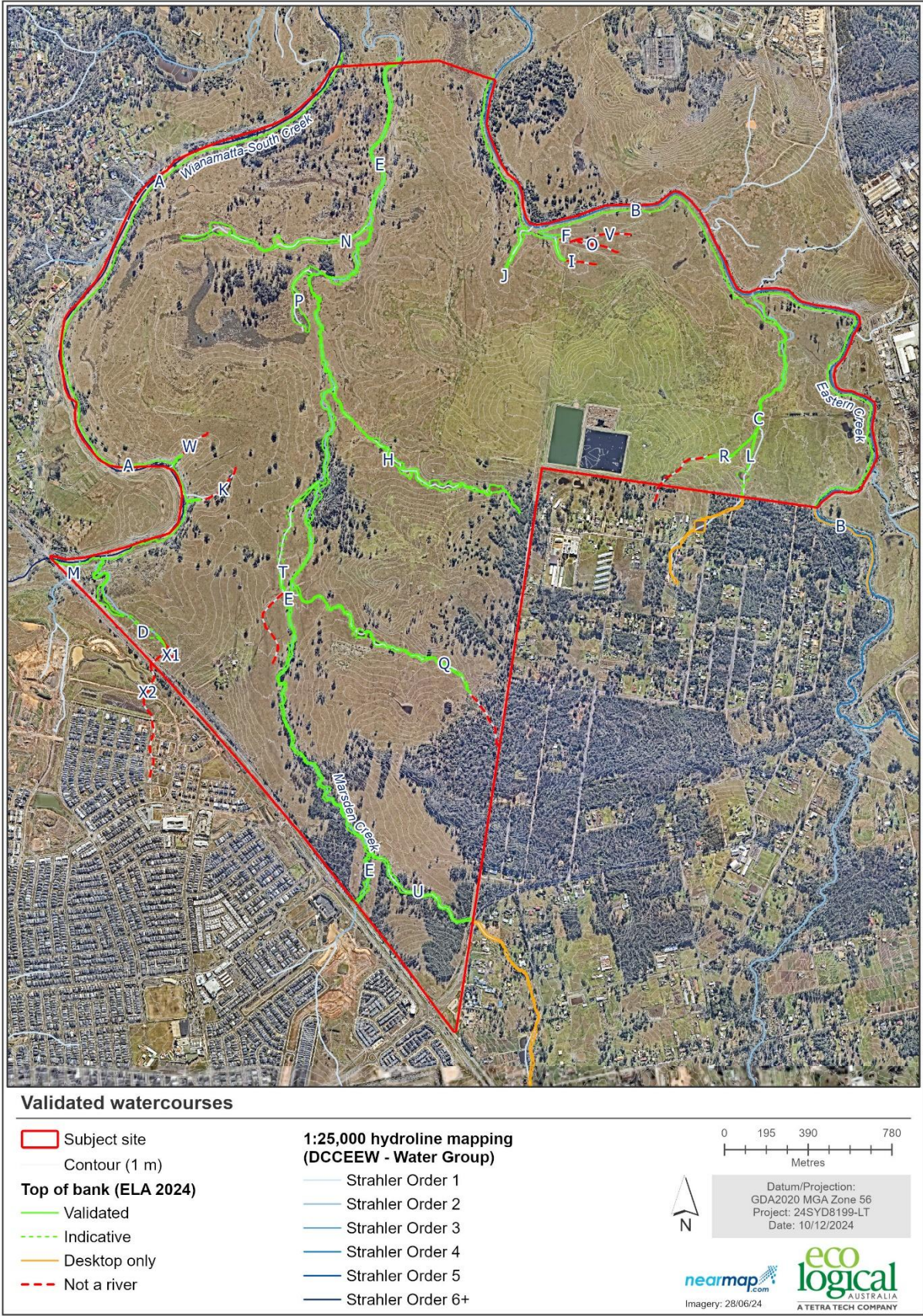


Figure 8: Field-validated watercourses and top of bank

4.3. Riparian and aquatic condition

The validated 1st order watercourses within the subject site generally present as dry, ephemeral channels in poor condition with occasional semi-permanent to permanent standing pools and minimal aquatic and riparian vegetation, as demonstrated by field observations and photographs in Appendix D. The channel and banks of Reach N and P toward the northwest of the subject site are less defined, but instead presented with moderate to dense aquatic vegetation and permanent bodies of water. Additional areas of permanent water and aquatic vegetation upstream of the hydroline within this northwest portion of the subject site exhibit features characteristic of freshwater wetland environments, as described in Marsden Park North Biodiversity Assessment (ELA 2025). 1st order watercourses which did not meet the definition of a 'river' under the WM Act are grassy depressions which lack evidence of a bed, bank or geomorphic processes (erosion and deposition) and provide negligible to no aquatic habitat values. All 1st and 2nd order watercourses within the subject site are in poor condition, owed to the lack of riparian vegetation and presence of heavily eroded banks. Eastern Creek and Wianamatta Creek are in a moderate condition, due to the presence of large woody debris and sparse to moderate canopy cover.

Overall, all validated watercourses within the subject site provide low to moderate aquatic and riparian value in their current state, presenting an opportunity for restoration and rehabilitation.

4.4. Groundwater Dependent Ecosystems (GDEs)

GDEs mapped in the subject site, highlighted in Figure 6 and Figure 7, are associated with the flood prone land, vegetation and / or associated with the drainage systems across the site. Vegetation within these locations may utilise groundwater fed base flows associated with shallower aquifers linked to Reaches A, B, E, N and P.

The dependence on groundwater varies greatly with each community and its position in the landscape. There is little available information on level of groundwater dependency of these patches of vegetation within the precinct. However, as a safeguard for precinct planning, freshwater GDEs such as streams, riparian zones and wetlands should be considered as highly dependent on groundwater, particularly during base flows.

5. Precinct Plan Assessment

5.1. Precinct Plan

The Marsden Park North Precinct Plan includes the following mechanisms for the protection of riparian and aquatic habitats:

- Retention of all existing watercourses. Minor encroachments into the riparian corridor have been offset in accordance with the Guidelines for Riparian Corridors on Waterfront Land
- Zoning of South Creek-Wianamatta, Eastern Creek and Marsden Creek as C2 Environment Conservation
- Applying additional protection clauses to riparian corridors including the Riparian zone and Native Vegetation Retention clauses.
- Requirement for a Vegetation Management Plan to be prepared and implemented when subdividing land adjoining a C2 zone (i.e. the riparian corridor).

5.2. Guidelines for Controlled Activities on waterfront land – Riparian corridors (WM Act)

Portions of the ILP is situated within waterfront land (40 m from the top of bank). Controlled activity approval (CAA) would be required for future development on waterfront land within the subject site unless the works are exempt under the WM Regulation.

The ILP will accommodate the full width of the riparian corridor for each validated watercourse within the subject site, except for areas of minor encroachment, indicated in red (Figure 10). 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 Appendix B, Table 5, as per the 'averaging rule' (Figure 12).

Areas of encroachment of the ILP into the VRZ of validated watercourses is highlighted in Figure 10, including the start of 1st order watercourses, Reach H, Q and R, and minor encroachment into the outer 50% VRZ of 2nd order watercourse, Reach E. Total riparian encroachment across the subject site equates to 0.24 ha, which would be offset within the indicative future VMP area.

Indication of proposed road crossing types would be required at the DA stage for assessment of consistency against the DCCEEW riparian guidelines. The ILP suggests future road crossings may be required over Reach Q, Reach E and Eastern Creek, which are 1st, 2nd and 4th order watercourses, respectively. Recommended crossing types as indicated by the DCCEEW riparian guidelines include a bridge or a culvert over Eastern Creek, and any road crossing type over Reach E and Reach Q. Furthermore, preparation of VMPs at the DA stage would protect and improve existing riparian and aquatic values, which would ensure future development upholds the principles and objectives of the WM Act.

2.80 ha have been identified for offsetting the above encroachments, however the area subject to the Native Vegetation Protection Area clause in the SEPP will far exceed this. 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. Modification to the planning proposal, if required, may change the encroachment and offset areas. Moreover, detailed encroachment and offset mapping would be required during a future DA process to indicate where features of designs such as batters, footpaths, or stormwater infrastructure would be located within the riparian corridor.

The Water Cycle Management Strategy (J Wyndham Prince, 2020) proposes a constructed wetland online on Marsden Creek. The wetland complies with the following elements of the Guidelines for Riparian Corridors on Waterfront Land:

- Online basins are permissible on 2nd order streams
- The wetland will be dry but will receive water following rainfall.
- The wetland is not intended to have permanent water.
- The wetland will be vegetated with native grasses. A 20m vegetated buffer will be established around the wetland.

However the basin will have a water quality function as described in the JWP (2020) report. The proposal will therefore be subject to a detailed assessment at the Development Application stage and will be require a Controlled Activity Approval under the Water Management Act.

The requirement for the preparation of a VMP is triggered through the CAA process and also via controls in the proposed SEPP amendment. The VMPs would be prepared and submitted with Development Applications for subdivision or other works in the riparian zone.

Figure 9 shows indicative future vegetation management zones. The objectives of each vegetation management zone (VMP area) varies depending on the ecological function.

- Riparian – to restore riparian vegetation along degraded waterways as per the corridor widths contained in the Guidelines for Riparian Corridors on Waterfront Land.
- Additional riparian – areas that are outside the above zone, but contain contiguous vegetation.
- Existing Native Vegetation (ENV) – to protect and manage existing native vegetation as identified in the biodiversity assessment. Several of these patches adjoin riparian corridors.
- Additional conservation – to restore areas which are contiguous with the above zones and are not zoned for urban development.
- Grazing – areas that are required for cut to generate fill elsewhere on the site. These areas will be restored to a mix of native and exotic species for the purpose of continued grazing.
- Migratory bird habitat – establishment of offline wetland habitat to provide for migratory bird.
- Stormwater Wetland – water detention and water quality controls, but planted with native vegetation which can provide additional habitat.

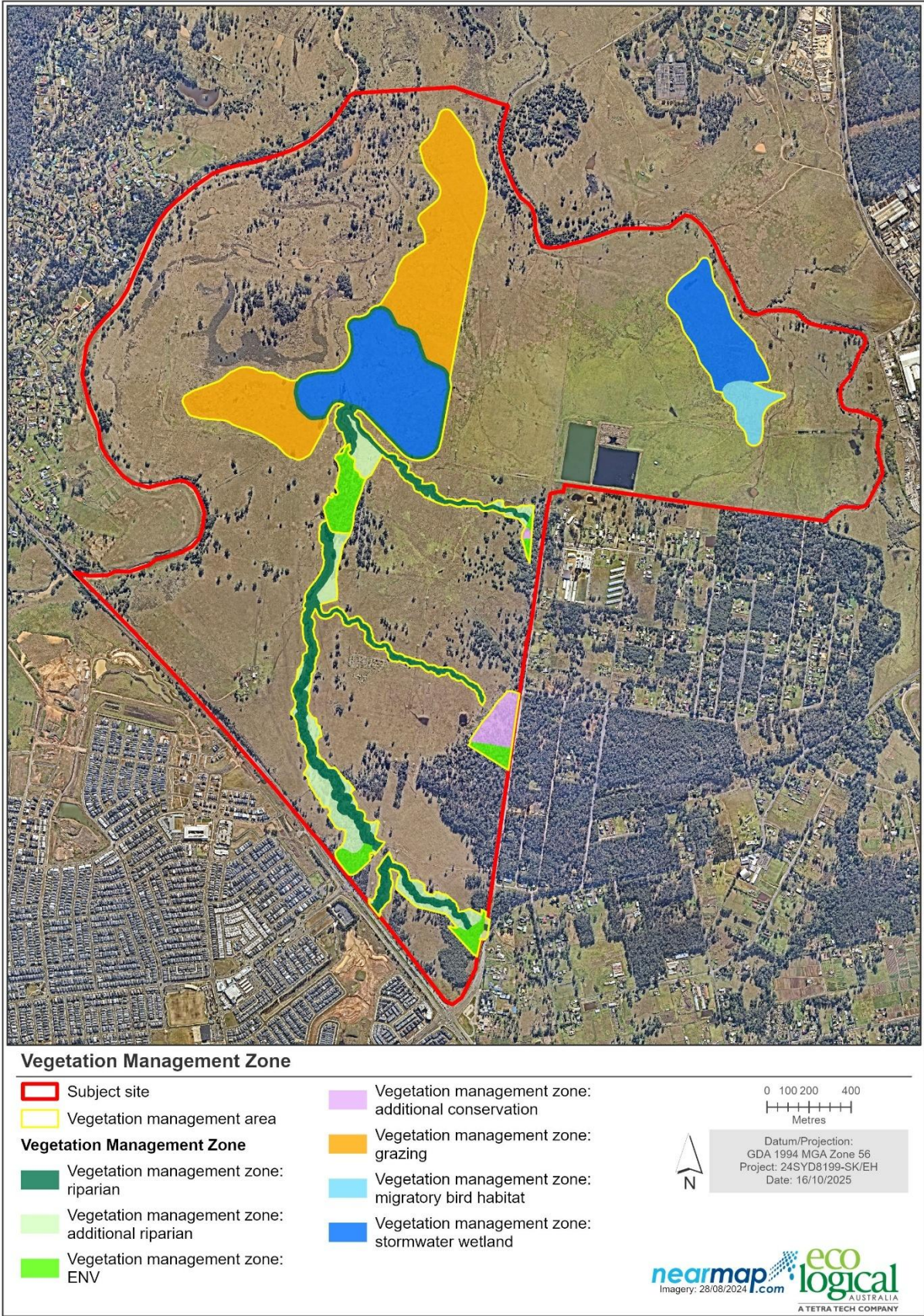


Figure 9: Indicative future VMP areas

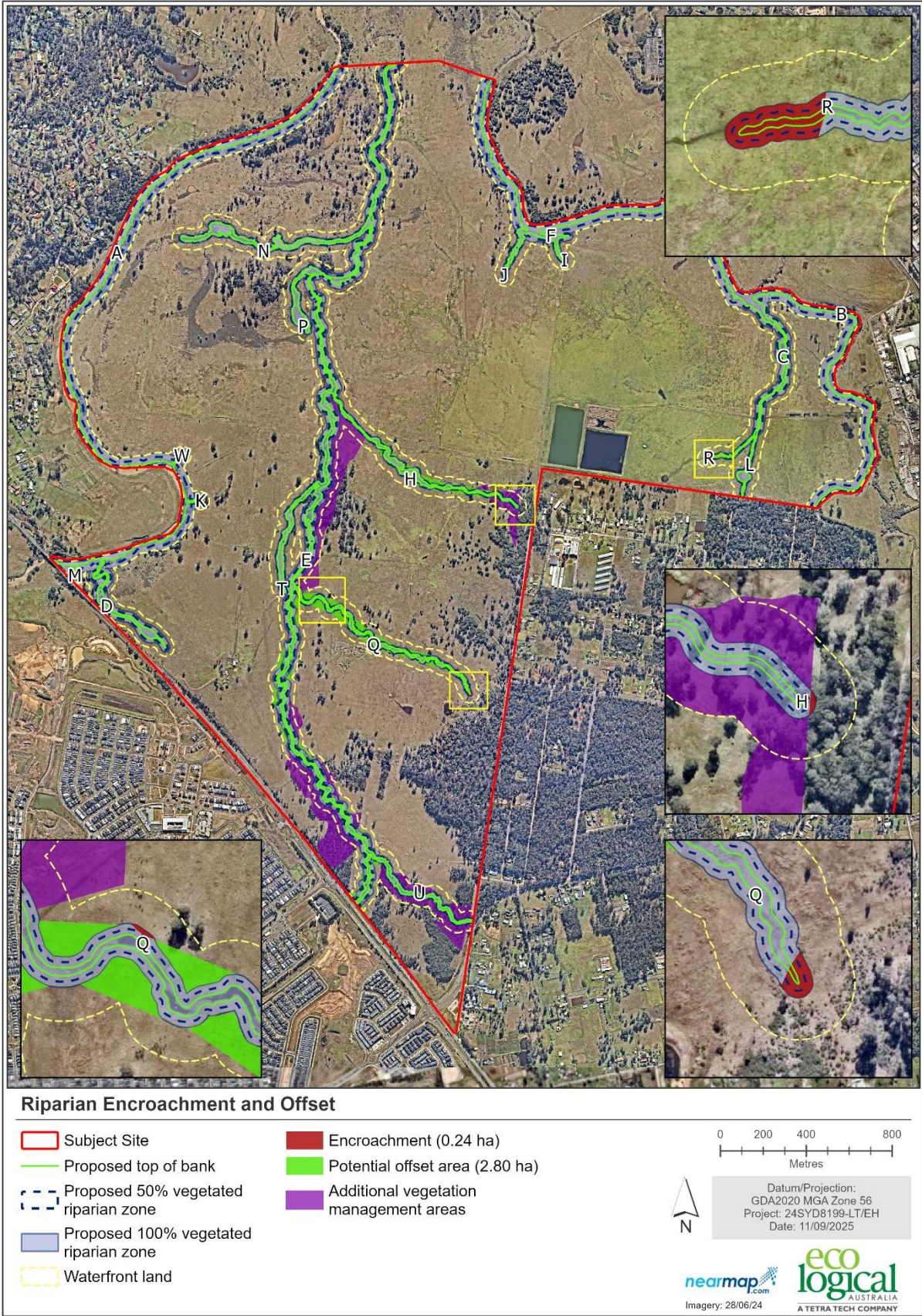


Figure 10: Encroachment of the indicative layout plan into the riparian corridor and potential areas for offsetting

5.3. DPI Fisheries policy and guidelines for fish habitat conservation (FM Act)

Key fish habitat exists within Wianamatta-South Creek and Eastern Creek, which border the subject site to the west and east, respectively. Under the DPI Fisheries guidelines (outlined in Appendix C), these two watercourses meet the criteria for *Type 1 – Highly sensitive key fish habitat* and *Class 1 – Major key fish habitat* due to the presence of large woody debris, native aquatic plants, and their permanently flowing nature. As such, the DPI Fisheries guidelines permit a bridge, arch structure or tunnel road crossing over Wianamatta-South Creek or Eastern Creek, where bridges are preferred to arch structures. The ILP indicates intention for a road crossing over Eastern Creek in northeast. Overall consistency of the road crossing with the DPI Fisheries guidelines would be determined at the DA stage, and consistency with the design considerations outlined in Fairfull and Witheridge (2003) would be determined at the detailed design stage.

The likelihood of occurrence of threatened species, populations or communities listed under the FM Act is presented in Appendix A. Adams's Emerald Dragonfly has a potential distribution spanning from south of Newcastle to south of Wollongong, extending west to the Great Dividing Range, past Lithgow (DPI 2013). However, this species prefers intact habitat with moss, abundant riparian vegetation and narrow, shaded riffle zones along small to moderate sized creeks with gravel or sandy bottoms. No such suitable riparian habitat exists within the subject site, as highlighted in Section 4.3, and the nearest ALA occurrence record is ~21 km east of the subject site. Therefore, no further assessment under the FM Act was deemed necessary for this species.

Results of the desktop assessment in Section 4.1, and riparian and aquatic condition assessment in Section 4.3 suggest the Endangered species, *Macquaria australasica* (Macquarie Perch), is unlikely to occur within the subject site. The subject site is approximately 10 km upstream of the Hawkesbury River, which has good freshwater fish community status. However, up until the confluence of the Nepean River and the Grosse River, the Hawkesbury River is tidally influenced (Manly Hydraulics Laboratory 2006) and unlikely to support non-diadromous species such as Macquarie Perch which are not known to enter brackish water. Moreover, the confluence of Wianamatta-South Creek with the Hawkesbury is a further ~19.2 km downstream of the mapped indicative distribution of Macquarie Perch, and the nearest ALA record of the species is approximately 20 km northeast of the subject site, separated by a sub-catchment drainage divide. As such, no further assessment under the FM Act for Macquarie Perch was deemed necessary.

The DPI Fisheries guidelines recommend a riparian buffer of 100 m for Type 1, Class 1 KFH. The proposal seeks to protect the riparian corridors of Wianamatta-South Creek and Eastern Creek through the application of the DCCEEW riparian guidelines. Moreover, the proposed ILP footprint does not fall within 100 m of these watercourses. Overall, the proposal is consistent with the assessment requirements under the DPI Fisheries guidelines (Table 2).

Table 2: Assessment requirements under DPI Fisheries' Policy and Guidelines for Fish Habitat Conservation

Assessment	Response	Comment
Has the proposal attempted to avoid impact to sensitive and valuable habitat, minimise unavoidable impact and mitigate severity of direct or indirect impact, offset with environmental compensation.	☒ Yes ☐ Potential ☐ No	The proposed ILP does not directly impact KFH. Consistency of proposed road crossings with the DPI Fisheries guidelines would be determined at the DA stage.

Assessment	Response	Comment
Will the proposed works directly or indirectly impact threatened species, populations or communities?	☐ Yes ☐ Potential ☒ No	No FM Act listed threatened species, populations or communities are anticipated to be impacted by the proposal. See Appendix A for their likelihood of occurrence. An assessment of potential impacts of future works would be completed at the DA stage.
Will the proposed works harm protected vegetation (seagrass, macroalgae, mangroves or saltmarsh)?	☐ Yes ☒ No	N/A -freshwater
Are the proposed works in or near critical habitat for the Grey Nurse Shark (Part 7A of FM Act)?	☐ Yes ☒ No	N/A -freshwater
Will the proposed works impact aquaculture leases or commercial fisheries?	☐ Yes ☒ No	N/A -freshwater
Are the works categorised as a key threatening process (as per Schedule 6 of the FM Act) for example: • Current shark meshing program in NSW waters • Hook and line fishing in areas important for survival of threatened fish species • Human-caused climate change • Instream structures and other mechanisms that alter the natural flow • Introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW • Introduction of fish to fresh waters within a river catchment outside their natural range • Removal of large woody debris from NSW rivers and streams • Degradation of native riparian vegetation along NSW watercourses.	☐ Yes ☒ No	No key threatening processes are proposed. Vegetated riparian zone buffers would be implemented along each validated watercourse within the subject site, as per the DCCEEW riparian guidelines (Figure 12). Preparation of a VMP at the DA stage is recommended for the rehabilitation and restoration of riparian corridors adjacent to proposed E3 and E4 zoned areas (Figure 9).
Will the works result in a 'net loss' of key fish habitat?	☐ Yes ☒ No	The proposal would not result in a net loss of KFH. Potential impacts of future works on KFH would be determined at the DA stage.
Do the works require a permit or consultation under Part 7 of the FM Act? Permits relate to: • Harming marine vegetation • Dredging and/or reclamation of bed or bank • Obstruction of fish passage • Relocation of threatened species.	☐ Yes ☐ Potential ☒ No	The requirement for a Part 7 permit would be determined at the DA stage.

5.4. State Environmental Planning Policy (Biodiversity and Conservation SEPP) 2021

An assessment under the Biodiversity and Conservation SEPP is provided below for controls on development generally (Table 3), which is applicable to development in the Hawkesbury-Nepean catchment. The controls below apply to development and do not apply to Planning Proposals such as the Marsden Park North Precinct Plan, however they are reviewed here to determine general consistency of the ILP.

Table 3: Impact assessment for Part 6.2, Division 2 - Controls on development generally

Item	Impact assessment
Clause 6.6 Water quality and quantity	<i>(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied the development ensures—</i> <i>(a) the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial.</i> The ILP accommodates for the full width of a VRZ as per the DCCEEW riparian guidelines, with minimal encroachment. Preparation of a VMP and Construction Environmental Management Plan (CEMP) at the DA stage would minimise the risk of adverse impacts to water quality from future works within the subject site. <i>(b) the impact on water flow in a natural waterbody will be minimised.</i> The ILP proposes to retain all existing validated watercourses. Moreover, a channel would be reinstated within small online dams on Reach H and Reach Q. which would restore a more natural flow regime within these reaches.

Item	Impact assessment
Clause 6.7 Aquatic ecology	<i>(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following—</i> <i>(a) the direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation will be kept to the minimum necessary for the carrying out of the development.</i> A CEMP prepared at the DA stage would include mitigation measures to ensure the proposed works would not have a direct, indirect or cumulative adverse impact on flora or fauna. Rehabilitation of the VRZ under a VMP would have a positive impact on aquatic ecology throughout the operational phase of future development, relative to the current aquatic and riparian condition of the watercourses (Section 4.3). Revegetation of the riparian corridor would increase aquatic habitat values through improved shading and bank stability, introduction of snags, increased native leaf litter as food for macroinvertebrates, and improvement of nutrient cycling and water quality. <i>(b) the development will not have a direct, indirect or cumulative adverse impact on aquatic reserves.</i> The subject site is approximately 45 km NW of the nearest aquatic reserve. Implementation of a CEMP and VMP at the DA stage would prevent potential adverse impacts on aquatic reserves downstream. <i>(c) if a controlled activity approval under the Water Management Act 2000 or a permit under the Fisheries Management Act 1994 is required in relation to the clearing of riparian vegetation—the approval or permit has been obtained.</i> Portions of the ILP fall within waterfront land. The requirement for approval or permit would be addressed as part of future integrated DAs. <i>(d) the erosion of land abutting a natural waterbody or the sedimentation of a natural waterbody will be minimised.</i> Erosion mitigation measures during construction would be addressed in a CEMP to be prepared at the DA stage. The preparation of a VMP during the DA stage would minimise sedimentation of watercourses through the operational phase, through revegetation and rehabilitation of riparian corridors. <i>(e) the adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area will be minimised.</i> As above.
Clause 6.8 Flooding	<i>(2) Development consent must not be granted to development on flood liable land in a regulated catchment unless the consent authority is satisfied the development will not—</i> <i>(a) if there is a flood, result in a release of pollutants that may have an adverse impact on the water quality of a natural waterbody.</i> To be determined at DA stage. <i>(b) have an adverse impact on the natural recession of floodwaters into wetlands and other riverine ecosystems.</i> The proposed ILP seeks to retain all existing validated watercourses within the subject land. The potential effect of the proposed wetlands on floodwater recession and wetlands downstream would be determined at the DA stage.
Clause 6.9 Recreation and public access	<i>(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following—</i> <i>(a) the development will maintain or improve public access to and from natural waterbodies for recreational purposes, including fishing, swimming and boating, without adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation.</i> Public access to the watercourses within the subject land would be improved relative to current public accessibility.

Item	Impact assessment
Clause 6.10 Total catchment management	<i>In deciding whether to grant development consent to development on land in a regulated catchment, the consent authority must consult with the council of each adjacent or downstream local government area on which the development is likely to have an adverse environmental impact.</i> This is the responsibility of council.

5.5. Resilience and Hazards SEPP requirements

The subject site contains three types of coastal management areas listed under Chapter 2 of the Resilience and Hazards SEPP. No works are proposed within the Coastal Environment Area. Consistency with the development controls for these management areas would be assessed at the DA stage where required.

5.6. Riparian management recommendations

5.6.1. Development controls in the precinct plan

It is recommended that a Riparian Protection Area Map be included within the amended SEPP to clearly identify the riparian lands to be protected.

5.6.2. Riparian ownership and management options

Where it can be achieved, riparian corridors should be in public ownership, which would increase the likelihood of achieving consistent environmental outcomes and provide integrated uses and access for the community.

An over-arching Vegetation Management Strategy should be prepared for the precinct to provide guidance for detailed Vegetation Management Plans that would be prepared at the DA stage. The Vegetation Management Strategy should identify the plant community type to be rehabilitated under the VMP.

5.6.3. Urban development principles

It is recommended that future urban development considers the provision of good quality instream habitat, longitudinal connectivity and fringing riparian vegetation. In addition, erosion and sediment control should be a key requirement during construction, and Water Sensitive Urban Design (WSUD) principles applied to help protect downstream environments.

The controlled activity guidelines do not encompass specific planning controls however they do contain objectives and a guide to works and activities generally allowable on waterfront land. The overarching objective of controlled activity provisions of the WM Act is to establish and preserve the integrity of riparian corridors. Ideally, the environmental functionality of riparian corridors should be restored and maintained by applying the following principles:

- Seek to maintain or recreate a riparian corridor / vegetated riparian zone with fully structured native vegetation in accordance with the riparian corridor requirements
- Seek to minimise disturbance and harm to the recommended riparian corridor / vegetated riparian zone

- Minimise the number of creek crossings and provide a perimeter road separating development from the riparian corridor / vegetated riparian zone
- Locate infrastructure and services outside the riparian corridor / vegetated riparian zone
- Where services or infrastructure are located within riparian corridors, co-locate facilities in one concentrated area to minimise overall disturbance and breaks in corridor continuity
- Treat stormwater runoff before discharging it into the riparian corridor

The DCCEEW riparian guidelines allow for a range of works and land uses within the outer (landward) edge of riparian corridors so long as they have minimal environmental harm (Table 6). The principles contained within the DCCEEW riparian guidelines, outlined in Appendix B, are to be considered as part of the planning proposal.

Works not associated with the establishment and maintenance of riparian corridors can be authorised within the outer riparian corridor provided that the average width of the vegetated riparian zone can be achieved over the length of the watercourse within the development site. That is, where appropriate, 50% of the outer vegetated riparian zone width may be used for non-riparian uses provided that an equivalent area is offset on site and is adequately connected to the riparian corridor vegetation. The inner 50% of the vegetated riparian zone is required to be fully protected and vegetated with native endemic riparian species and satisfy the minimum area requirements to maintain bed and bank stability. The averaging rule (Figure 12) should generally be applied to cleared waterfront land. Development proposals involving waterfront lands that contain ENV should seek to preserve the existing vegetation in accordance with the riparian corridor widths outlined in Table 6.

6. Conclusion

The ILP suggests all validated watercourses within the subject site would be retained, with only minor encroachment of 1st and 2nd order watercourses which can be sufficiently offset along the riparian corridor as per the 'averaging rule' under the DCCEEW riparian guidelines. Moreover, no threatened aquatic species, populations or communities listed under the FM Act or EPBC Act are anticipated to be directly or indirectly impacted by the proposal.

Overall, the proposed zoning is consistent with the principles and objectives of the DCCEEW riparian guidelines and DPI Fisheries guidelines. Consistency of future development with these guidelines would be determined at the DA stage. Preparation of a CEMP and VMP at the DA stage would protect and improve existing riparian and aquatic values, which would ensure future development upholds the principles and objectives of the WM Act and FM Act.

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Appendix A – Likelihood of Occurrence Assessment

The table below provides the collated results from the 10 km database searches (buffered around the study site) of the NSW BioNet Atlas and the EPBC Protected Matters Search Tool. The Atlas of Living Australia (ALA) dataset was used for threatened aquatic species, populations and communities listed under the FM Act. An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database searches. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal site, results of the field survey and professional judgement. The terms for likelihood of occurrence are defined below:

- ‘yes’ = the species was or has been observed on the site
- ‘likely’ = a medium to high probability that a species uses the site
- ‘potential’ = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- ‘unlikely’ = a very low to low probability that a species uses the site
- ‘no’ = habitat within the development footprint and in the vicinity is unsuitable for the species.

Table 4: Likelihood of occurrence for threatened fauna listed under the Fisheries Management Act.

Scientific Name	Common Name	BC Act/FM Act Status	EPBC Act Status	Distribution	Habitat	Number of BioNet records within 10 km	Likelihood of occurrence within subject site
<i>Archaeophya adamsi</i>	Adam's Emerald Dragonfly	E	-	Indicative potential distribution is from south of Newcastle to north of Shellharbour, and as far west as the Great Dividing Range. However, this species is only known from a few sites in the Greater Sydney Region, including Somersby Falls and Floods Creek in Brisbane Waters National Park near Gosford; Berowra Creek near Berowra and Hornsby; Bedford Creek in the Lower Blue Mountains; and Hungry Way Creek in Wollemi National Park.	Aquatic larvae have been found in narrow, shaded riffle zones with moss and abundant riparian vegetation (often closed canopy) in small to moderate sized creeks with gravel or sandy bottoms.	0*	Unlikely – no suitable habitat. The nearest record is approximately 21 km east within Berowra Valley National Park.
<i>Macquaria australasica</i>	Macquarie Perch	E	E	Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments.	Habitat for this species is bottom or mid-water in slow-flowing rivers with deep holes, typically in the upper reaches of forested catchments with intact riparian vegetation. Macquarie Perch also do well in some upper catchment lakes. In some parts of its range, the species is reduced to taking refuge in small pools which persist in midland-upland areas through the drier summer periods.	0*	Unlikely – nearest record approximately 20 km northwest of the subject site near Kurrajong, separated by a sub-catchment drainage divide.

Scientific Name	Common Name	BC Act/FM Act Status	EPBC Act Status	Distribution	Habitat	Number of BioNet records within 10 km	Likelihood of occurrence within subject site
<i>Prototroctes maraena</i>	Australian Grayling	E	V	Streams and rivers on the eastern and southern flanks of the Great Dividing Range; in NSW, it occurs south from the Shoalhaven River. Australian Graylings migrate between freshwater streams and the ocean and is generally accepted to be a diadromous species.	This species can be found in coastal rivers and streams, and fresh and brackish coastal lagoons. It spends only part of its lifecycle in freshwater, mainly inhabiting clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops.	0*	Unlikely - The nearest modelled distribution is south of Wollongong.

EPBC ACT: V= VULNERABLE; E= ENDANGERED, CE = CRITICALLY ENDANGERED ACT, M = MIGRATORY.

BC ACT: E1 = ENDANGERED, E2= ENDANGERED POPULATION, E4 = EXTINCT, E4A = CRITICALLY ENDANGERED, V = VULNERABLE.

*ATLAS OF LIVING AUSTRALIA (ALA) RECORDS WITHIN 10 KM

BC ACT: E1 = ENDANGERED, E2= ENDANGERED POPULATION, E4 = EXTINCT, E4A = CRITICALLY ENDANGERED, V = VULNERABLE

Appendix B – DCCEEW riparian guidelines

The Guidelines for Controlled Activities on waterfront land—Riparian corridors (DCCEEW 2025) (DCCEEW riparian guidelines) 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 11). VRZ widths are applied to each stream order, using the Strahler system of ordering watercourses calculated from the published ‘hydroline’ (Table 5).

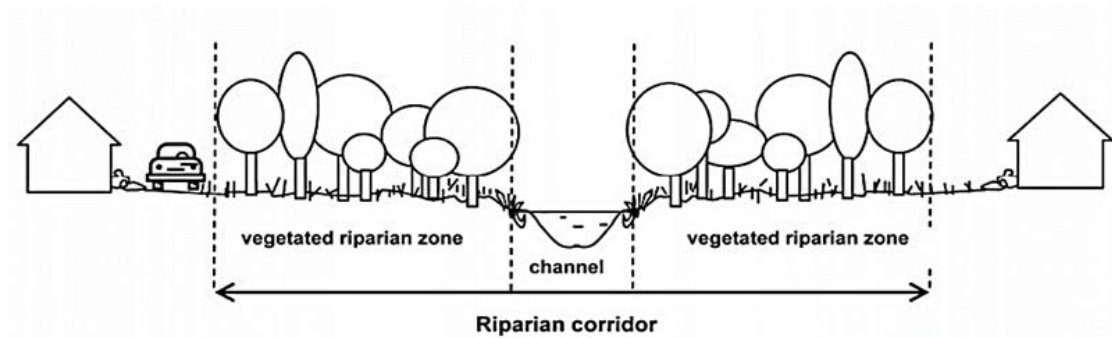


Figure 11: Vegetated riparian zone and watercourse channel comprising the riparian corridor (DCCEEW 2025)

Table 5: Recommended riparian corridor widths relative to Strahler stream order (DCCEEW 2025)

Watercourse type	VRZ width (each side of watercourse)	Total riparian corridor width
1 st order	10 m	20 m + channel width
2 nd order	20 m	40 m + channel width
3 rd order	30 m	60 m + channel width
4 th 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 6 and key below). 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 12).

Table 6: Riparian corridor (RC) matrix of permissible use (DCCEEW 2025)

Stream order	Vegetated Riparian Zone (VRZ)	RC offsetting 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
1 st	10 m	•	•	•	•	•	•	•		
2 nd	20 m	•	•	•	•	•		•		
3 rd	30 m	•	•	•		•			•	•
4 th +	40 m	•	•	•		•			•	•

Key to riparian corridor matrix

Stream order: The watercourse order as classified under the Strahler system based on Hydroline Spatial Data published on the Department's website¹ when zoomed in at a scale of 2 km or less. A stream may separate and then converge—this is called a 'braided stream'. A braided stream retains the same stream order throughout the braid, as though it were a single stream. For the riparian guidelines, stream order is fixed and is not to be altered if an upstream hydroline is not considered waterfront land.

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 12.

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

Detention basins: Detention basins can be built in the outer 50% of the VRZ or online where indicated. Offline detention basins do not need to be offset so long as there is an equivalent VRZ for the corresponding watercourse and they are built in compliance with the department's Guidelines for watercourse crossings and Guidelines for in-stream works. If a proposed basin will not have an equivalent VRZ for the corresponding watercourse, it may still be built in the outer 50% of the VRZ but must be offset. 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 in Appendix C).

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

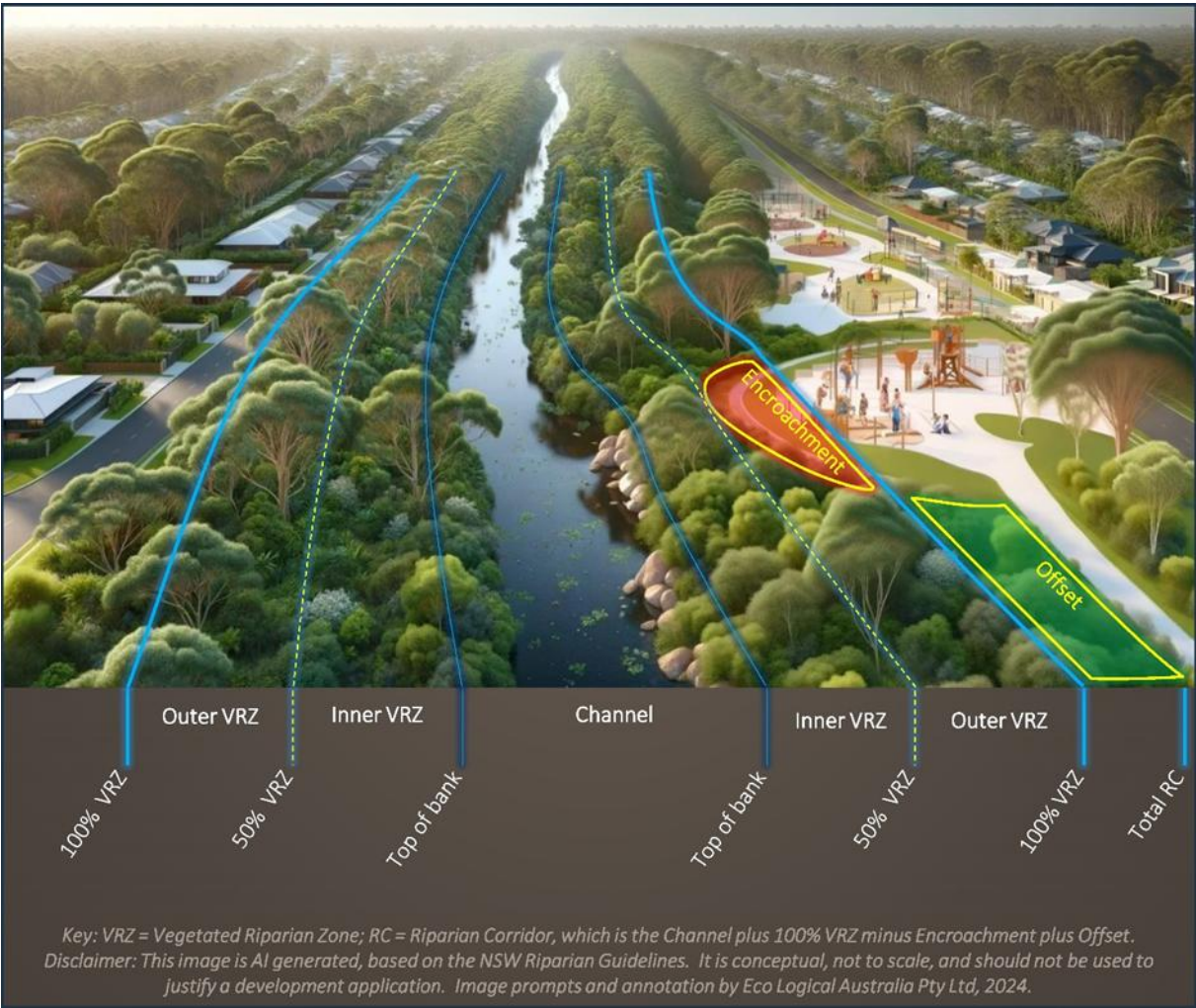


Figure 12: Riparian 'averaging rule' for offsetting encroachment into the outer 50% of the VRZ (adapted from DCCEEW 2025)

Appendix C – DPI Fisheries guidelines

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 2019, 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 waterway (Table 7) and sensitivity of the key fish habitat present, which determines the potential disturbance and offsetting required for development (Table 8).

Table 7: Classification of waterway 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).

Key to crossing type

^[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 8: 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:	
	<i>Posidonia australis</i> (strapweed)
	<i>Zostera</i> , <i>Heterozostera</i> , <i>Halophila</i> and <i>Ruppia</i> 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 (now Resilience and Hazards SEPP), 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:	
	<i>Zostera</i> , <i>Heterozostera</i> , <i>Halophila</i> and <i>Ruppia</i> species of seagrass beds <5 m ² in area
	Mangroves
	Coastal saltmarsh <5 m ² in area
	Marine macroalgae such as <i>Ecklonia</i> and <i>Sargassum</i> 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:	
	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

Appendix D – Riparian and aquatic field observations

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
A (Wianamatta-South Creek)	6 th	'River' (WM Act) Moderate condition Perennial creek with several instream woody debris and sparse aquatic vegetation. Banks are heavily degraded, with sparse canopy cover and negligible midstorey. Key fish habitat (FM Act)	 <i>Wianamatta-South Creek, facing upstream (left) and downstream (right), at the southwestern subject site boundary</i>  <i>Wianamatta-South Creek exhibiting degraded and unstable banks facing upstream (left) and downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition	Photographs
B (Eastern Creek)	4 th	'River' (WM Act) Moderate condition Perennial creek with several large woody debris. Instream aquatic vegetation and riparian vegetation sparse. Key fish habitat (FM Act)	A photograph showing a view of Eastern Creek looking upstream. The water is calm and reflects the sky. The banks are lined with green trees and grass. A photograph showing a view of Eastern Creek looking downstream. The water is calm and reflects the sky. The banks are lined with green trees and grass. <i>Eastern Creek, facing upstream (left) and downstream (right), along eastern subject site boundary</i> A photograph showing a view of Eastern Creek looking upstream. The water is calm and reflects the sky. The banks are lined with green trees and grass. A photograph showing a view of Eastern Creek looking downstream. The water is calm and reflects the sky. The banks are lined with green trees and grass. <i>Eastern Creek, facing upstream (left) and downstream (right), downstream of the confluence with Reach C along the northeastern subject site boundary</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
C	2 nd	'River' (WM Act) Poor condition Ephemeral channel ~1.5 m wide with small stagnant pools containing little to no instream aquatic vegetation, no riparian vegetation, and evidence of cattle pugging. Where banks are defined, they are generally heavily eroded. Not 'key fish habitat' (FM Act)	 <i>Stagnant pool along Reach C with a small, incised channel, facing perpendicular to flow direction (left) and downstream (right)</i>  <i>Widened channel and stagnant pools along Reach C, upstream of confluence with Eastern Creek, facing upstream (left) and downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
D	2 nd	'River' (WM Act) Poor condition Start of channelisation in the form of a bare bed and small banks indicates the start of the 'river'. In this location, no riparian vegetation is present. Channelisation is disrupted by an overland flow path dominated by grasses and rushes, before becoming more defined downstream, upstream of the confluence with Wianamatta-South Creek, where canopy cover is moderate, and dominated by <i>Melaleuca</i> sp. Not 'key fish habitat' (FM Act)	 <i>Start of the 'river' at Reach D, facing upstream (left) and downstream (right)</i> <i>Reach D facing downstream along overland flow path (left), and upstream of the confluence with Wianamatta-South Creek</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
E (Marsden Creek)	2 nd	'River' (WM Act) Poor condition Reach E traverses the site centrally from south to north, varying in aquatic and riparian condition along its length, exhibiting a mixture of low-flow channels and standing pools. Upstream (south), the channel was ~1 – 4 m wide with sparse to moderate canopy cover. Aquatic vegetation observed instream and on banks include <i>Juncus</i> sp., <i>Typha orientalis</i>, (Broad Leaved Cumbungi) and <i>Schoenoplectus validus</i> (River Clubrush). Mid-reach, some sparse native aquatic vegetation was observed, including <i>Juncus</i> sp. (Juncus), <i>Ottelia ovalifolia</i> (Swamp Lily) and <i>Schoenoplectus validus</i> (River Clubrush). A collapsed crossing creates a barrier to fish passage, and the banks are eroded and vegetated by pasture grasses. Several non-native <i>Gambusia holbrooki</i> were observed. Further downstream exhibited heavily eroded banks with cutbank erosion, a low flow channel and standing pools. Sparse aquatic vegetation including <i>Schoenoplectus</i>	 Reach E within the southern portion of the subject site, facing upstream (left) and downstream (right)  Central portion of Reach E with little to no canopy cover and minimal aquatic vegetation, facing upstream (left) and downstream (right)

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
		<i>validus</i> (River Clubrush) was observed. Not 'key fish habitat' (FM Act)	
F	2 nd	Partial 'river' (WM Act) Poor condition Predominantly dry, ephemeral channel with small, shallow stagnant pools containing pest species <i>Gambusia holbrooki</i> (Eastern Gambusia) and aquatic vegetation such as <i>Cotula coronopifolia</i> (Water Buttons). The start of the 'river' downstream of hydroline is indicated by the start of channelisation in the form of small banks and a grassy to bare bed downstream from an overland flow path. Downstream of the river start, the channel quickly widens upstream of the confluence with Reach I.	

Northern portion of Reach E at confluence with Reach N, with heavily eroded banks, facing upstream (left) and downstream (right)

Start of river at Reach F, facing upstream (left) and downstream (right)

Reach	Strahler Stream Order	WM Act status and condition	Photographs
Not 'key fish habitat' (FM Act)			
H	1 st	'River' (WM Act) Poor condition Upstream channel was 1 – 2 m wide and well defined with standing pools of water containing some small woody debris. Aquatic vegetation such as <i>Cotula coronopifolia</i> (Water Buttons) and <i>Juncus</i> sp. were observed, and canopy cover was moderate density, dominated by <i>Melaleuca</i> sp. trees. Downstream, approximately 200 m upstream of confluence with Reach E, the channel was narrow (0.5 – 1.5 m) and incised, with eroded banks dominated by pasture grasses. No canopy or midstory present. Occasional aquatic vegetation was observed, including <i>Cycnogeton procerum</i> (Water Ribbons) and <i>Juncus</i> sp. Several non-native <i>Gambusia holbrooki</i> (Eastern Gabusia) were observed. Not 'key fish habitat' (FM Act)	 Start of the 'river' at Reach H, facing upstream (left) and downstream (right)  Downstream of piped crossing, upstream of confluence with Reach E, facing upstream (left) and downstream (right)

Reach	Strahler Stream Order	WM Act status and condition description	Photographs	
I	1 st	'River' (WM Act) Poor condition Channel is wide, dry, and ephemeral with shallow, eroded banks. No riparian or aquatic habitat values present. A small incised channel containing <i>Gambusia holbrooki</i> (Eastern Gabusia) was observed. Not 'key fish habitat' (FM Act)		
			Reach I facing upstream, at the confluence with Reach F (left) and at the start of the 'river' (right)	
				
			Small incised channel containing Eastern Gambusia in Reach I facing upstream (left) and the wide, dry channel with shallow banks, facing perpendicular to flow direction (right)	

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
J	1 st	'River' (WM Act) Poor condition Predominantly dry, ephemeral channel with heavily eroded, unvegetated banks. Riparian and aquatic vegetation negligible. Cattle pugging and erosion control debris observed downstream of small bridge crossing. Not 'key fish habitat' (FM Act)	 <i>Start of the 'river' at Reach J, facing upstream (left) and downstream (right)</i>  <i>Bridge crossing and cattle pugging at Reach J, facing upstream (left) and downstream (right), with erosion control debris supporting the heavily eroded banks</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
K	1 st	Partial 'river' (WM Act) Poor condition Gully erosion downstream of online dam indicates start of the 'river'. Moderate canopy cover dominated by <i>Melaleuca</i> sp. No instream aquatic vegetation observed. Not 'key fish habitat' (FM Act)	 Start of the 'river' at Reach K, downstream of the online dam, facing upstream (left) and downstream (right)
L	1 st	'River' (WM Act) Poor condition Reach L begins upstream of the subject site boundary and enters site as an overland flow path. Downstream of the online dam, a dry channel and shallow banks were observed with instream aquatic vegetation such as <i>Eleocharis equisetina</i> (Sag), <i>Juncus</i> sp., and <i>Schoenoplectus validus</i> (River Clubrush). Not 'key fish habitat' (FM Act)	 Overland flow path upstream of online dam at Reach L, facing upstream, over subject site boundary (left) and downstream toward online dam (right)

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
			
			<i>Start of channelisation at Reach L with evidence of a bed and banks facing downstream (left), and overland flow path upstream of river start, downstream of online dam (right)</i>
M	2 nd	'River' (WM Act) Poor condition Defined channel originating from culvert under the road, with steep, eroded banks. Sparse midstorey and no canopy cover present. Some instream woody debris and aquatic vegetation present, including <i>Schoenoplectus validus</i> (River Clubrush) and <i>Cynnogeton procerum</i> (Water Ribbons). Not 'key fish habitat' (FM Act)	
			<i>Reach M facing upstream (left) and downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs	
N	1 st	'River' (WM Act) Poor condition Ephemeral channel with shallow standings of water/wetlands and instream aquatic vegetation such as <i>Juncus</i> sp. and <i>Cotula coronopifolia</i> (Water Buttons). No canopy or midstorey present. Not 'key fish habitat' (FM Act)		
			<i>Muddy channel along Reach N, facing upstream (left) and downstream (right)</i> 	
			<i>Shallow channel/wetland along Reach N, facing upstream (left) and downstream (right)</i> 	

Reach	Strahler Stream Order	WM Act status and condition	Photographs
			
Narrow channel along Reach N between online dams, facing upstream (left) and downstream (right)			
O	1 st	Not a 'river' (WM Act) Poor condition Dry overland flow path with no defined bed or banks. No riparian vegetation present. Sparse aquatic vegetation such as <i>Juncus</i> sp. present within small muddy depression, upstream of Reach F. Not 'key fish habitat' (FM Act)	
Overland flow path along Reach O, facing upstream (left) and downstream (right)			

Reach	Strahler Stream Order	WM Act status and condition description	Photographs	
P	1 st	'River' (WM Act) Poor condition Ephemeral channel with shallow standings of water/wetlands and instream aquatic vegetation such as <i>Juncus</i> sp. and <i>Cotula coronopifolia</i> (Water Buttons). No canopy or midstorey present. Not 'key fish habitat' (FM Act)		
			<i>Vegetated channel/wetland along Reach P, facing upstream (left) and downstream (right)</i> 	
			<i>Shallow wetland at Reach P, upstream of confluence with Reach E, facing upstream (left) and downstream (right)</i> 	

Reach	Strahler Stream Order	WM Act status and condition description	Photographs	
Q	1 st	'River' (WM Act) Poor condition Ephemeral, predominantly dry channel with sparse instream aquatic vegetation such as <i>Cycnogeton procerum</i> (Water Ribbons). Upstream, an eroded channel with shallow banks indicates the start of the 'river'. Reach Q alternates between overland flow paths and defined channels with a bed and banks along its length. No riparian canopy or midstorey present. The aquatic weed <i>Juncus acutus</i> was observed. Not 'key fish habitat' (FM Act)		
			<i>Start of the 'river' at reach Q, facing upstream (left) and downstream (right)</i>	
				
			<i>Overland flow path facing upstream (left) which flows into a defined channel, facing downstream (right)</i>	

Reach	Strahler Stream Order	WM Act status and condition	Photographs
			
		<i>Predominantly dry channel with Cycnogeton procerum (Water Ribbons) upstream of confluence with Marsden Creek, facing upstream (left) and downstream (right)</i>	
R	1 st	Partial 'river' (WM Act) Poor condition Upstream portion of Reach R presented as an overland flow path with no defined bed or banks. Channelisation begins approximately 400 m downstream of the online dam, with defined banks and instream sedges present, including <i>Juncus</i> sp. Not 'key fish habitat' (FM Act)	
		<i>Overland flow path upstream of the online dam, with no defined bed or banks</i>	

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
			
			<i>Start of the river, defined bed and banks with sedges, approximately 400 m downstream of online dam</i>
T	1 st	Partial 'river' (WM Act) Poor condition At the river start, the channel was dry and narrow (~0.5 m), then flows into a wider, muddy overland flow path dominated by sedges such as <i>Juncus</i> sp, with small depressions which would be inundated during periods of high rainfall. Upstream of this location, the hydroline was characteristic of an overland flow path. Not 'key fish habitat' (FM Act)	
			<i>Start of the river facing upstream (left) and downstream, and overland flow path downstream of this location toward confluence with Reach E, facing downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
U	1 st	'River' (WM Act) Poor condition Defined channel and bed with sparse to moderate canopy cover and heavily eroded banks. Instream woody debris and sparse instream aquatic vegetation observed. Not 'key fish habitat' (FM Act)	 <i>Reach U facing upstream (left) and downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
V	1 st	Not a 'river' (WM Act) Poor condition No defined bed, banks or channel. Some <i>Juncus</i> sp. observed in a small wet standing. Not 'key fish habitat' (FM Act)	 Reach V facing upstream toward small wet standing

Reach	Strahler Stream Order	WM Act status and condition description	Photographs
W	1 st	Partial 'river' (WM Act) Poor condition Defined channel, bed and banks. Beginning of 'river' identified by start of gully erosion, downstream of hydroline start. Not 'key fish habitat' (FM Act)	 <i>Start of the 'river' at Reach W, facing upstream (left) and downstream (right)</i>
X1	1 st	Not a 'river' (WM Act) Poor condition No defined channel, bed or banks. This reach likely acts as an overland flow path during periods of high rainfall. Not 'key fish habitat' (FM Act)	 <i>Reach X1, facing upstream (left) and downstream (right)</i>

Reach	Strahler Stream Order	WM Act status and condition	Photographs
X2	1 st	Not a 'river' (WM Act) Poor condition No defined channel, bed or banks. This reach likely acts as an overland flow path during periods of high rainfall. Not 'key fish habitat' (FM Act)	 <i>Reach X2, facing upstream toward road(left) and downstream (right)</i>

