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NEWCASTLE SYDNEY

Aquatic Ecology Report

898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW

Prepared for: Lochinvar Developments Pty Ltd

C/- ADW Johnson Pty Ltd

AEP Ref: 2699.05

Revision: 01

July 2024

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Document Control

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Project Number	2699.05
Client Name	Lochinvar Developments Pty Ltd
AEP Project Team	Brendon Young Jarod Baxter Natalie Black

Revision

Revision	Date	Author	Reviewed	Approved
00	26/06/2024	Brendon Young	Natalie Black	Natalie Black
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Distribution

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00	26/06/2024	Mathew London	ADW Johnson Pty Ltd
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EXECUTIVE SUMMARY

Anderson Environment & Planning (AEP) has been requested by Lochinvar Developments Pty Ltd (the client) to undertake field investigations and reporting to prepare an Aquatic Ecology Report (AER) for submission with a Dredge and Reclamation permit application to the NSW Department of Primary Industries – Fisheries (DPI Fisheries) under Part 7 of the *Fisheries Management Act 1994* (FM Act). The proposed works on water land will include a residential subdivision and stream re-alignment, and associated infrastructure.

An Aquatic Habitat Survey was undertaken and the data was used to inform the assessment of both direct and indirect impacts of the proposal in accordance with NSW Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013).*

Assessment of the water land at the location of the stream realignment resulted in the following key findings:

- The Subject Site is mapped by NSW Hydroline Spatial Data 1.0 as a 2nd and 3rd order stream; however, assessment of the reach determined a 1st order stream is present due to the impacts of urban development within the catchment.
- A creek and riparian corridor in a degraded condition dominated by exotic aquatic vegetation and limited native riparian vegetation used for fish habitat.
- No threatened species listed under the FM Act were identified within the proposed area of works.

This data was used to inform the assessment for both the direct and indirect impacts associated with the development of a proposed subdivision, including stream realignment. This assessment showed that the proposed realignment will have a direct impact to water land during construction only by diverting flow and reducing the limited habitat. Post construction there will be no direct impacts as the proposed regeneration works and adjoining Biodiversity Management Plan (BMP) are likely to significantly improve the water quality, flows, availability of fish habitat, and riparian and instream vegetation. Rehabilitation under the proposed BMP focuses on achieving a naturally regenerating ecosystem through construction of important Key Fish Habitat features such as refuge pools, meanders and riffles. The removal of weeds and plantings of native vegetation, removal of instream obstructions to fish passage and the installation of instream snags will assist in improving the habitat for both native terrestrial and aquatic flora and fauna.

The construction of the natural channel design is proposed to be undertaken when the waterway is under stagnant conditions, however a sudden flow of the creek may require a temporary diversion channel be put in place as a contingency to allow natural water movement.

All proposed works have been assessed in accordance with the relevant requirements of the *Fisheries Management Act 1994* (FM Act), *Fisheries Management (general) Regulation 2019* and DPI Fisheries polices and guidelines.

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List of Acronyms

AER	Aquatic Ecology Report
AHS	Aquatic Habitat Survey
API	Aerial Photography Interpretation
BC Act	*Biodiversity Conservation Act 2016*
BMP	Biodiversity Management Plan
CAA	Controlled Activity Approval
CEMP	Construction Environmental Management Plan
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DCP	Development Control Plan
DPE	NSW Department of Planning and Environment
DPI Fisheries	NSW Department of Primary Industries - Fisheries
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Communities
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
HEVAE	High Ecological Value Aquatic Ecosystem
KFH	Key Fish Habitat
LEP	Local Environment Plan
LGA	Local Government Area
MHWM	Mean High Water Mark
NRAR	Natural Resource Access Regulator
SEED	Sharing and Enabling Environmental Data in NSW
SVTM	State Vegetation Type Mapping
TEC	Threatened Ecological Communities
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WFL	Waterfront Land
WFLT	NRAR Waterfront Land Tool
WM Act	*Water Management Act 2000*

Study Certification and Licensing

Fieldwork was undertaken by Brendon Young B.Sc (Fisheries), Master Env. Management (Water Res.). This report was drafted by Brendon Young with contributions from Jarod Baxter B.Sc (Marine Sys. & Mgmt), and approved by Natalie Black B.Sc (Hons), Master Planning, BAAS: 19076) of Anderson Environment & Planning.

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence SL101313;
- Animal Research Authority (Trim File No: 14/600(2)) issued by NSW Agriculture; and
- Animal Research Establishment Accreditation Number 53724.

Certification:

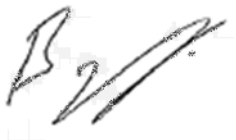
As the principal author, I, Brendon Young, make the following certification:

The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the subject site.

Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, unless specified departures from industry standard guidelines are justified for scientific and/or animal ethics reasons.

All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the Animal Research Act 1995, BC Act and the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

Principal Author and Certifier:



Brendon Young

Aquatic Ecologist / Project Manager

Anderson Environment & Planning

03/07/2024

1.0 Introduction

At the request of Lochinvar Developments Pty Ltd (the client), Anderson Environment & Planning (AEP) have undertaken the necessary investigations at 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar to inform the production of an Aquatic Ecology Report (AER) in accordance with Part 7 of the *Fisheries Management Act 1994* (FM Act). The proposal involves the development of a Subdivision, including stream realignment within R1 zoned lands. The AER has been completed in conjunction with, and informed by, the following assessments:

- A Streamlined Biodiversity Development Assessment Report (SBDAR) in accordance with the *Biodiversity Conservation Act 2016* (BC Act); and
- Riparian Assessment Report (RAR) in accordance with the *Water Management Act 2000* (WM Act) and Natural Resources Access Regulator (NRAR) *Waterfront Land Tool* (2020).

The creek is a highly degraded condition due to past and current land uses. The design has utilised results of the RAR and applicable Controlled Activity Approval (CAA) guidelines for riparian corridors on waterfront land, and concluded the Subject Site is commensurate with an Order 1 stream.

In this context, the AER aims to recognise the relevant requirements of the FM Act and NSW Department of Primary Industries – Fisheries (DPI Fisheries) policies and guidelines.

This report is informed by, and should be read in conjunction with the following documents:

> Anderson Environment & Planning (2024). *Streamlined Biodiversity Development Assessment Report for 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar NSW*. Published report for Lochinvar Developments Pty Ltd.

2.0 Scope and Purpose

This AER is being prepared to assess water land within 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar, NSW and determine direct and indirect impacts of the proposed subdivision and stream realignment.

This AER has been informed by background research, literature review, database searches, consultation with NSW Fisheries, targeted ecological fieldwork, mapping, detailed habitat assessment, and ultimately, impact assessment consideration against the type and form of the proposal.

Specifically, the production of the AEA will be in accordance with the FM Act and assessed against DPI *Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (2013 Update)* to:

- Identify Key Fish Habitat (KFH) within the Subject Site;
- Determine KFH sensitivity type;
- Determine KFH waterway classification;
- Assess the direct and indirect impacts of the proposal on Key Fish Habitat;
- Identify aquatic species within the extent of works, including any threatened species listed under the FM Act and EPBC Act;
- Assess the potential for the proposal to have a significant impact on any threatened species, populations or EEC (or their habitats) listed under the FM Act as identified within the Subject Site;
- Assess the proposal to block fish passage, either in design or during construction; and
- Recommend measures to be implemented to identify, minimise, mitigate and ameliorate potential environmental impacts of the proposal.

3.0 Site Particulars

Table 1 provides a summary of the site particulars.

Table 1 – Site Particulars

Detail	Comments
Client	Lochinvar Developments Pty Ltd
Address	898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar NSW
Titles	Lot 2 to 6 DP 747391, Lot 12 and 13 DP 1219648, and Lot 9 DP 747391
Proposed Development	The proposed development is to construct a 258 Lot residential subdivision and associated infrastructure. The development will include the re-alignment and reconstruction of an unnamed watercourse, and Regeneration of associated Vegetated Riparian Zones (VRZ) (**Appendix A**).
Study Area	The Study Area comprises the entirety of the Lots listed above.
Subject Site	The Subject Site is defined by mapped Key Fish Habitat associated with the watercourse proposed for realignment (**Figure 1**)
LGA	Maitland
Zoning	Under the *Maitland Local Environmental Plan 2011* (the LEP) (pub. 21-4-2023), the Subject Site is zoned R1 – General Residential.
Current Land Use	The Study Area is a fenced paddock consisting of unmanaged grassland and is currently used as cattle pasture.
Surrounding Land Use	The surrounding land is predominantly low density residential and rural residential properties to the east and west, and large lot rural property to the north. The New England Highway (NEH) is south of the Subject Site.

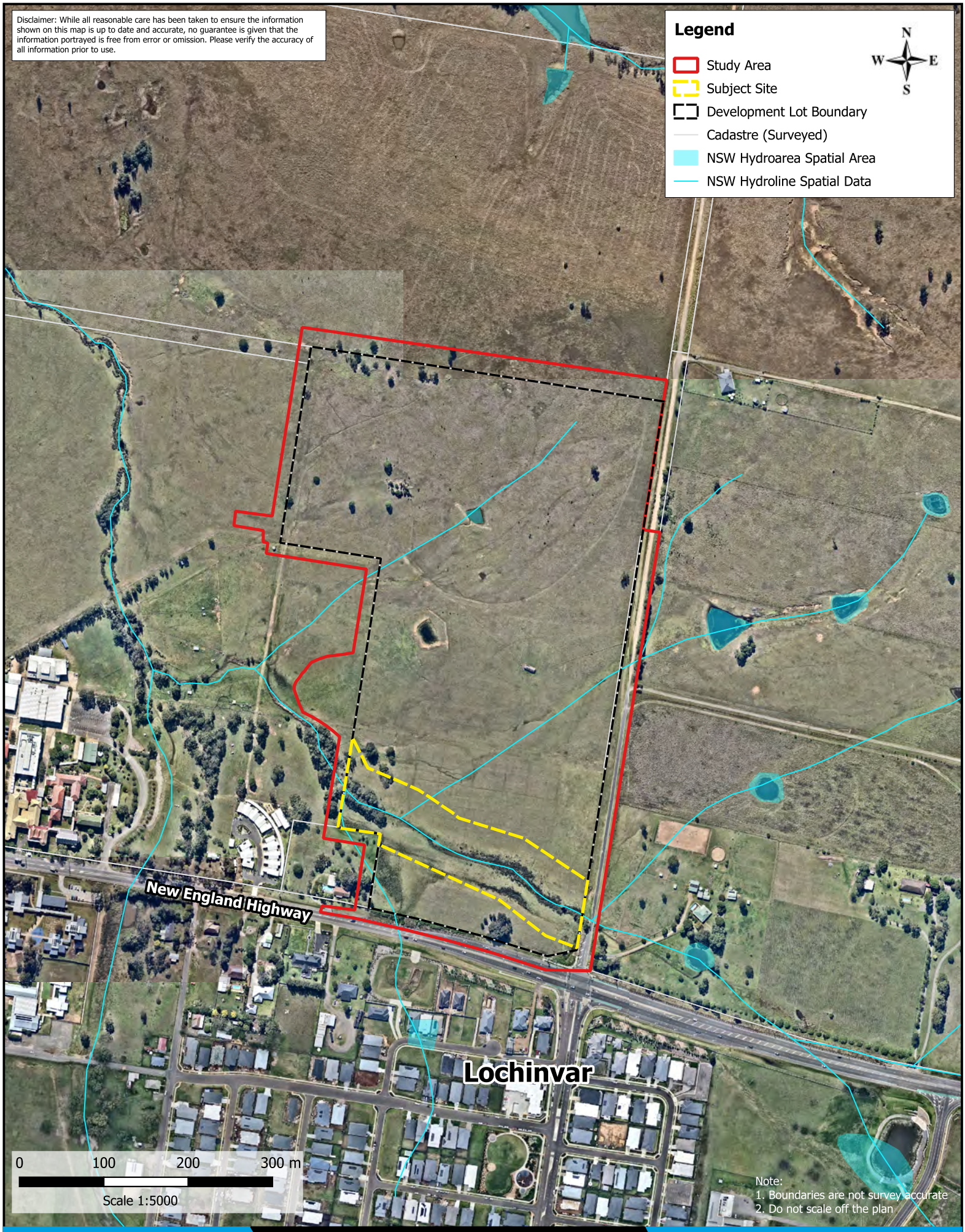


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Figure 1 - Site Location

Date: July 2024

Location: 898 New England Highway, 25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699.05

4.0 Methods

The assessment approach was tailored to undertake sufficient works relating to threatened and native aquatic species, and their habitats, to ensure that legislative requirements were met for the proposal.

To ensure a robust impact assessment approach, where any potential doubt remained over species impact, presence within the Study Area was assumed to ensure a precautionary approach was employed.

Consideration of other matters such as downstream and catchment effects are included.

4.1 Literature Review

In producing this report, we have been informed by:

- Briefing materials provided by the Client;
- Our advanced knowledge of the NSW planning, biodiversity legislation, and our previous experience in gaining similar approvals;
- Relevant council, state and federal legislation, policies and guidelines; and
- Other documentation and information held by AEP for the wider Maitland area and aquatic environment.

4.1.1 SBDAR

Results of native vegetation assessment within the Study Area are presented within the SBDAR completed by AEP (2024). Results determined two (2) Plant Community Types (PCT) are present in varying conditions, alongside two (2) other vegetation zones within the Subject Site (**Figure 2**):

- PCT 4044 - *Northern Creekflat Eucalypt-Paperbark Mesic Swamp Forest*
- PCT 3433 - *Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest*
- Planted Native (*Cynodon dactylon*); and
- Exotic Riparian.

4.1.2 RAR

Findings from the RAR determined significant impacts from the construction of the NEH and surrounding land developments have likely altered the hydrology and geomorphology of the landscape from historical conditions (**Appendix B**). Assessment of the reach reveals much-reduced presence of watercourse features and bed and bank, as a defined by NSW Department of Planning & Environment (DPE) guidelines. Consequently, it is concluded a single Order 1 stream now occurs within the Subject Site for the purposes of determining appropriate Vegetated Riparian Zones for management of the riparian corridor (**Figure 3**).

4.2 Mapping Programs Review

Primary spatial data information sources reviewed included:

- Aerial Photograph Interpretation (API) of the site and surrounding locality;
- Review of spatial data presented by the Fisheries NSW Spatial Data Portal (**Figure 4**), including;
    - Key Fish Habitat;

- Estuarine Macrophytes;
- NSW Marine Protected Areas;
- Aquaculture leases;
- Freshwater Fish Community status; and
- Freshwater Threatened Species.

- Review of Department of Primary Industries Threatened Species Lists and distribution maps;
- NSW ePlanning Portal; and
- Collective knowledge gained from previous aquatic ecological survey and assessment in the Maitland area over more than 25 years has also been relied upon.

4.3 Legislation Review

4.3.1 Fisheries Management Act 1994

Under *Part 4* of the *Environmental Planning and Assessment Act, 1979*, (EP&A Act), NSW DPI is a 'determining authority' for local development that requires one or more of the following permits under the FM Act:

- ***Section 144*** - aquaculture permit (i.e. cultivating fish or marine vegetation for sale/commercial purposes);
- ***Section 201*** - permit to carry out works of dredging or reclamation (i.e. any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land that disturbs, moves or harms these in-stream habitats);
- ***Section 205*** - permit to harm (cut, remove, injure, destroy, shade etc) marine vegetation (saltmarshes, mangroves, seagrass and seaweeds); and
- ***Section 219*** – permit to obstruct the free passage of fish.

Additionally, potential impacts to threatened species listed under the FM Act are to be considered under:

- **Section 220** – Significant effect on threatened species, populations or ecological communities, or their habitats

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Figure 2 - Ground-truthed Vegetation

Date: July 2024

Location: 898 New England Highway, 25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699.05

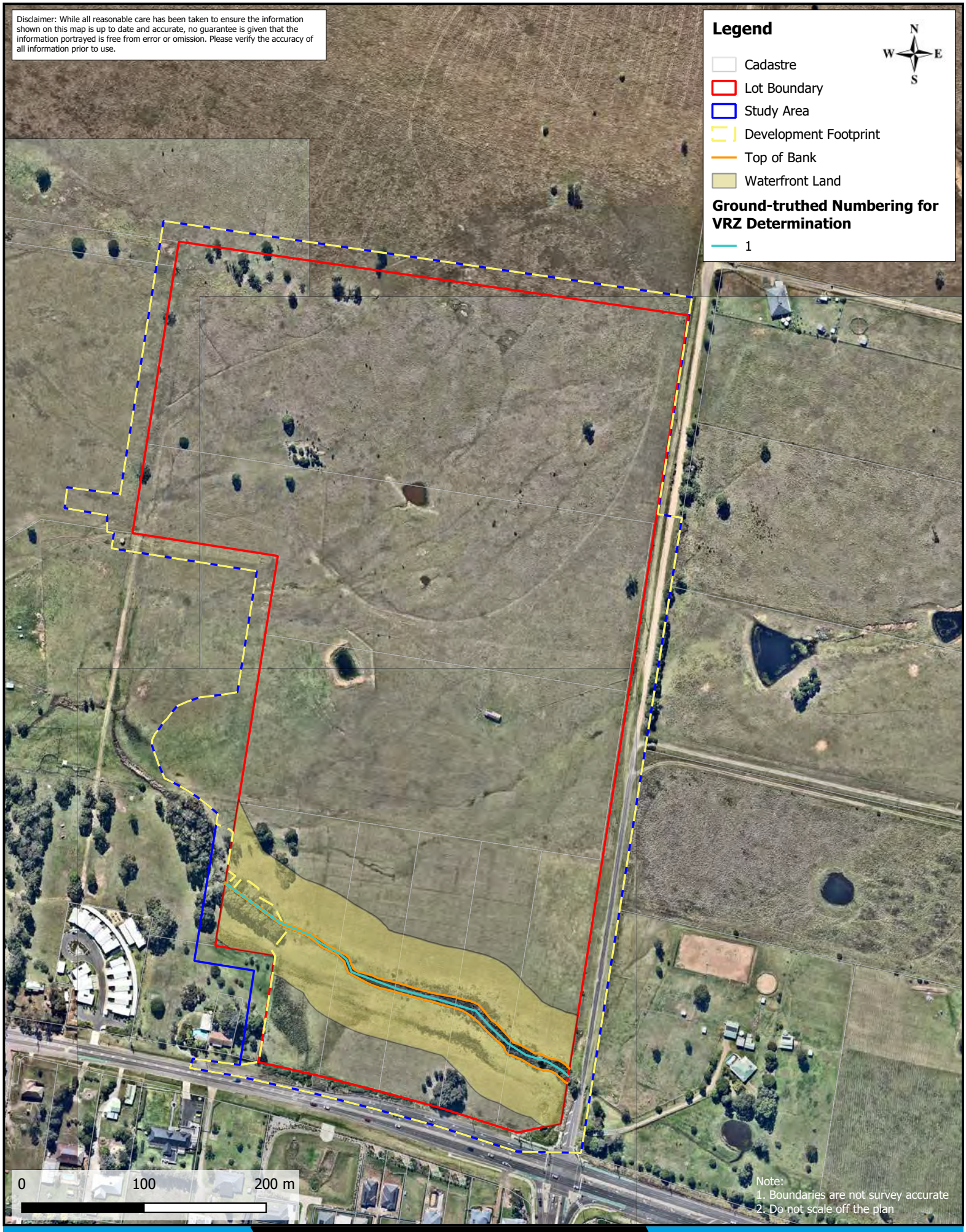

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Figure 3 - Ground-truthed WFL Assessment

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699.05

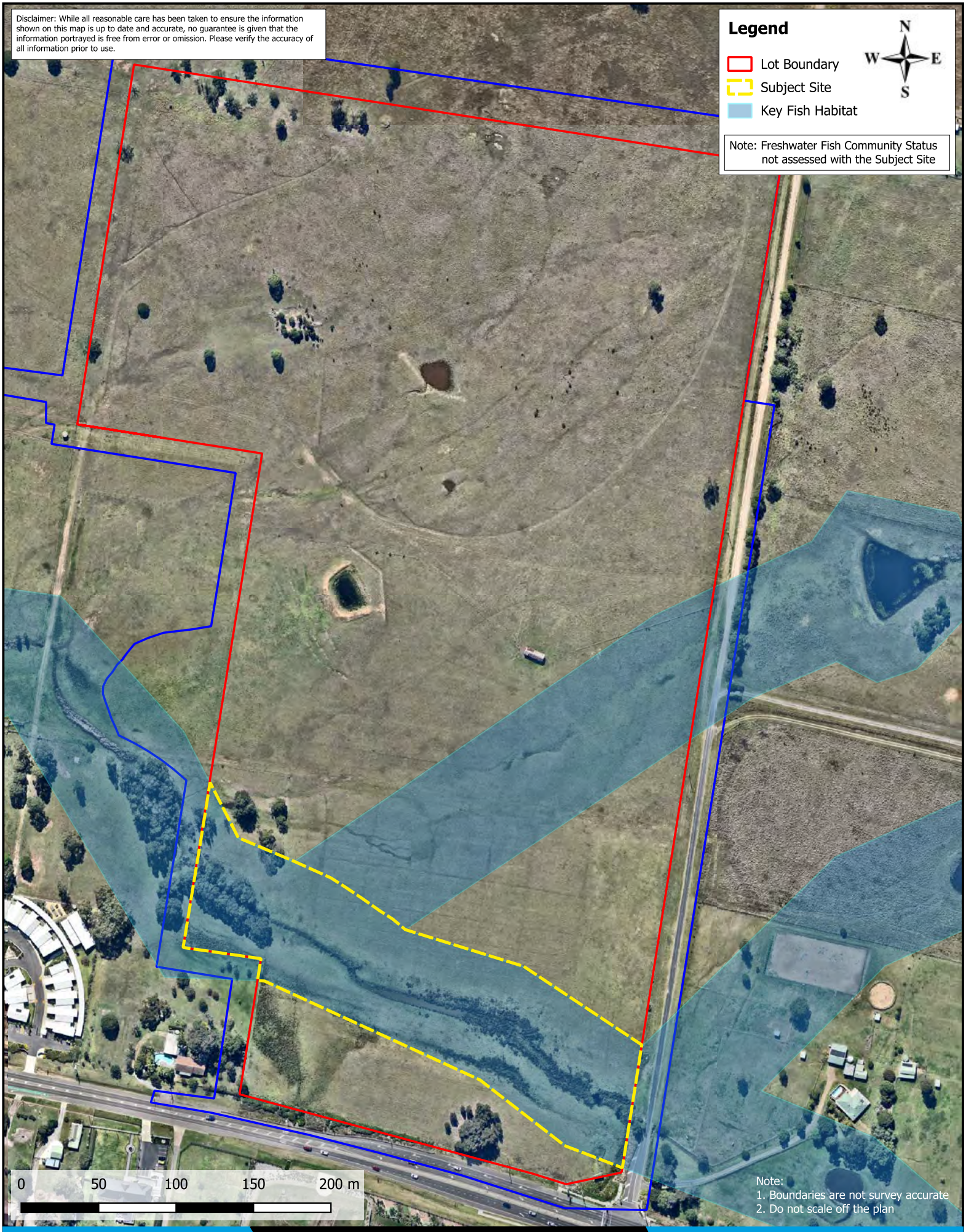

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Figure 4 - Fisheries NSW Spatial Data

Date: July 2024

Location: 898 New England Highway,25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699.05

4.4 Field Survey

Aquatic and riparian vegetation and habitat were surveyed utilising a variety of methods including:

- Visual survey of the low flow channel for presence of aquatic flora / fauna;
- Dip netting targeting threatened species
- Bank and bed assessment;
- Ground-truth top of bank;
- Aquatic and riparian vegetation surveys;
- Detailed condition of stream, including obstructions to fish passage; and
- Identification of habitat features including refuge pools, overhanging vegetation and timber snags.

Table 2 and **Figure 5** outline the survey effort and periods.

Table 2 – Field Survey Effort

Date	Time	AEP Staff	Activity
30/08/2022	08:30 – 13:30	CW, KB	Riparian Assessment
02/04/2024	09:00 -11:00	BYO	Riparian Assessment
02/04/2024	9:00 – 1:00	BYO	Aquatic Habitat & Fauna Assessment
11/04/2024	10:00 – 11:30	DN, EO	Biodiversity Management Plan preliminary inspection

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Figure 5 - Survey Effort

Date: July 2024

Location: 898 New England Highway,25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699.05

6.0 Aquatic Survey Results

The watercourse sits in a floodplain between open grassland pasture to the north and a strip of approximately 100m of open pasture and the New England Highway to the south. The watercourse enters the Subject Site under a culvert under Wyndella road on the eastern boundary. Culverts under the NEH allow flow to enter the site in the south west and south east corner of the Study Area. Recent developments on the southern side of the NEH channel stormwater through both culverts, discharging on the north side of the NEH, into the Study Area where flow disperses before entering the creek.

The stream is perennial, however may be discontinuous during extended dry periods. The paddock the creek runs through is utilised by cattle. There is significant instream impact and erosion, portions of the creek become very shallow with minimal flow. Water quality is highly disturbed/ turbid by cattle in shallow sections. A few deep holes are upstream of the cattle impacted shallow areas and are bound by juncus. The pools have very low turbidity. The quality of flow entering from the southern culverts may be impacted by the adjacent development and the NEH. Aquatic associated vegetation is present immediately north of the south west NEH culvert due to excessive runoff from developments south of the NEH, and freshwater wetland is beginning to for, albeit in very early stage.

A small, ephemeral floodplain channel was observed to the south of the main channel, this would offer some refuge for short to moderate periods of time after flooding.

The creek is a tributary of Lochinvar Creek, which in turn flows into the Hunter River approximately 3.5km north of the Subject Site. A number of potential natural and constructed barriers to fish passage occur along the Subject Site water course and Lochinvar Creek.

6.1 Key Fish Habitat

One of the objectives of the FM Act is to 'conserve key fish habitats'. To achieve the objectives of DPI - Fisheries have mapped 'Key Fish Habitats' throughout NSW. The mapped habitat are those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species.

'Key Fish Habitat' (KFH) includes

- All marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides); and
- Most permanent and semipermanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.

Exclusions from KFH are:

- Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded;
- Farm dams constructed on such systems;
- Wholly artificial waterbodies such as irrigation channels, urban drains and ponds; and
- Salt and evaporation ponds are also excluded except where they are known to support populations of threatened fish or invertebrates.

To assess KFH DPI Fisheries developed assessment criteria based of both desktop and field surveys. The assessment considers the ‘sensitivity’ of the affected fish habitat. In this context, ‘sensitivity’ is defined by the importance of the habitat to the survival of fish (noting that ‘fish’ under the FM Act includes all aquatic invertebrates) and its robustness (ability to withstand disturbance). **Table 4** defines those

habitats that are considered ‘key fish habitats’ for the purposes of the application of the FM Act, and also includes a fish habitat sensitivity ranking which is used to differentiate between permissible and prohibited activities or developments related to the importance of the ‘TYPE’ of key fish habitat.

Figure 4 shows current KFH spatial data provide by DPI Fisheries.

6.1.1 Habitat Survey Results

The section of Lochinvar creek to the east and within the Subject Site is highly degraded and modified, limiting its function to support fish communities or native aquatic flora. The Field surveys identified the following features (**Figure 6**):

- A narrow flood plain channel was observed, limited to no native riparian vegetation.
- The creek bank was dominated by the exotic *Juncus acutus.* The native aquatic plant *Ottelia ovalifolia* was observed in one pool.
- Stream channels and Substrates – sandy erosive soils with rills and gullies within erosion gullies in the flood plain.
- A number of deep pools on the eastern portion of the watercourse.
- Bed and banks impacted by cattle, creating erosion and a barrier to fish passage in low flow conditions.

Plates 1-8 provide examples of habitat within the Study Area.

Plate 1: West aspect. Main channel on the right, and floodplain channel on the left.

Plate 2: A deep pool in the eastern portion of the Subject Site. *Juncus acutus* dominates the banks.

Plate 3: East aspect. Deep pool ends with narrow, shallow channel westward.

Plate 4: Bed and bank heavily impacted by cattle.

Plate 5: Riparian vegetation to be retained near the western boundary.

Plate 6: Cattle crossings between *Juncus acutus*.

Plate 7: Aquatic vegetation south of the NEH culvert discharge. Immature wetland.

Plate 8: *Ottelia ovalifolia* in a pool.

6.1.2 Habitat Sensitivity

To assess KFH DPI Fisheries developed assessment criteria based of both desktop and field surveys. The assessment considers the 'sensitivity' of the affected fish habitat. In this context, 'sensitivity' is defined by the importance of the habitat to the survival of fish (noting that 'fish' under the FM Act includes all aquatic invertebrates) and its robustness (ability to withstand disturbance). DPI Fisheries (2013) guidelines provide a definition of those habitats that are considered 'key fish habitats' for the purposes of the application of the FM Act, and also includes a fish habitat sensitivity ranking which is used to differentiate between permissible and prohibited activities or developments related to the importance of the 'TYPE' of key fish habitat.

Table 3 provides an assessment of the field survey results and desktop mapping review against criteria for KFH habitats set out by the guidelines.

Table 3 – KFH Sensitivity Classification Assessment

Habitats	TYPE 1 - Highly sensitive key fish habitat	TYPE 2 – Moderately sensitive key fish habitat:	TYPE 3 – Minimally sensitive key fish habitat	Assessment
Marine Attributes	• *Posidonia australis* (strapweed) • *Zostera, Heterozostera, Halophila* and *Ruppia* species of seagrass beds >5m^2 in area • Coastal saltmarsh >5m^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.	• *Zostera*, *Heterozostera, Halophila* and *Ruppia* species of seagrass beds <5m^2 in area • Mangroves • Coastal saltmarsh <5m^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 plan) • 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	• 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.	The Subject Site does not occur in the marine environment.

Habitats	TYPE 1 - Highly sensitive key fish habitat	TYPE 2 – Moderately sensitive key fish habitat:	TYPE 3 – Minimally sensitive key fish habitat	Assessment
		beaches with large populations of in-fauna		
Freshwater Attributes	• 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 • Mound Spings	• 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.	• Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation	Due to lack of riparian vegetation and native aquatic vegetation the Creek is in a highly degraded state with severe erosion within the low flow channel and the rills/gully erosion within the floodplain. The native aquatic plant *Ottelia ovalifolia* was identified during field survey.
Wetland Attributes	• 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[2]	N/A	N/A	No wetlands occur within the Subject Site.
Threatened Species	• Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act	N/A	N/A	No threatened species or communities listed under the FM Act were identified during field surveys.
Results	**TYPE 3 – Minimally sensitive key fish habitat**			

6.1.3 Waterway classification

NSW DPI Fisheries has provided a waterway classification scheme (**Table 3**) for assessment of watercourses (primarily freshwater and brackish) and classifies these streams using indicators such as (DPI Fisheries, 2013):

- hydraulic geometry (stream shape and size),
- frequency of stream flows (perennial, intermittent or ephemeral),
- presence of aquatic habitat units (pools, riffles, vegetation, snags),
- presence of threatened or protected fish species and other native fish, and
- connection to adjacent habitats (e.g. floodplain wetlands).

Waterway **CLASS** can be used to assess the impacts of certain activities on fish habitats in conjunction with the habitat sensitivity **TYPE**. The waterway **CLASS** scheme can also be used to assess impacts on different fish habitats, such as waterway crossings, and make recommendations to minimise impact.

The Subject Site is a semi-permanent waterway with a small number of deep pools in the east. The western portion of the Subject Site is shallow, narrow and heavily impacted by cattle. The western portion is likely ephemeral and only connects the deep pools to lower sections of the reach after moderate rainfall. While the banks are dominated by *Juncus acutus*, the native aquatic *Ottelia ovalifolia* was observed within the pools. Therefore, the Subject Site is considered a Class 3 waterway (**Table 4**).

Table 4 – Classification of waterways for fish passage

Classification	Characteristics of waterway class
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'.
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 pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
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.
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 free-standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).

Source: DPI Fisheries, 2013.

6.2 Snags Assessment

Large woody debris, or 'snags', refers to the large woody debris from trees and shrubs, including whole fallen trees, broken branches and exposed roots that have fallen or washed into a waterway and are now wholly or partially submerged by water. Snags also include submerged large rocks (of greater than 50cm in two dimensions).

Snags tend to accumulate in freshwater and upper estuarine areas and form one of the most important habitat components for fish within streams by:

- providing places to rest out of the main current flow;

- providing sites to hide from predators or avoid direct sunlight;
- providing ‘markers’ to designate territorial boundaries for species that move or migrate within the river system (e.g. Murray cod and golden perch);
- providing breeding sites for species such as river blackfish and Murray cod which lay adhesive eggs onto hard substrates;
- providing a surface for algal, fungal, bacterial, plants and insects to colonise;
- stabilising sediments and protecting the stream bed and banks, thereby preventing stream erosion; and

The removal of woody debris and snags or work that involves the removal of any other material from water land that disturbs, moves or harms woody debris and snags is considered “dredging” under the FM Act.

“Removal of large woody debris from NSW rivers and streams” is listed as a key threatening process under Part 7A of the FM Act. This imposes certain requirements upon authorities when authorising an activity or development that may involve in-stream woody habitat removal.

6.2.1 Results

No snags were observed within the Subject Site. The riparian corridor was primarily devoid of trees except a small patch on the western border. The surrounding landscape is predominately rural residential and pasture, and combined with urban development in the upper reaches, upstream sources of large woody debris are minimal.

6.3 Fish Passage Assessment

Australian native fish require unimpeded access along waterways in order to survive and reproduce. Both fresh and saltwater fish move within waters at different times to access food and shelter, to avoid predators, pest management, and to seek out mates. Of the 83 species of freshwater fish in south eastern Australia, over half migrate at least once as part of their life cycle, migrating hundreds of meters to thousands of kilometres.

Barriers to fish passage prevent movement of native fish species, which can have severe implications for these populations. In extreme cases, barriers can result in localised extinctions. This has occurred for golden perch populations above several large weirs and dams.

Barriers can be:

- physical structures (e.g. dams, floodgates, causeways and weirs);
- hydraulic (e.g. areas of high velocity flow or turbulence);
- chemical (e.g. pollution plumes, acid sulfate soil discharge and low dissolved oxygen slugs); and
- behavioural obstructions (e.g. dark tunnels or unnatural substrates created by pipes).

Habitats where food and shelter are degraded may also impact upon the migration of native fish species. Fish passage barriers can adversely impact native fish by:

- interrupting spawning or seasonal migrations;
- restricting access to preferred habitat and food resources;
- increasing the chance of predation and disease; and

- reducing genetic flow between populations through population fragmentation.

Assessment of barrier includes assessment of cumulative effect of barriers to fish passage, as this is listed as a Key Threatening Process to the continuing survival of several species of native fish in Australia.

Under *Section 219* of the FM Act, fish passage is not to be blocked without a permit from NSW DPI Fisheries:

6.3.1 Results

The narrow and shallow western portion of the creek acts as a fish barrier due to the impacts of cattle erosion and degradation of the bed and bank (**Figure 6**). Connectivity to lower reaches would only occur during flood conditions. The blockages have resulted in the Creek having limited to no fish connectivity with the main arm of Lochinvar Creek and the greater Hunter River Catchment.

6.4 Aquatic Fauna Survey

Fish communities are co-occurring populations of individual fish species within habitats. Changes in fish communities are driven by a range of interactions within the ecosystem such as:

- Species health;
- Waterway health;
- Habitat availability;
- Access / movement through a system (obstructions);
- Foraging availability;
- Predation;
- Natural events (fire, drought, flood); and
- Disturbance, both natural and human induced.

The combined effects of each of these processes governs the species composition and relative abundances of species within the community. Given the large catchment area of the Hunter River and the extensive altitudinal range and underlying geological features, consequent range of habitats, and spatial variation in the level and type of human disturbance, the composition of fish communities occurring at sites are unlikely to be consistent with healthy section of the catchment.

Fish identified by Howell and Creese (2010) found that in the upland tributaries of the Hunter the following native fish are likely to be present:

- *Anguilla* spp;
- Australian bass;
- Australian smelt;
- Cox's gudgeon;
- *Hypseleotris* spp;
- Short-finned eel; and
- Flat head gudgeon.

Table 5 details observed fauna during field surveys.

Table 5 – Observed Species List

Scientific Name	Common Name	NSW status	Comm. status
Fish			
*Gambusia holbrooki**	Gambusia, Plague Minnow, Mosquito Fish	-	-

***exotic**

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Figure 6 - Key Fish Habitat Survey Results Date: July 2024

Location: 898 New England Highway,25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd AEP ref: 2699.05

6.5 Threatened Species, Populations and Ecological Communities

A threatened species is a plant or animal that has been assessed by the independent Fisheries Scientific Committee and found that they are at risk of extinction. The assessment considers a number of criteria, including:

- if there is a reduction in its population size, geographical distribution or genetic diversity;
- the rate of and trends in the reduction;
- life history and ecology of the species including its ability to recover from low numbers;
- the resilience of the population to threatening processes; and
- if there are few mature individuals.

A species may be listed under the FM Act as:

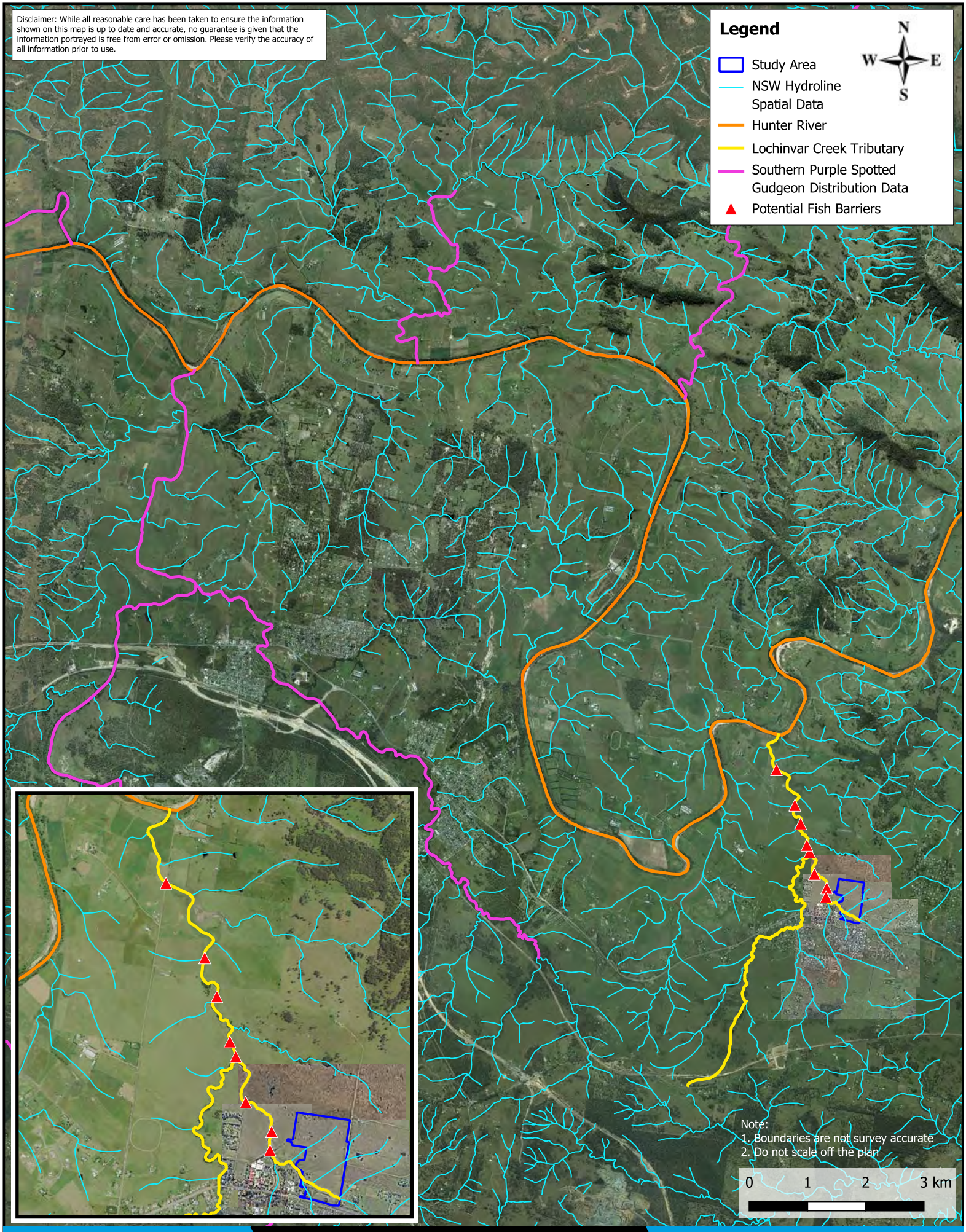
- vulnerable;
- endangered;
- critically endangered; or

presumed extinct

Table 6 provides an assessment of the listed species and endangered communities with potential to occur on site based on species distribution, habitat preferences and site ecology.

Table 6 – Listed Species Appraisal

Scientific Name	Common Name	Status	Distribution	Habitat	Likelihood of Occurrence	Key Subject Species
Archaeophya adamsi	Adams Emerald Dragonfly -	E	Adam's Emerald Dragonfly is one of the rarest dragonflies in the country. It breeds in rivers and streams in coastal areas. In the past 35 years it has been collected from only four sites in the Greater Sydney region.	Adam's Emerald Dragonfly larvae occur in narrow shaded riffle zones with moss and abundant river bank vegetation in small to moderate sized creeks with gravel or sandy bottoms.	The species has been recorded in upper reaches of the Hunter River Catchment. However, the habitat required for the species being shaded narrow riffle sections with gravel beds is not present within the Subject Sie or greater Study are, due to past and present land uses. Not considered due to habitat being highly degraded and not present within the Subject Site	No
Mogurnda adspersa	Southern Purple Spotted Gudgeon	E	The Southern Purple Spotted Gudgeon occurs in the Murray-Darling basin as well as parts of coastal northern NSW and Queensland.	The species can be found in a variety of habitats such as rivers, creeks, streams and billabongs with slow-flowing or still waters. Cover in the form of aquatic vegetation, overhanging vegetation from river banks, leaf litter, rocks or snags are important for the species.	Species distribution data indicates Southern Purple Spotted Gudgeon habitat is connected approximately 19km downstream of the Subject Site and the species has the potential to occur within the Study Area (**Figure 7**). However, the habitat required for the species being aquatic vegetation, overhanging vegetation from river banks, leaf litter, rocks or snags is limited and when present is highly degraded consisting mostly of exotic species. Additionally, API revealed multiple potential natural and constructed obstruction to fish passage along Lochinvar Creek, downstream of the Subject Site (**Figure 7**). Given the mapped results for the species in the Hunter Catchment AEP has used the precautionary principle and will undertake further assessment.	Yes



AEP

Figure 7 - Threatened Species Distribution Spatial Data Date: July 2024

Location: 898 New England Highway,25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd AEP ref: 2699.05

6.6 Water Treatment Assessment

To accurately assess the impact of the proposed development stormwater parameters both pre- and post-development have been reviewed and assess against Aquatic Ecological values. **Figure 8** shows the proposed stream realignment and design plans area provided in **Appendix A**.

AEP have reviewed the proposed Stormwater Management Plan (SWMP) (**Appendix C**) to assess how the proposed management strategies provide Water Sensitive Urban Design (WSUD).

The Stormwater assessment provides an understanding of what impacts may arise from residential development such as:

- increased runoff volumes;
- increase in pollutant loads;
- changes in peak flows; and
- changes in velocity.

The stormwater software MUSIC was utilised to model the pre without control and post with controls, to assess the impact on both aquatic and terrestrial ecosystems. AEP has assessed these to determine impact on key fish habitat within the subject site. **Table 7** has been extracted from ADW Johnson SWMP (2024) and shows the Basin with treatment meet or are within reasonable variation to the pre development levels for all parameters, which will ensure limited change for the aquatic flora and fauna. Combine these results with management of the aquatic zone under a BMP (**Appendix D**) it is likely the fish habitat will improve.

Table 7 – MUSIC Modelling of Basin Pollutant Loads (ADW Johnson SWMP, 2024)

Southern Discharge Point			
	Total Suspended Solids (kg/yr)	**Total Nitrogen (kg/yr)**	**Total Phosphorous (kg/yr)**
Post Developed No Controls	15400	224	32.9
Post Developed with Controls	2980	104	11.6
Reduction (%)	80.7	53.5	64.8

As per the SWMP (2024) **Table 8** shows that peak flows during larger storms being discharged through the area identified as key fish habitat have been reduced back to that of the pre-developed scenario.

By combining best practices, communities can reduce the adverse impacts of impervious surfaces on fish habitat and improve overall water quality in catchment areas. This approach supports sustainable urban development while protecting valuable aquatic ecosystems.

Table 8 – Peak Flow Modelling Results Southern Basin (ADW Johnson SWMP, 2024)

Design Average Recurrence	**Peak Flowrate (m^3/s)**	
	Predeveloped	**Post Developed (with detention)**
63%	1.678	1.570
5%	6.002	5.783
1%	9.427	7.942

AEP

Figure 8 - Proposed Stream Realignment Date: July 2024

Location: 898 New England Highway,25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd AEP ref: 2699.05

6.7 Summary of Aquatic Survey Results

The Subject Site is located within the Maitland LGA and is mapped Key Fish habitat. Riverine habitat within the Subject Site includes a degraded creek traversing in-use pasture and creek banks dominated by the exotic *Juncus acutus*. The upper catchment has been modified by urban development. A number of deep pools remain in the eastern portion of the Subject Site, however are disconnected except during periods of flood. Cattle cross the creek in the west and have severely degraded the bed and bank in the shallowest sections, resulting in erosion and blockage of fish passage.

Site assessment determined Type 3 – minimally sensitive KFH occurs within the Subject Site and the creek is a Class 3 – Minimal KFH waterway. No native or threatened fish were observed during field surveys. Riparian and aquatic vegetation is dominated by the exotic *Juncus acutus*, with the native aquatic plant *Ottelia ovalifolia* present in low abundance. A patch of native casuarina and eucalypt riparian vegetation occurs near the western boundary and will be retained.

Modelling undertaken by ADW Johnson SWMP (2024) indicates post-development treatment of stormwater runoff will meeting Maitland Council guidelines for discharge rate and water quality.

7.0 Fisheries Management Act 1994 Assessment

The *Fisheries Management Act 1994* objectives are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. The proposed stream realignment requires the following sections to be considered under the FM Act:

- ***Section 201*** – Circumstances in which a person (other than a public or local government authority) may carry out dredging or reclamation;
- ***Section 219*** – permit to obstruct the free passage of fish; and
- ***Section 221ZV*** – Determination of whether proposed development or activity likely to significantly affect threatened species, population or ecological community.

Under the FM Act, water land is defined as *land submerged by water whether permanently or intermittently*. Using the results of the desktop review and field survey, an assessment of the proposal against the requirements of the FM Act, Dredge and reclamation Permit and NSW Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* was undertaken.

7.1 Threatened Species, Populations and Ecological Communities

Detailed analysis of DPI Fisheries Threatened Species List and Spatial Data Portal were undertaken in April 2024. Species distribution data and habitat preferences indicates *Mogurnda adspersa* (Southern Purple Spotted Gudgeon) has the potential to occur within the Study Area. This species are considered unlikely to utilise the Subject Site, however, following the precautionary principle, further assessment is considered in **Table 9** in accordance with Department of Primary Industries (2008) *Threatened species assessment guidelines: The Assessment of Significance.*

Table 9 – Threatened Species Impact Assessment

Clause		Assessment
a)	In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	*Mogurnda adspersa (Southern Purple Spotted Gudgeon)* was not identified during field surveys. Given the poor water quality, numerous downstream barriers and limited habitat it is considered unlikely this species would utilise the Subject Site.
b)	in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	No endangered populations are currently mapped within the Study Area or surrounds. No species belonging to an endangered population was observed during field surveys. The proposal is considered unlikely to impact a listed endangered population.
c)	in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	There were no endangered ecological communities or critically endangered ecological communities within the aquatic environment identified within the Subject Site.

Clause		Assessment
d)	in relation to the habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and	The watercourse within the Subject Site will be re-aligned, and will be reconstructed incorporating watercourse features to improve the quality and quantity of available riparian and riverine Key Fish habitat. This will include the construction of in-stream pools, riffles, meanders and snags. The Riparian Corridor will be managed under a 5-year Vegetation Management Plan to ensure benchmark riparian condition is achieved.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	The removal of the existing blockages to fish passage will significantly improve connectivity within the Lochinvar Creek and greater Hunter River Catchment.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The Subject Site is currently in poor condition from historical and surrounding land uses. Development of the stream realignment with natural channel design is likely to improve site ecological condition.
e)	whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).	No critical habitat was listed as occurring within the Study Area.
f)	whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.	DPI Fisheries Priority Action Statement lists a number of habitat Regeneration objectives. While the Subject Site is unlikely to support *Mogurnda adspersa (Southern Purple Spotted Gudegon),* improvements to water and riparian quality from the associated BMP would align with these objectives.
g)	whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	***Degradation of native riparian vegetation along New South Wales water courses.*** Riparian vegetation is dominated by the exotic *Juncus acutus*. Good condition native riparian vegetation will be retained in the west with some impact from detention basin tailout design. These impacts are to be offset within the associated BMP. Given the small area of impact and the larger area to be managed and retained under the BMP, it is considered likely the overall ecological and biodiversity conditions of the site will be improved. ***Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams*** The proposed stream realignment will be designed to incorporate natural watercourse and fish habitat features. The design will consider low-flow conditions and water velocity as per DPI's Policy and guidelines for fish habitat conservation and passage. ***Removal of large woody debris from New South Wales rivers and streams***

Clause		Assessment
		Large woody debris was not identified during field habitat surveys. In-stream snags will be provisioned in the proposed BMP and stream realignment, resulting in an increase in KFH.

7.2 Dredge and Reclamation

A Dredge and Reclamation application requires evaluation of risk of environmental impacts from the proposed works as per **Section 228** of the *Environmental Planning and Assessment Regulation 2000*. The EP&A Regulation 2000 has subsequently been superseded by the *Environmental Planning and Assessment Regulation 2021*. Therefore, evaluation has been undertaken against the criteria listed in **Section 171** of the *EP&A Regulation 2021* (**Table 10**).

Table 10 – Environmental Risk Assessment

Risk	Level (High, Moderate, Low, Nil)	AEP Assessment
The environmental impact on the community,	Low	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor.
The transformation of the locality,	Low	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH.
The environmental impact on the ecosystems of the locality,	Low	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
Reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality,	Low	Given the degraded condition and proposed BMP works, the environmental value contained within the site will be improved post construction.
The effects on any locality, place or building that has— (i) aesthetic, anthropological,	Low	Refer to SBDAR for detailed assessment.

Risk	Level (High, Moderate, Low, Nil)	AEP Assessment
archaeological, architectural, cultural, historical, scientific or social significance, or (ii) other special value for present or future generations,		
The impact on the habitat of protected animals, within the meaning of the Biodiversity Conservation Act 2016,	Low	Refer to SBDAR for detailed assessment.
The endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,	Low	The limited flora and fauna identified within the Subject Site is primarily exotic. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH.
Long-term effects on the environment,	Low	The environmental effects associated with the proposal are expected to be temporary during construction, and long term the proposal will improve environmental values.
Degradation of the quality of the environment,	Low	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH.
Risk to the safety of the environment,	Low	The proposed work not likely to pose an environmental risk with appropriate sediment and erosion controls.
Reduction in the range of beneficial uses of the environment,	Low	The proposed stream realignment are to be designed to meet DPI Fisheries guidelines and the riparian areas are to be regenerated and managed under a BMP.
Pollution of the environment,	Low	The portion of Subject Site within the development footprint exists in an already-polluted state due to proximity to agricultural land. Development of a Sediment Control Plan associated with the proposed works is recommended before construction activities commence.
Environmental problems associated with the disposal of waste,	Low	A CEMP will be implemented during construction detailing appropriate methods for disposal and storage of waste.
Increased demands on natural or other resources that are, or are likely to	Low	It is unlikely that the proposal will have any major effect on natural resource supplies.

Risk	Level (High, Moderate, Low, Nil)	AEP Assessment
become, in short supply,		
The cumulative environmental effect with other existing or likely future activities,	Low	Cumulative impacts of adjacent developments and historical agricultural land use have resulted in highly degraded habitat within the Subject Site. The proposal will result in an increase to environmental condition and availability.
The impact on coastal processes and coastal hazards, including those under projected climate change conditions,	Low	Due to the temporary nature of the proposed works and infrequent flow of Subject Site it is unlikely that the installation will have any major effect on coastal processes and hazards.
Other relevant environmental factors.	Low	No other environmental factors are likely to be impacted by the proposed stream realignment.

7.3 Policy and Guidelines for Fish Habitat

NSW DPI Fisheries *Policy and guidelines for fish habitat conservation and management* (2013) outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments. The following sections of the guidelines are applicable to the proposed stream realignment.

7.3.1 Riparian and Freshwater Aquatic Vegetation Assessment

Table 11 outlines DPI Fisheries policy and guideline criteria and AEP assessment for this proposal.

Table 11 – Riparian and Freshwater Vegetation Policy and Guidelines

Assessment Criteria	AEP Assessment
1) NSW DPI will generally not approve or support works that may harm freshwater aquatic vegetation (TYPE 1 and 2 habitats – see Table 1), unless adequate mitigation, Regeneration and/or demonstrated compensation measures are in place (see section 3.3).	A single aquatic species, *Ottelia ovalifolia*, was identified during field surveys occupying a single pool. A BMP will be prepared to regenerate the aquatic and riparian communities, including freshwater wetland.
2) NSW DPI will generally require riparian buffer zones to be established and maintained for developments or activities in or adjacent to TYPE 1 or 2 habitats or CLASS 1-3 waterways (see guidelines below). Riparian buffer zones shall be measured from the top of the bank/drainage depression along CLASS 1 to 3 waterways (see Table 2). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new	The stream is classed as a Type 3 and is in a degraded condition due to surrounding land use. A BMP is proposed to rehabilitate and reconstruct the KFH.

Assessment Criteria	AEP Assessment
access roads, new road developments along a new alignment).	
3) NSW DPI will require the design of riparian buffer zones to incorporate the maintenance of lateral connectivity between aquatic and riparian habitat. Installation of infrastructure, terraces, retaining walls, cycle ways, pathways and grass verges within the riparian buffer zone shall be avoided or minimised.	BMP will incorporate approx. 10-20m either side of the Creek for regeneration of both aquatic and riparian lands.
4) NSW DPI will generally support proposals that aim to remove willows or other exotic trees or other weeds from the watercourse, followed by Regeneration with native species. Willows and other exotic trees should only be removed from the stream where stream stability is not unduly compromised.	The BMP proposes to remove and manage all weeds and exotic species.
a) NSW DPI will assess the width of the riparian buffer zone based on the habitat TYPE and waterway CLASS (see Tables 1 and 2), the possible extent of the disturbance and the susceptibility of the riverbank to erosion. As a guide the following are recommended: • TYPE 1, CLASS 1: 100 metres • TYPE 2, CLASS 2-3: 50 metres • TYPE 3, CLASS 3-4: 10-50 metres b) For guidelines on designing filter strips for this purpose (including appropriate widths) please refer to Prosser and Karssies (2001) (see Appendix 2). Advice on protecting aquatic macrophytes in wetlands and shallow lakes can be obtained from Bailey et al. (2002) (see Appendix 2).	The proposed BMP will manage approx. 10-20m either side of the Type 3 creek with an aim to regenerate instream structure and riparian condition.
c) Riparian buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and stock access management).	The BMP will provide these measures to provide protection of water quality and aquatic ecosystem.
d) Developments should ensure that existing native riparian vegetation is retained to the greatest extent possible in an undamaged and unaltered condition. Revegetation of disturbed areas with local native species should also be considered as part of development controls (e.g. stabilisation of sediment, sediment filters during and post-construction) and mitigation measures. Monitoring should be undertaken to ensure successful establishment of vegetation in these areas.	Native riparian vegetation occurs on the western boundary and will be avoided and retained. Other riparian vegetation throughout the Subject Site is exotic, dominated but *J. acutus*, and pasture grasses. The implementation of a BMP will significantly increase the availability of native riparian vegetation.
e) Where establishment or Regeneration of a riparian zone is required, the Regeneration strategy should include native in-stream vegetation (macrophytes) and snags where appropriate.	The BMP Lands will include full aquatic planting as a Management Zone.
f) Mitigation or Regeneration measures for developments should include weed control.	The BMP will provide a detailed approach to management of weeds within entire BMP lands.

Assessment Criteria	AEP Assessment
g) Willow control guidelines can be accessed at www.environment.gov.au/biodiversity/invasive/weeds/index.html or www.weeds.org.au/WoNS/willows/	No willows were identified within the Subject Site.

7.3.2 Snags Assessment

Table 12 outlines the assessment that AEP have undertaken in accordance with the criteria for Snag management.

Table 12 – Snag Assessment

Assessment Criteria	AEP Assessment
1) NSW DPI supports the retention of snags within streams (i.e. CLASS 1-3 in Table 2) to the greatest extent possible and will generally not support or approve snag management proposals that do not demonstrate a significant public benefit. In particular, NSW DPI will generally not support or approve the removal of snags purely for aesthetic purposes.	As there are no recorded snags within the Subject Site this clause does not apply, however there will be installation of snags within the BMP.
2) NSW DPI will generally not support or approve snag management proposals aimed at improving or enhancing navigability of streams. NSW DPI may, however, agree to proposals which aim to maintain (not enhance) navigability in those areas where there is a long history of boating use, providing the habitat of a threatened species will not be adversely affected and it is not contrary to a recovery or threat abatement plan.	N/A
3) NSW DPI will generally not support or approve snag management proposals aimed at improving or enhancing the hydraulic capacity of streams or reducing flood risk.	Snag installation is proposed to increase the availability and quality of KFH.
4) NSW DPI may support or approve snag management proposals which are part of a larger strategy or program to rehabilitate and stabilise degraded streams, providing the proposal aims to minimise the level of disturbance. In particular, NSW DPI will support proposals that aim to remove willows or other exotic trees from the watercourse, and replace them with native vegetation, except in cases where stream stability is likely to be unduly compromised.	As there are no recorded snags within the Subject Site this clause does not apply, however there will be installation of snags within the BMP.
5) NSW DPI will adopt a conservative approach to snag management proposals in TYPE 1 habitat areas (i.e. habitats for threatened fish species, populations, or ecological communities) (see Table 1) and will evaluate the environmental benefits of the works versus the potential short-term negative impacts of the works on such habitat areas.	As there are no recorded snags within the Subject Site this clause does not apply, however there will be installation of snags within the BMP.

Assessment Criteria	AEP Assessment
6) NSW DPI will support proposals for reintroduction of snags to waterways where: • it can be shown that snags have been removed in the past and are now depleted and it can be done without significant adverse impacts upon other waterway uses, users or waterway stability, or • riparian vegetation has been cleared and no new source of large woody debris is readily available.	As there are no recorded snags within the Subject Site this clause does not apply, however there will be installation of snags within the BMP.
a) Proposals for snag management should: • clearly outline the objectives to be achieved, • document the action to be taken for each individual snag, • detail the methods and machinery to be used, and • specify the season or time period over which the works will be carried out.	The BMP will address these management aims.
b) As a general principle for timber snags, **lopping** should be considered as the first priority for the management of snags. Where lopping will not solve the immediate problem, **re-alignment** should be considered as the next possibility, followed by **relocation**. **Removal** of a snag is the least desirable option and should only be adopted as a last resort. Proposals for snag removal should be accompanied by a 7-part test and/or Species Impact Statement were proposed in areas that are TYPE 1 aquatic habitats (see Table 1 and section 2.6.9).	As there are no recorded snags within the Subject Site this clause does not apply, however there will be installation of snags within the BMP.
c) In general, snags that extend for a distance of less than 25% of the total stream width from the bank towards the stream centre should not be interfered with. Exceptions may be made for those snags which are causing deflection of water onto the riverbank and causing accelerated erosion. In these cases, the snag should be realigned or relocated in preference to being removed.	The BMP will address these management aims.
d) Where snag management is part of a wider stream restoration project, snag removal should be kept to a minimum and if possible, re-snagging should be undertaken to enhance the in-stream habitat.	The BMP will address these management aims.
e) Where snags are pointing upstream or at right angles to the bank and are deflecting water towards the bank, they should be realigned to point downstream so that water is deflected towards the centre of the stream. The base (or root wad) of the snag should be placed closely against the bank. However, in areas that are known habitat for Trout Cod, research has found that this species has a demonstrated preference for snags pointing upstream and therefore this guideline does not apply in these areas.	The BMP will address these management aims.

7.3.3 Blockage to Fish Passage

The current proposed stream realignment will not block fish passage and will remove an existing obstruction to increase available habitat. To ensure passage is not blocked during construction a temporary flow diversion channel is proposed, with a planned 72hr period to construct the diversion. It is considered unlikely this design would significantly impact volumetric flow rates; however hydrological testing would be required to confirm. **Table 13** assesses the proposal against fish passage guidelines.

Table 13 – Fish Passage Policy and Guidelines

Assessment Criteria	AEP Assessment
1) NSW DPI will consider habitat TYPE (sensitivity) and waterway CLASS when assessing development proposals that may create barriers to fish passage (see Tables 1 and 2). Permanent or temporary barriers on CLASS 1 or 2 waterways will not be approved unless adequate fish passage is provided. Please note that a temporary barrier to fish passage (including a temporary waterway crossing), is considered to be one that is used for a short time only (generally less than 6-12 months) while the construction of a permanent barrier or waterway crossing is constructed. Once the permanent barrier or crossing is completed, the temporary barrier is then removed.	All current blockages to fish passage will be removed and the stream realignment will be undertaken in accordance with DPI Fisheries design guidelines and ensure fish passage, within the entire Subject Site.
2) A permit is required for all works that may obstruct the free passage of fish whether permanently or temporarily in TYPE 1-3 habitats (see Table 1).	A dredge and reclamation permit will be lodged at Subdivision Works Certificate stage.
3) Developments that include one or more of the following aspects will require assessment by NSW DPI to ascertain whether they may create an obstruction to fish passage: • any development across the full width of a waterway that creates discontinuity in the flow including dams, weirs, regulators, waterway crossings, pipeline crossings and in-stream Regeneration measures. • any development which increases the mean stream velocity for a given cross-section through the constriction of flow (through pipes, culverts or channelised waterways) or leads to significant reductions in water depth (at wet crossings and causeways) (refer to section 4.2). • any development which prevents or impedes tidal inundation of a given area (e.g. through the installation or modification of a floodgate or similar structure) (refer to section 4.4). • any development which will result in the release of water into a waterway at a temperature that differs more than two degrees Celsius from receiving waters.	The design will ensure compliance with these measures and the BMP will provide regeneration of the highly degraded system.
4) NSW DPI requires that the environmental assessment for all in-stream works address potential impacts on lateral and longitudinal fish habitat connectivity and consideration must be given to potential impacts of barriers (including the	The proposed stream realignment is designed to meet DPI Fisheries guidelines and the riparian areas are to be regenerated and managed under a BMP.

Assessment Criteria	AEP Assessment
construction phase) on threatened species, populations, ecological communities or their habitat (including 'critical habitat') listed under Part 7A of the FM Act.	
a) The timing of any works should be planned so as not to interfere with the possible migration of fish within the waterway. Temporary blockages should not be placed within a waterway during the months of September to March, which are the key months when the majority of native fish are moving to spawn or recruit within NSW waters.	These measures will be incorporated into the BMP and CEMP.
b) The timing of works should coincide with low flow periods within the respective catchment.	These measures will be incorporated into the BMP and CEMP.
c) In-stream works (e.g. pads, coffer dams, sediment controls) should be designed and staged to avoid blocking the entire waterway. If the entire waterway is to be blocked, measures need to be implemented to maintain historic base flow conditions within the waterway (e.g. diversion channel) for the duration of the proposed works.	All current blockages to fish passage will be removed and the installation of the stream realignment will be undertaken in accordance with DPI Fisheries design guidelines and ensure fish passage, within the entire Subject Site.

8.0 Standard Precaution and Mitigation Measures

To ensure protection of aquatic environments Table 12 -14 provide comprehensive assessment in accordance the *Fisheries Management Regulations 2019* and Department of Primary Industries (Fisheries) Policies and Guidelines:

- Precaution and Mitigation Measures;
- Regeneration Measures; and
- Waterway Management.

Table 14 – Precaution and Mitigation Measures

Assessment Criteria	AEP Assessment
• Deployment of environmental safeguards (silt curtains, booms, etc) before, during and as long as necessary after construction of works to ensure there is no escape of turbid water into the aquatic environment. NSW DPI strongly recommends the use of The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004) (see www.landcom.nsw.gov.au/news/publications-and-programs/the-blue-book.aspx) when planning sediment and erosion controls in or adjacent to aquatic environments.	A sediment and erosion plan will be prepared in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004) and will ensure there is limited to impact on the water quality, especially during fish migration.
• Programming of work to ensure that it takes place during low flow periods (freshwater habitats) or during the lower half of the tidal cycle (tidal waterways).	Timing will be incorporated into the BMP to ensure compliance.
• Directions on the use of sediment and erosion controls for in-stream works to avoid impacts on water quality and fish passage. For example, where it is not possible to work in the dry (out of the water), a sediment or silt screen may be required around the entire work area, but should not extend across the waterway (as it may obstruct fish passage). Silt screens should be placed to isolate the works area and be attached to the same bank upstream and downstream of the work site. Sediment or silt screens should be inspected daily and maintained to prevent the escape of suspended sediments. Sediment control devices should not be removed until the risk of sedimentation and erosion is negligible and the site has been stabilised or revegetated following construction. Screens or other guards should be carefully removed after the work is completed. Silt screens should generally only be used in still water conditions. When placed in higher flows, water either spills over the top or lifts the curtains.	A sediment and erosion plan will be prepared in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004) and will ensure there is limited to impact on the water quality, especially during fish migration.
• Directions on the use of coffer dams or temporary access tracks to keep disturbance to the substrate and blockages to fish passage to a minimum. The use of temporary dam materials such as sheet piling will reduce impacts on the substrate. Coarse rock confined by gabion baskets or mattresses should be used in preference to sand or soil.	These measures will be incorporated in the BMP.

Assessment Criteria	AEP Assessment
• Provisions to protect fish during the dewatering process of any coffer dams or the clearing of screens. These should include: o discharging water into a bunded or screened site to allow fish to be rescued, o any fish caught in the dewatering process must be immediately released upstream (fish will want to continue migrating upstream) of the site, o pumps and screens must be of a suitable capacity and size, and pump velocities slow enough, to allow fish to escape during the dewatering process.	These measures will be incorporated in the BMP.
• Ensuring that foreshore works in estuaries are restricted to calm weather conditions. This helps prevent the suspension of fine sediment particles into the water column and ensures the silt screen is not disturbed by wave action.	N/A
• Ensuring that river works in freshwater environments are restricted to periods of low flow.	These measures will be incorporated in the BMP.
• Providing direction on the stockpiling of fill or excavated materials on flood prone lands to avoid sedimentation. Particular care should be made in siting stockpiles and dumps. Preferred sites should be situated either above the highest astronomical tide, or be secure from a 1 in 10-year flood and have effective sediment control measures in place to contain any runoff.	These measures will be incorporated in the BMP.
• Ensuring that only natural material is used as fill during reclamation works. Contaminated material, tyres, building and demolition rubble or acid sulfate soils (ASS) should not be used as fill in any aquatic environment.	These measures will be incorporated in the BMP.
• Directions on the use and maintenance of buffer zones around the immediate area of the proposed works to ensure that sediment is controlled off site and impacts on the surrounding ecosystem are kept to a minimum.	These measures will be incorporated in the BMP.
• Ensuring that the area is rehabilitated after completion of works in accordance with a NSW DPI approved method or plan. This may involve establishment of native riparian vegetation.	These measures will be incorporated in the BMP.

Table 15 – Regeneration Measures

Assessment Criteria	Assessment
1) As noted in general policy 7 in section 3.1, NSW DPI enforces a 'no net loss' habitat policy as a permit condition or condition of consent. This may require proponents to conduct habitat Regeneration and/or provide environmental compensation. A monetary bond or payment may be required to be lodged with NSW DPI to ensure the works are completed in accordance with the	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage;

Assessment Criteria	Assessment
permit conditions (see section 3.3.4 below for further information on bonds).	• Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; and • Installing snags; and Rehabilitating vegetation within the riparian corridor.
2) NSW DPI calculates habitat compensation on a minimum 2:1 basis for all key fish habitat (TYPE 1-3 in Table 1) to help redress other indirect impacts of development. A greater compensation ratio may be considered if opportunities for compensation are not available in the vicinity of, or of the type of, habitat that has been lost. Please note that compensation for disturbances to SEPP 14 coastal wetlands (which may include TYPE 1 and 2 habitats) requires approval from the Department of Planning and Infrastructure and a ratio of 10:1 generally applies. This is calculated at the rate of $51/m26 for marine and freshwater vegetation which equates to $102/m2 to meet the 2:1 habitat offset requirement.	Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat.
3) NSW DPI does not support seagrass transplanting as an impact compensation measure as the viability of transplanting methods is yet to be scientifically proven for all species (see Ganassin and Gibbs 2008). Transplanting may be allowed in future for those species where viability is scientifically proven. In circumstances where seagrass is likely to be negatively impacted and cannot be avoided or mitigated, environmental compensation will be required and calculated in line with the rate outlined in point 2 above.	N/A
4) In the case of mangroves and saltmarsh, transplanting the vegetation from the impact site to the compensation site may be required.	N/A
5) NSW DPI requires a management plan be developed for any compensatory area of habitat that ensures: • replanting, transplanting and monitoring methods are documented in accordance with the permit conditions; • the site is suitable for habitat creation (e.g. is of suitable substrate and depth, not exposed to excessive pollution); • in the case of revegetation, species used must be endemic to the area and suitable for the site; • performance indicators are set to adequately measure success of the project over time and to identify where responses are not being achieved.	These measures will be incorporated within the BMP.
a) Opportunities to enhance and/or protect existing key fish habitat, and to avoid direct or indirect impacts on such habitats is preferred and should always be explored as a first option.	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within

Assessment Criteria	Assessment
	the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
b) NSW DPI supports strategic resource investment such that Regeneration efforts should primarily be invested in areas where there is likelihood of Regeneration success (key fish habitats with high recovery potential).	Given the high level of degradation within Lochinvar Creek the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat.
c) Subject to point b above, habitat Regeneration and compensation should take place as close as possible to the site of the impact to achieve 'no net loss' of habitat within the area affected and the catchment as a whole.	The stream realignment will occur approx. 50m south of the existing watercourse. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
d) Pre-development habitat compensation (i.e. prior to disturbance) is recommended over post-development compensation (i.e. after the habitat is lost).	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
e) Repair of degraded habitat is recommended over habitat creation and should be conducted as close to the site of proposed 'habitat loss' as possible.	The stream realignment will occur approx. 50m south of the existing watercourse.

Assessment Criteria	Assessment
	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
f) Transplanting of aquatic vegetation should only be undertaken if an appropriate donor site is available or where re-establishment is likely to be successful (e.g. plants with vegetative growth and fairly shallow roots – e.g. sedges and rushes). NSW DPI recommends that donor sites are selected in consultation with the local Aquatic Habitat Protection Unit staff (see Appendix 5 for contact details). Mangrove Regeneration projects/activities should be undertaken in accordance with the NSW DPI "Mangroves" Primefact (Primefact No. 746) available on the NSW DPI website at www.dpi.nsw.gov.au.	N/A – transplanting is not proposed.
g) Where affected habitat is less sensitive, secondary compensation may be more appropriate than implementing a 'like for like' habitat replacement policy. For example, in catchments and/or estuaries where the habitat being replaced is not sensitive or under threat, alternative environmental measures may achieve greater environmental gain (e.g. removal of 1 ha of river mangrove might require the transplanting of 2 ha of endangered saltmarsh).	The existing creek is highly degraded and regeneration measures will result is net gain of KFH.
h) Habitat Regeneration efforts should be directed at achieving the maximum benefits for fish habitat and fisheries. Local councils, government departments, community groups or individuals who wish to rehabilitate degraded marine, estuarine or freshwater aquatic habitats should discuss their proposals with NSW DPI. This will ensure that efforts are directed at key fish habitat areas as a priority, methods used are appropriate and relevant approvals are obtained prior to the commencement of works.	The stream realignment will occur approx. 50m south of the existing watercourse. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and

Assessment Criteria	Assessment
	• Rehabilitating vegetation within the riparian corridor.

Table 16 – Urban Streams Policy Assessment

Maintaining fish passage in urban streams	
Assessment Criteria	**Assessment**
1) NSW DPI must be consulted in regard to urban stream works that will obstruct fish passage as they may require a permit under the FM Act.	A Dredge and Reclamation Permit will be submitted at the Subdivision Works Certificate stage.
2) NSW DPI will treat artificial habitats that are linked to natural habitats upstream as 'on-line systems'. As such, NSW DPI will generally require that the created lands provide for connectivity between habitats including continuous fish passage.	Fish passage will be restored to this section of Lochinvar Creek, through the proposed development.
3) NSW DPI requires that off-line artificial habitats be designed to have minimal impact on adjacent natural systems or receiving waters. Diversion of flows from natural habitats into off-line artificial wetlands will generally not be approved.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
4) NSW DPI requires that detention ponds and other stormwater treatment devices should be located off-stream and at-source to ensure they do not interfere with fish passage.	All proposed offline.
5) NSW DPI will generally only support the creation of artificial wetlands when they are not at the expense of existing natural habitat.	N/A
Water Management in Urban Areas	
1) NSW DPI will generally not support proposals that damage, destroy or alienate existing key fish habitats in the process of creating new development in urban areas.	The stream realignment will occur approx. 50m south of the existing watercourse. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
2) NSW DPI will require water quality controls used to treat run-off to be located in areas where treatment can occur prior to discharge into the riparian zone and stream channel.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
3) NSW DPI will generally not approve proposals to construct new sewage outfalls, stormwater drains and outlet structures that will discharge within 100 m of TYPE 1 and 50 m of TYPE 2 marine vegetation (see Table 1) unless effective compensation is provided.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.

Maintaining fish passage in urban streams	
Assessment Criteria	**Assessment**
4) NSW DPI will require the environmental assessment of development proposals in urban areas to address the cumulative impacts on water quality and quantity including the management of stormwater, potential Acid Sulfate Soil and salinity issues, groundwater and land contamination, water volumes and flow velocities.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
5) NSW DPI will require new urban development proposals to achieve 'no net impact' upon the receiving waterway from water quality and quantity and flow velocity. NSW DPI therefore requires the environmental assessment of any development proposals to take account of the existing water quality and flow conditions of the receiving waterway.	Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat.
a) There are many tools used to achieve water-sensitive urban design, the appropriateness of each being dictated by site characteristics. In general, the objective is to reduce the volume and improve the quality of water leaving a site. OEH has several useful technical documents on water sensitive urban design and stormwater management which can be accessed via www.environment.nsw.gov.au under "stormwater".	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
b) Development Control Plans developed for urban catchments should include provisions to ensure that there is no net increase in runoff and no reduction in water quality of receiving waters from urban areas.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
c) Stormwater treatment devices should be checked and maintained regularly. Management and maintenance plans should be developed and implemented.	All stormwater management systems will be designed in accordance with council requirements and ensure compliance with WSUD principles.
d) SEPP 62 (Sustainable Aquaculture) requires the referral to NSW DPI of any proposal that might impact on water quality in an oyster growing area. SEPP 62 can be viewed at www.legislation.nsw.gov.au	N/A
Minimising habitat alteration	
1) NSW DPI will generally not support or approve the permanent piping or channelising of CLASS 1 2 or 3 waterways.	Permanent piping or channelising is not proposed.
2) NSW DPI will generally not support or approve permanent realignment works in TYPE 1 and 2 habitats.	The subject site has been determined to be TYPE 3 habitat and Class 3 waterway. Assessment under the WM Act determined the Subject Site is considered an order 1 stream under the Strahler ordering system, and is therefore unlikely to represent key fish habitat (refer AEP RAR, 2024). The stream realignment will occur approx. 50m south of the existing watercourse.

Maintaining fish passage in urban streams	
Assessment Criteria	**Assessment**
	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor. The proposed rehabilitation measures will ensure high quality Type 1 and 2 KFH is present post-development.
3) Temporary piping, channelizing or realignment works may be considered for public infrastructure projects (e.g. public road projects) where the works are short time only (generally less than 6-12 months) and the final construction of permanent works will result in the achievement of NSW DPI's no net loss policy (see section 3.3.3).	These measures will be incorporated into the BMP.
a) If proposed stream works in a given area achieve clear environmental improvements (including fish passage, habitat and water quality outcomes), certain channel modifications may be approved on a case-by-case basis. For example, major stream works may be approved in heavily degraded urban streams that are isolated from key fish habitat upstream and downstream.	The stream realignment will occur approx. 50m south of the existing watercourse. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
b) Where channel modification is approved (e.g. in degraded areas), streams should remain as open channel systems.	The proposed stream will remain and open channel.
c) Channel modification designs should include natural stream features including meanders, pools, riffles, bars and riparian and in-stream vegetation.	The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features

Maintaining fish passage in urban streams	
Assessment Criteria	**Assessment**
	and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
d) Regeneration of existing streams is recommended as opposed to construction of new channels.	The stream realignment will occur approx. 50m south of the existing watercourse. The Subject Site is highly degraded and not able to naturally regenerate, regulate water quality or provide habitat for fish communities. The proposed development will aim to provide these features within the BMP Lands via reconstruction of instream features and the riparian corridor. The proposal will improve the quality of KFH by: • Removing a barrier to fish passage; • Excluding cattle from the riparian corridor; • Constructing addition instream habitat features such as pools and riffles; • Regenerating freshwater wetland; • Installing snags; and • Rehabilitating vegetation within the riparian corridor.
e) Regeneration efforts, including the removal of concrete and other artificial stream linings and restoration of stream morphology and vegetation, are supported, particularly in CLASS 1-3 waterways where fish communities and opportunities for fish passage are greater. Such efforts should focus on enhancing the connectivity of the Regeneration works with other sections of key fish habitat (see Table 1).	In stream obstructions will be removed and a natural channel design will be rehabilitated.
Protecting urban riparian vegetation	
1) NSW DPI requires that developments within urban areas be designed in a manner that protects the natural values of the existing riparian zone and ensures that the protected zone functions as a 'natural' system.	Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat.
2) NSW DPI will assess urban development proposals on a case-by-case basis but with due regard to the cumulative impacts of development on riparian vegetation and key fish habitat (see Table 1).	Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat.
3) NSW DPI will require riparian buffer zones to be established and maintained for developments in	Assessment of the catchment identified impacts of urban development and historical rural agricultural

Maintaining fish passage in urban streams	
Assessment Criteria	**Assessment**
or adjacent to TYPE 1 or 2 habitats (see guidelines below). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment). Riparian buffer zones shall be measured from: 4) the highest astronomical tide level in tidal areas (generally 1.0 m AHD), or 5) from the top of the bank/drainage depression along CLASS 1 to 3 waterways (see Table 2). 6) NSW DPI will require the design of riparian buffer zones to incorporate the maintenance of lateral connectivity between aquatic and riparian habitat. Installation of infrastructure, terraces, retaining walls, cycle ways, pathways and grass verges within the riparian buffer zone shall be avoided or minimised.	land use, and findings from the Riparian Assessment Report (AEP, 2024) determined the Subject Site is commensurate with an order 1 stream. Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat. The BMP Lands will include approx. 20m either side of the Creek.
a) NSW DPI will assess the width of the riparian buffer zone based on the habitat TYPE and waterway CLASS (see Tables 1 and 2), the possible extent of the disturbance and the susceptibility of the riverbank to erosion. As a guide the following are recommended: • TYPE 1, CLASS 1: 100 metres • TYPE 2, CLASS 2-3: 50 metres • TYPE 3, CLASS 3-4: 10-50 metres For guidelines on designing filter strips for this purpose (including appropriate widths) please refer to Prosser and Karssies (2001) (see Appendix 2). Advice on protecting aquatic macrophytes in wetlands and shallow lakes can be obtained from Bailey *et al.* (2002) (see Appendix 2).	Given the high level of degradation within the Subject Site the proposed regeneration, under the management of a BMP, will provide a net gain in Aquatic and riparian habitat. The BMP Lands will include approx. 20m either side of the Creek.
b) Riparian buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and public access management).	This measure will be incorporated into the BMP.

9.0 Permits Required

9.1.1 *Fisheries Management Act 1994*

The above assessment results require the following permits:

- Permit under *Section* 201 permit to carry out works of dredging or reclamation.
- Permit under Section 219 to block fish passage. The blockage is temporary to allow for reconstruction of the stream and fish passage will be fully restored after completion of the installation, including the removal of an existing instream obstruction.

Application for the above permits should be prepared and approved prior to issuing of Subdivision Works Certificate.

10.0 Recommendations

The following general recommendations are made for consideration to minimise localised impacts on biodiversity in general, and to ensure overall improved environmental outcomes for aquatic flora and fauna habitat in the locality, as a result of the proposal:

- Implementation of the BMP;
- Prior to construction, a suitably experienced and qualified Project Ecologist should be appointed to oversee ecological works to mitigate construction impacts on native biota welfare;
- Prior to construction commencing, temporary construction fencing and signage will be installed to delineate construction zone from retained riparian vegetation;
- No machinery or material should be stored within retained vegetation or within the dripline of retained trees;
- Equipment should be cleaned thoroughly and disinfected before entering and exiting site to prevent weed and disease introduction such as *Phytophthora cinnamomi* (Root-rot fungus), *Puccinia psidii* (Myrtle Rust) and others;
- Bridge and culvert designs should incorporate recommendations in DPE guidelines: *Controlled activities – Guidelines for watercourse crossings on waterfront land* and DPI Fisheries guidelines: *Policy and Guidelines for Fish Friendly Waterway Crossings* and *Why do fish need to cross the road?*
- The removal of in-stream woody debris should be minimised where possible during construction;
- Construction should occur in stages to ensure continual flow of the river;
- Construction should occur during periods of reduced flow;
- Bank stabilisation measures should be implemented during construction and operation of the of the crossings to minimise erosion risk. This could include localised reshaping of the incised bank, installation of ground stabilising matting and/or terracing, and revegetation using suitably dense planting of groundcovers, trees, and shrubs. Such works are to be undertaken and managed under an approved five-year BMP;
- Aquatic floating screening should be utilised around the extent of the works area to ensure that mobilised sediment and debris is not distributed into the wider system;
- Erosion and Sediment plan must be prepared prior to commencement of works; and
- It is recommended approval is conditioned to provide a Construction Environmental Management Plan that specifies the procedure for waste disposal during construction.

11.0 Conclusion

The proponent engaged AEP to prepare an Aquatic Ecology Assessment to determine the presence of Key Fish Habitat, its condition, and appropriate management actions to avoid or minimise impacts.

The unnamed creek is present in a highly degraded condition within the Subject Site, with a blockage to fish passage present. Field surveys did not identify native fish. A high level of bank and bed erosion was observed due to the impacts of cattle. The combination of blockages and highly degraded nature of the unnamed creek resulted in a classification of Type 3 – minimally sensitive key fish habitat.

The proposed development has avoided and retained the only patch of native riparian vegetation within the Subject Site. A BMP is proposed to restore fish passage and construct fish habitat within the Subject Site and regenerate aquatic habitat and riparian land. The stream realignment will construct KFH features such as pools, meanders and riffles, and will provide a net gain in catchment health, increasing the quantity and quality of fish habitat.

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Appendix A – Design Plans

240332-ESK-022(A)

PROPOSED STORMWATER BASIN

PROPOSED RESIDENTIAL LOTS. SUBJECT TO CONFIRMATION

EXISTING WATERCOURSE TO REMAIN

BATTER MAX 1V:4H

BATTER MAX 1V:6H

PROPOSED BERM

MEANDERING BASE FLOW CHANNEL

PROPOSED PARK

EXISTING WATERCOURSE TO BE REALIGNED

DISCONTINUATION OF HIGH FLOW BANK ALONG DISPERSION AREA

EXISTING DISPERSION AREA TO BE RETAINED

HIGH FLOW BANK

TOP OF BANK

TOP OF BANK

PROPOSED ROAD

PROPOSED PATH

APPROX. LOCATION OF FUTURE CULVERT SUBJECT TO AURA ROAD WIDENING

08% TYP.

BATTER MAX 1V:4H

EXISTING HEADWALL TO BE EXTENDED

PROPOSED ACCESS TRACK

BATTER MAX 1V:4H

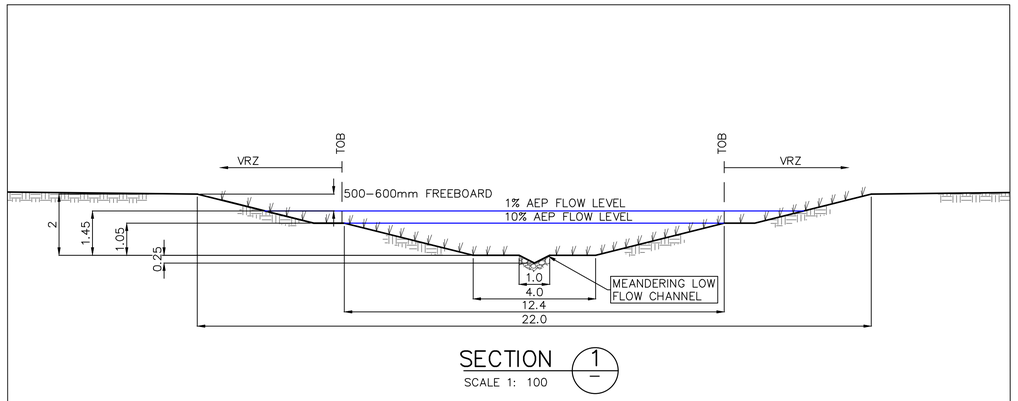
LOCHINVAR CREEK TRIBUTARY (FIRST ORDER)

CENTRAL CULVERT OUTLET TO BE RECESSED FOR FISH PASSAGE

EXISTING COMMS SERVICE TO BE ADJUSTED AS REQUIRED

EXTEND EXISTING DN600 TO WATERCOURSE

EXISTING 'HEREFORD HILL' SUBDIVISION



SECTION 1
SCALE 1: 100

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- LIMIT OF CONSTRUCTION
- 18 DESIGN SURFACE CONTOUR
- PROPOSED KERB
- EXISTING KERB
- PROPOSED STORMWATER
- C EXISTING COMMS
- ex g EXISTING GAS
- ex w EXISTING WATER
- EXISTING WATERCOURSE
- HYDROLINE
- EXISTING ELECTRIC POLES
- PROPOSED POOLS (SUBJECT TO DETAILED DESIGN)
- LAND TO WHICH THE VMP APPLIES

MGA

ver.	date	comment	drawn	pm	co-ordinate information	level information	scale (A1 original size)	notes
A	16.05.2024	INITIAL ISSUE	DN	ML	CO-ORDINATE SYSTEM: MGA 56	DATUM: GDA94 CONTOUR INTERVAL: 0.5m	0 12.5 25.0m SCALE: 1:500 (FULL)	FOR INFORMATION ONLY

drawing title:

WATERCOURSE CONCEPT PLAN

location: NEW ENGLAND HIGHWAY AND WYNDELLA ROAD, LOCHINVAR

council: MAITLAND CITY COUNCIL

dwg ref: 240332-ESK-022(A)

client: CPG ESTATES

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working beyond expectations

Appendix B – Riparian Assessment Report

AEP

BIODIVERSITY | BUSHFIRE | ARBORICULTURE

NEWCASTLE SYDNEY

Riparian Assessment Report

898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW

Prepared for: Lochinvar Developments Pty Ltd

C/- ADW Johnson Pty Ltd

AEP Ref: 2699

Revision: 01

July 2024

Newcastle | Sydney
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Document Control

Document Name	Riparian Assessment Report for 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW
Project Number	2699
Client Name	Lochinvar Developments Pty Ltd C/- ADW Johnson Pty Ltd
AEP Project Team	Brendon Young Jarod Baxter Kathleen Bushell Chris Wark Natalie Black

Revision

Revision	Date	Author	Reviewed	Approved
00	26/06/2024	Jarod Baxter	Brendon Young	Natalie Black
01	19/07/2024	Jarod Baxter	Brendon Young	Natalie Black

Distribution

Revision	Date	Name	Organisation
00	26/06/2024	Matthew London	ADW Johnson Pty Ltd
01	19/07/2024	Matthew London	ADW Johnson Pty Ltd

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Abbreviations

API	Aerial Photography Interpretation
CAA	Controlled Activity Approval
DA	Development Application
DPI	NSW Department of Primary Industries
DPE	NSW Department of Planning and Environment
DPIE	The former NSW Department of Planning, Industry and Environment
LGA	Local Government Area
NEH	New England Highway
NRAR	Natural Resource Access Regulator
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
SEED	Sharing and Enabling Environmental Data in NSW
SVTM	State Vegetation Type Mapping
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WFL	Waterfront Land
WFLT	Waterfront Land Tool
WM Act	*Water Management Act 2000*
WM Regulations	*Water Management (General) Regulation 2018*

1.0 Introduction

Anderson Environment & Planning was commissioned by ADW Johnson to undertake a Riparian Assessment Report (RAR) to determine the presence of Waterfront Land within the Subject Site. 'Waterfront land' is defined as the bed of any river, lake or estuary, and the land within 40 metres of the river banks, lake shore or estuary mean high-water mark (NSW Department of Planning, Industry and Environment, 2020).

This report has been prepared in accordance with NSW Department of Planning, Industry and Environment, Natural Resources Access Regulator, 2020, Waterfront Land Tool (WFLT). The WFLT was developed by the Department to assist applicants determine what is waterfront land under the controlled activity provisions of the Water Management Act 2000 (WM, Act) within a Subject Site.

The WFLT identifies waterfront land based on consideration of three key factors:

- The presence of defined bed and banks;
- Evidence of flow and geomorphic features; and
- A change in vegetation indicating a wetland.

The WFLT steps through a series of questions to ensure that the right information is assessed to determine the presence or absence of these features and whether the combination of features is indicative of waterfront land. The results of which allow an applicant to prepare ground-truthed map showing the location of waterfront land to inform the required Vegetated Riparian Zones (VRZs) for the Controlled Activities Approval (CAA).

AEP has undertaken the desktop and field assessment to prepare RAR to inform the requirements of a CAA for potential residential subdivisions at 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW, refer **Figure 1**.

For the purposes of referencing, this document should be referred to as:

> Anderson Environment & Planning (2024). *Riparian Assessment Report for 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW.* Unpublished report for ADW Johnson.

2.0 Site Particulars

Table 1 – Site Details

Detail	Comments
Client	ADW Johnson
Address	898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd Lochinvar, NSW
Title(s)	Lot 2/DP 747391; Lot 3/DP 747391; Lot 4/DP 747391; Lot 5/DP 747391; Lot 6/DP 747391; Lot 12/DP 1219648; Lot 13/DP 1219648; and Lot 9/DP 747391.
Study Area	The Study Area encompasses the entirety of Lot 2/DP 747391; Lot 3/DP 747391; Lot 4/DP 747391; Lot 5/DP 747391; Lot 6/DP 747391; Lot 12/DP 1219648; Lot 13/DP 1219648; and Lot 9/DP 747391, and all upstream tributaries mapped by Water Management (General) Regulation 2018 hydroline spatial data 1.0 and associated Waterfront Land as defined by the *Water Management Act 2000* (**Figure 1**).
Subject Site	The Subject Site approx. 22.54ha, consists rural land currently being grazed. The vegetation is dominated by pasture grasses, exotics and weeds with remnant native vegetation dominate by scattered paddock trees
LGA	Maitland City Council
Zoning	C3 - Environmental Management: (pub. 21-4-2023) R1 - General Residential: (pub. 21-4-2023)
Current Land Use	The Study Area is a vacant, fenced lot consisting of unmanaged grassland and hydrolines, likely historically used as pasture.
NSW River Condition Index	This map describes the riverine condition. It is used to combine a range of indicators into a single condition score. The indicators include riparian vegetation, geomorphic condition, hydrologic stress, biodiversity, catchment disturbance and water quality. The Subject Site is mapped as “Very Poor”.
NSW River Styles Mapping	This map describes the physical characteristics and diversity of rivers and assesses geomorphic stream condition. It considers their capacity to adjust, sensitivity to change due to disturbance, and the pressures (natural and human) that affect their geomorphic condition. The Geomorphic stream condition of the Subject Site is mapped as “Poor”.
High Ecological Value Aquatic Ecosystem (HEVAE) Mapping	This map describes a range of instream values and their importance for NSW freshwater river reach. This includes values such as diversity, distinctiveness, naturalness and vital habitat. NSW HEVAE Instream Value is “Low” within the Subject Site.
Proposed Development	The proposed development includes a residential subdivision within the Lochinvar Urban Release Area.

AEP

Figure 1 - Site Location

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699

3.0 Methodology

The WFLT requires assessment of both desktop and field components to determine the status of waterfront land.

3.1 Information Sources

Information and spatial data provided within this RAR has been compiled from various sources including:

- Department of Planning, Industry and Environment (2020), Natural Resources Access Regulator Waterfront Land Tool;
- Aerial Photograph Interpretation (API) of the site and surrounding locality using the latest NSW Spatial Services (SIX Maps) and NearMap imagery, accessed May 2024;
- NSW Government (2018) *Determining Stream Order* Fact Sheet;
- *Water Management (General) Regulation 2018 Hydroline spatial data 1.0*, accessed May 2024 (refer **Appendix A**);
- SVTM v2.0 for native vegetation of southeast NSW; and
- Collective knowledge gained from previous ecological survey and assessment in the area over the past 30 years.

3.2 Desktop Assessment

The desktop assessment consists of a historical assessment and State mapping review to inform the report and established data for field assessment.

3.2.1 Historical Assessment

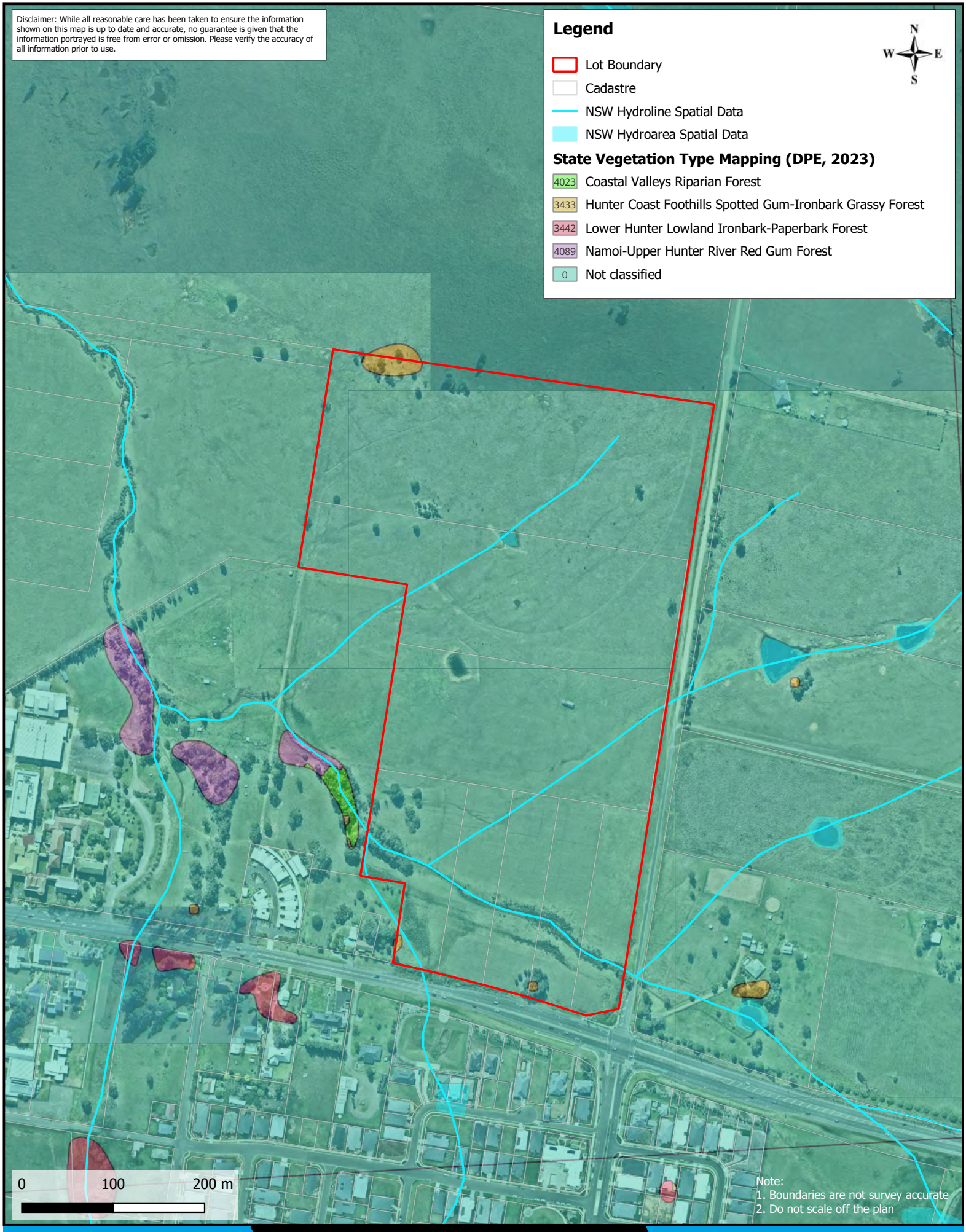
Review of historical API revealed a number of impacts to the mapped reach, upstream of the Subject Site, likely to influence the presence of waterfront land:

- The New England Highway was constructed bisecting the Study Area and channels water along road side swales were flow traverses the highway via a series of culverts;
- Larger urban developments on the southern side of the NEH have resulted in the construction of significant stormwater infrastructure including stormwater drainage systems, on-site detention systems and detention basins. A large detention basin collects water and discharge through culverts under the NEH within the Study Area; and
- Numerous farm dams have been historically constructed on mapped hydrolines throughout the reach Study Area.

3.2.2 State Mapping Review

AEP undertook a detailed assessment of the current State mapping programs where the following was determined and used to establish the field proforma for the Subject Site:

- STVM v2.0 accessed via the SEED Portal (May 2024) was utilised to identify vegetation communities occurring within the Subject Site (**Figure 2**);
- *Water Management (General) Regulation 2018 Hydroline spatial data 1.0* was used to show Strahler Stream Order in accordance with Schedule 2 of the *Water Management (General) Regulation 2018* (**Figure 3**); and
- The literature review, historical assessment and the Strahler Stream ordering is used to establish the survey sites and allocate segments for assessment in the field (**Figure 4**).



AEP

Figure 2 - State Vegetation Type Mapping (DEP, 2023) Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd AEP ref: 2699

AEP

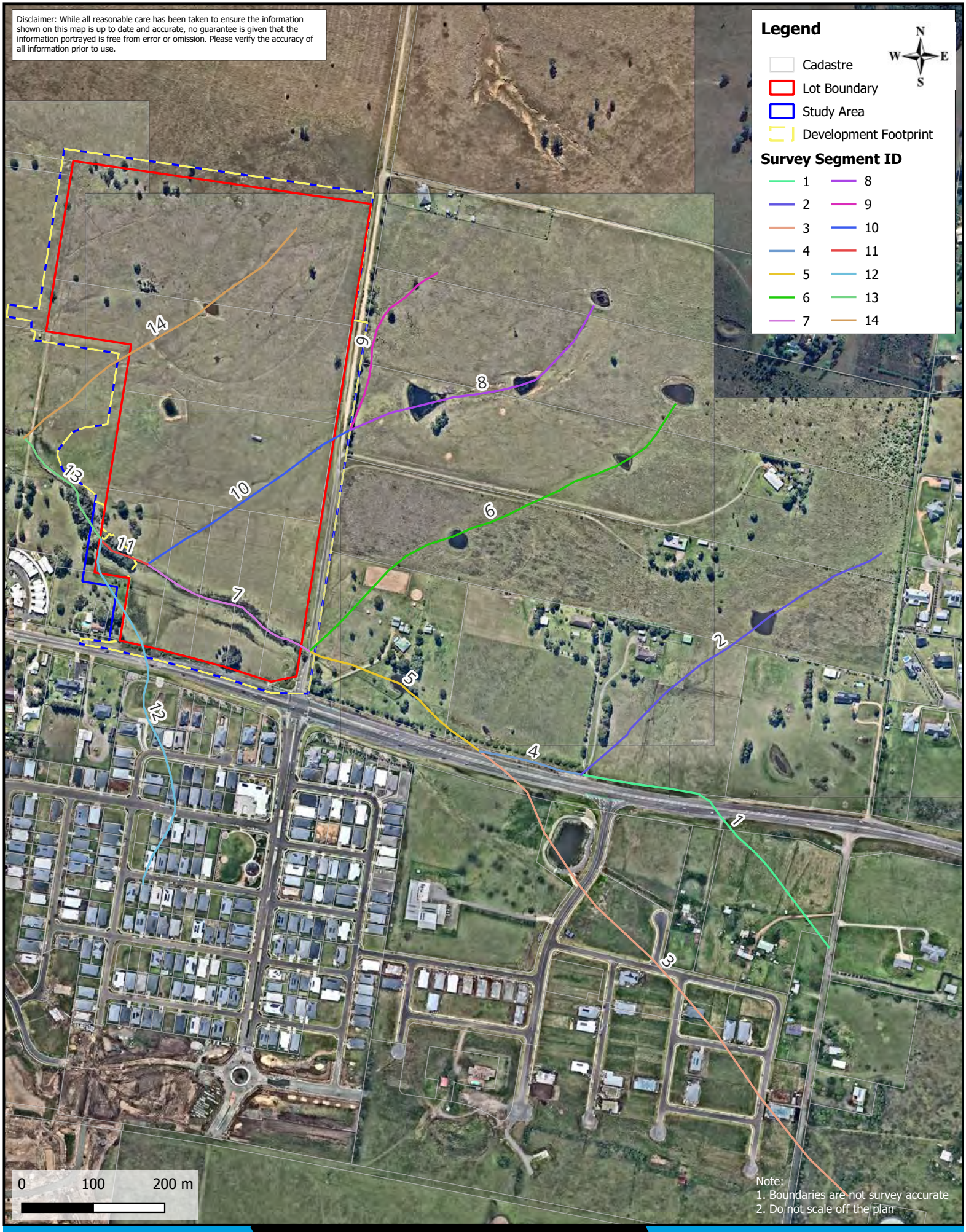
Figure 3 - NSW Hydroline Data

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699



AEP

Figure 4 - Hydroline Segment ID

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699

3.3 Site Assessment

The mapped hydrolines within the Subject Site were assigned individual Segment ID numbers (refer **Figure 4**) and assessed at various survey points with the mapped WFLT.

Desktop stream order indicated two (2) 1st order streams two (2) 2nd order streams and one (1) 3rd order stream was mapped within the Study Area. As a result, fifteen (15) hydroline segments and eighteen (18) survey points were identified for investigation. General observations outside of the Subject Site were undertaken to assess the hydrolines in the broader locality (refer **Figure 5** for survey effort). Investigations for streams outside of the Subject Site consist of roadside visual inspections and further desktop analysis.

The following data was collected at each Survey Point in accordance with the WFLT to ground-truth desktop level assessments:

- Identification of defined bed and banks;
- The location of the top of bank and high bank;
- Identification of the type of watercourse present;
- Determine and notate watercourse features;
- Determine presence of any Lakes or Wetlands; and
- Determine and notate any changes in vegetation communities indicating the presence of a wetland.

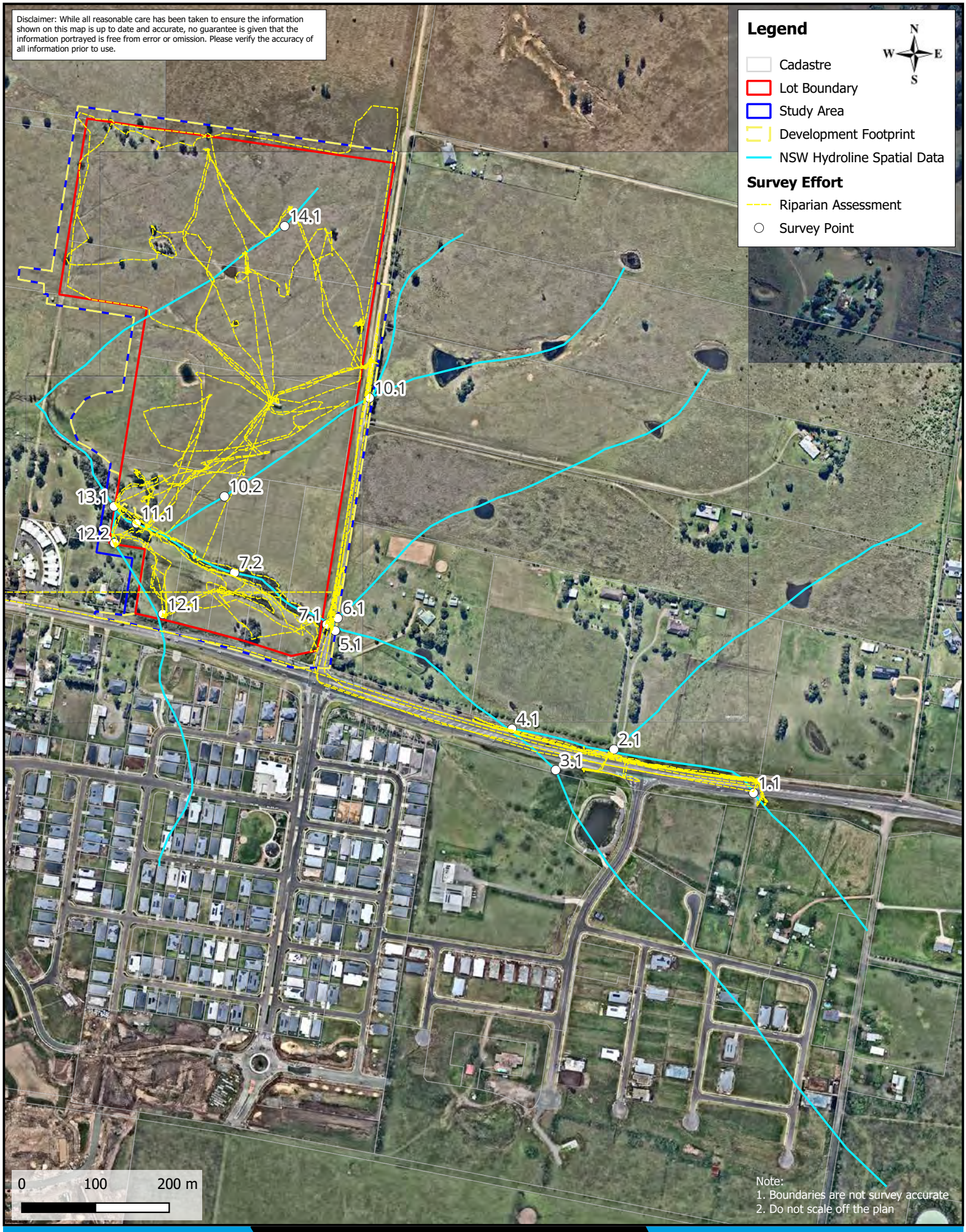


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Figure 5 - Survey Effort

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699

4.0 Site Assessment Results

Fieldwork was conducted on 23rd and 30th August 2022 and the 20th May 2024 to assess desktop determined Survey Points with the WFLT.

Site investigations to ground-truth waterfront land for the purpose of determining appropriate Vegetated Riparian Zones (VRZs) based on current hydrology and geomorphology identified some variation from the mapped hydrolines and stream order. Results of the WFLT site assessment are provided in **Tables 2-16**.

Table 2 – Segment ID 1 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 1.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 1 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 1.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and Outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 1 is mapped as a 1st order stream and the location is now occupied by a swale along the NEH. Urban development has altered the hydrological and geomorphological characteristics of the landscape. The inspection showed stormwater infrastructure through an urban environment. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland were identified. Survey Point 1.1 does not constitute waterfront land.		

Site Photos – Survey Point 1.1

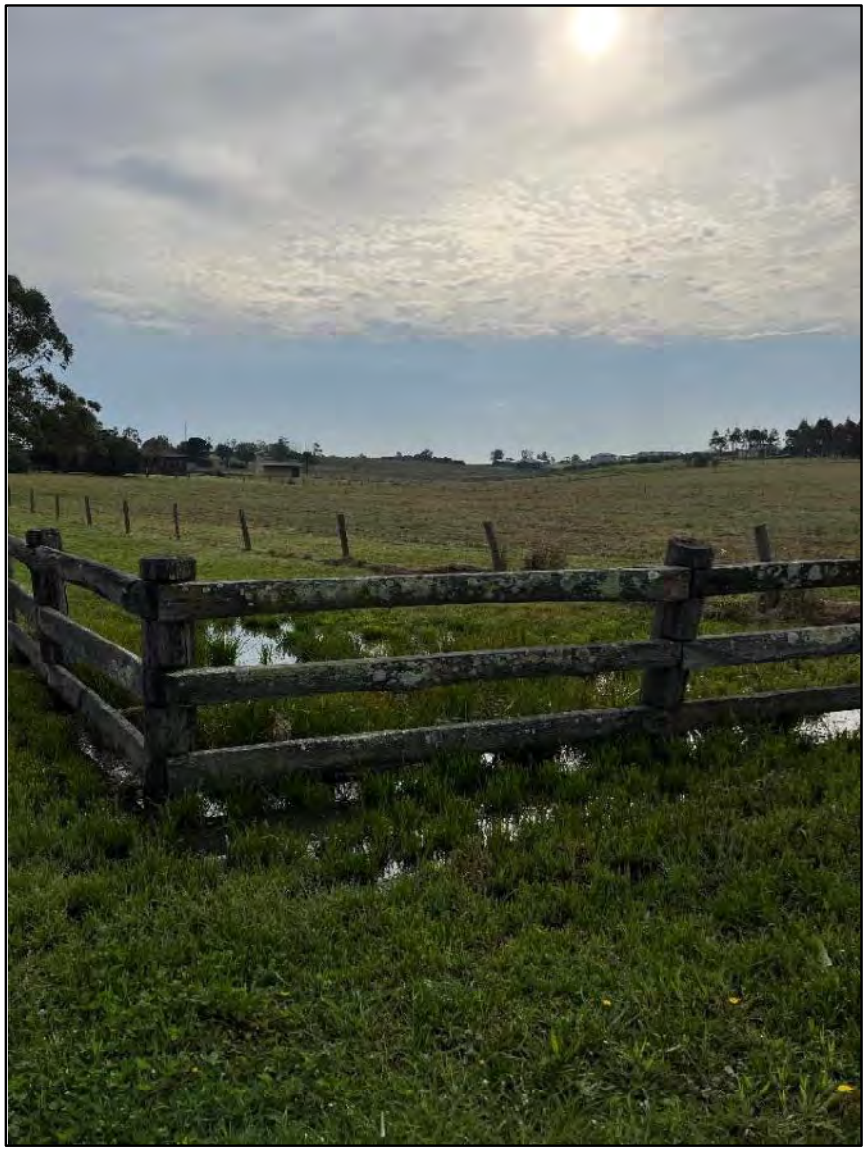
Survey Point 1.1

Table 3 - Segment ID 2 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 2.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 2 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 2.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 2 is mapped as a 1st order stream. No WFL features, such as a defined bed and bank, or a change in vegetation indicating a wetland were identified. A farm dam is visible on aerial photography north east of Survey Point 2.1, and likely historical land use for agriculture has altered the surface hydrology and geomorphology of the mapped hydroline. Survey Point 2.1 does not constitute waterfront land.		

Site Photos – Survey Point 2.1



Survey Point 2.1 - mapped upstream

Table 4 – Segment ID 3 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 3.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 3 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 3.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 3 is mapped as a 1st order stream. A roadside swale along the NEH and recently constructed detention Basin for a subdivision development on the southern side of the NEH have likely altered the hydrological and geomorphological characteristics of the landscape. The inspection showed stormwater infrastructure through an urban environment (swales, culverts and detention basin). No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland were identified. Survey Point 3.1 does not constitute waterfront land.		

Site Photos – Survey Point 3.1

Survey Point 3.1 mapped upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 3.1 mapped downstream

Table 5 – Segment ID 4 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 4.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	2	Based on the desktop assessment, Segment ID 4 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 4.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 4 is mapped as a 2nd order stream and the location is now occupied by a swale along the NEH. Urban development has altered the hydrological and geomorphological characteristics of the landscape. The previously mapped hydroline is not present. The inspection showed stormwater infrastructure through an urban environment. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland were identified. Survey Point 4.1 does not constitute waterfront land.		

Site Photos – Survey Point 4.1

Survey Point 4.1 – mapped upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 4.1 – mapped downstream

Table 6 – Segment ID 5 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 5.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 5 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 5.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 5 is mapped as a 2nd order stream. Urban development has altered the hydrological and geomorphological characteristics of the landscape. The adjacent rural property is occupied by a farm dam and dam overflow flows under an internal access road culvert and along a straight drainage channel to an existing culvert under Wyndella road. The inspection showed farm and stormwater infrastructure through a modified environment. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland were observed. Survey Point 5.1 does not constitute waterfront land.		

Site Photos – Survey Point 5.1

Survey Point 5.1 – mapped upstream

Table 7 – Segment ID 6 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 6.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 6 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 6.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	N/A	Not applicable	-
Comments	Segment 6 is mapped as a 1st order stream. Rural development has altered the hydrological and geomorphological characteristics of the landscape. Multiple farm dams and a horse training yard occupy the upstream area mapped as Segment 6. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland. Survey Point 6.1 does not constitute waterfront land.		

Site Photos – Survey Point 6.1

Survey Point 6.1

Table 8 – Segment ID 7 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 7.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	2	Based on the desktop assessment, Segment ID 7 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 7.1			
Defined Bed and Banks (Yes / No)	Yes	Defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	Type 3b	Laterally Unconfined Continuous – Low Sinuosity	6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	Yes	Pools, Erosion, Deposition	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	Riparian vegetation is present, such as Casuarina and *Juncus usitatus,* however a wetland is not present.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	Yes		7
Ground-truthed Waterfront Land present?	Yes	The survey identified a defined bed and bank, and watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does constitute waterfront land.	7
Ground-truthed Numbering to Determine VRZ	1	Under *Water Management (General) Regulation 2018* Schedule 2, Survey Point 7.1 is	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
		considered Order 1 for the purposes of determining the appropriate VRZ.	
Controlled Activity Approval Required (Y / N)	Yes	CAA required for works within 40m of the top of banks.	6
Vegetated Riparian Zone Requirement	10m	A VRZ of 10m is required from the top of bank either side of the watercourse.	7
Comments	Survey Point 7.1 occurs at a culvert on the western side of Wyndella, Road. Discharge from the culvert has resulted in WFL and includes watercourse features such as a defined bed and bank, pools and a change in vegetation indicating a wetland. Survey Point 7.1 constitutes waterfront land and a CAA is required for works within 40m of the top of bank.		
Site Photos – Survey Point 7.1			

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 7.1 - upstream

Survey Point 7.1 - downstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 7.2			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	2	Based on the desktop assessment, Segment ID 8 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 7.2			
Defined Bed and Banks (Yes / No)	Yes	Defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	Type 3b	Laterally Unconfined Continuous – Low Sinuosity	6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	Yes	Pools, Erosion, Deposition	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	Riparian vegetation is present, such as Casuarina and *Juncus usitatus,* however a wetland is not present.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	Yes		7
Ground-truthed Waterfront Land present?	Yes	The survey identified a defined bed and bank, and watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does constitute waterfront land.	7
Ground-truthed Numbering to Determine VRZ	1	Under *Water Management (General) Regulation 2018* Schedule 2, Survey Point 7.1 is	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
		considered Order 1 for the purposes of determining the appropriate VRZ.	
Controlled Activity Approval Required (Y / N)	Yes	CAA required for works within 40m of the top of banks.	6
Vegetated Riparian Zone Required (m)	10m	A VRZ of 10m is required from the top of bank either side of the watercourse.	7
Comments	Watercourse features are present at Survey Point 7.2. Survey Point 7.2 constitutes waterfront land and a CAA is required for works within 40m of the top of bank.		
Site Photos – Survey Point 7.2			

Survey Point 7.2 - upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 7.2 - downstream

Table 9 – Segment ID 10 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 10.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	2	Based on the desktop assessment, Segment ID 10 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 10.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 10 is mapped as a 2nd order stream and Survey Point 10.1 represents the juncture of Segment 8 and 9. Roadside inspection reveal a lack of bed and bank, and watercourse features, north east in the direction of mapped Segment 8 and 9. A culvert is present under Wyndella Road, with small erosion pools at the entrance and exit points, formed by the convergence of over land flow at the culvert. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland were observed. Survey Point 10.1 does not constitute waterfront land.		

Site Photos – Survey Point 10.1

Survey Point 10.1 – mapped upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 10.1 - downstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 10.2			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	2	Based on the desktop assessment, Segment ID 10 is mapped as a 2nd order stream.	3
Field Assessment – Survey Point 10.2			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Segment 10 is mapped as a 2nd order stream and the location is now occupied by managed grassland. Rural development has likely altered the hydrological and geomorphological characteristics of the landscape through pastural land use and construction of farm dams and drainage lines. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland. Survey Point 10.2 does not constitute waterfront land.		
Site Photos – Survey Point 10.2			

Survey Point 10.1

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 10.2 -downstream

Table 10 – Segment ID 11 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 11.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	3	Based on the desktop assessment, Segment ID 11 is mapped as a 3rd order stream.	3
Field Assessment – Survey Point 11.1			
Defined Bed and Banks (Yes / No)	Yes	Defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	Type 3a	Laterally Unconfined Continuous – Bank Confined	6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	Yes	Erosion, Deposition, Riffle	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	Yes	Yes, there are change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	Yes	The survey did identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	Yes	1	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	Yes	CAA required.	6
Vegetated Riparian Zone Required (m)	10m	Defined bed and bank visible	7
Comments	Watercourse features are present at Survey Point 11.1. The bed and bank have been heavily impacted by cattle. Survey Point 11.1 constitutes waterfront land and a CAA is required for works within 40m of the top of bank.		
Site Photos – Survey Point 11.1			

Survey Point 11.1 – upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 11.1 - downstream

Table 11 – Segment ID 12 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 12.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 12 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 12.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	A roadside swale along the NEH and recently constructed detention Basin for a subdivision development on the southern side of the NEH have likely altered the hydrological and geomorphological characteristics of the landscape. The inspection showed stormwater infrastructure through an urban environment (swales, culverts and detention basin). No WFL features, such as a defined bed and bank were observed. Inundation due to discharge from the NEH culvert has resulted in sporadic occurrence of *Juncus spp.* Survey Point 12.1 does not constitute waterfront land.		
Site Photos – Survey Point 12.1			

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Survey Point 12.1 – mapped upstream			

Survey Point 12.1 – mapped downstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 12.2			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 12 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 12.2			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	A roadside swale along the NEH and recently constructed detention Basin for a subdivision development on the southern side of the NEH have likely altered the hydrological and geomorphological characteristics of the landscape. No WFL features, such as a defined bed and bank were observed. Inundation due to discharge from the NEH culvert has resulted in sporadic occurrence of *Juncus spp.* Survey Point 12.2 does not constitute waterfront land.		
Site Photos – Survey Point 12.2			

Survey Point 12.2 – mapped upstream

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures

Survey Point 12.2 – mapped downstream

Table 12 – Segment ID 13 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 13.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 13 is mapped as a 3rd order stream.	3
Field Assessment – Survey Point 13.1			
Defined Bed and Banks (Yes / No)	Yes	Defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	Type 3a	Laterally Unconfined Continuous – Bank Confined	6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	Yes	Erosion, Deposition, Riffle, Pool	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	Yes		-
Ground-truthed Waterfront Land present?	Yes	The survey did identify a defined bed and bank, and watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	Yes	1	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	Yes	CAA required.	6
Vegetated Riparian Zone Required (m)	10m	Defined bed and bank visible	7
Comments	Watercourse features are present at Survey Point 13.1. Survey Point 13.1 constitutes waterfront land and a CAA is required for works within 40m of the top of bank.		
Site Photos – Survey Point 13.1			

Survey Point 13.1

Table 13 – Segment ID 14 Riparian Assessment

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Desktop Assessment – Survey Point 14.1			
Is your property located on a watercourse, lake or estuary within the shaded area in any of the NRAR waterfront land maps? (Appendix 1- NRAR Guidelines, 2020)	No	The Subject Site is not located in a nominated shaded area, and is not exempt from Controlled Activity Approval.	1
Is your property within the shaded area on the NRAR Map—Western land map local government area? (Appendix 2- NRAR Guidelines, 2020)	No	The site location is Maitland LGA, which is excluded from the Western Land map.	1
Is there a watercourse visible on your property?	Yes	Yes, NSW Hydroline Spatial Data 1.0 indicates there is one (1) hydroline within the Subject Site and an additional twenty (20) hydroline segments within the upstream reach (Study Area).	3
Is there a lake or wetland on your property or within 40 metres of the proposed work? (Appendix 3 - NRAR Guidelines, 2020—Lakes and Wetlands)	No	No wetlands or lakes are within 40m of the Subject Site.	3
Using the Determining Stream Order fact sheet (Appendix 4 - NRAR Guidelines, 2020) and the NSW Hydro Line Spatial Data Map, what is the stream order of your watercourse?	1	Based on the desktop assessment, Segment ID 14 is mapped as a 1st order stream.	3
Field Assessment – Survey Point 14.1			
Defined Bed and Banks (Yes / No)	No	No defined bed and bank visible	6
Type of Watercourse: Type 1, Type 2, Type 3a, Type 3b, Type 3c, Type 4, Type 5, Type 6, Type 7, None (Refer Appendix 5 - NRAR Guidelines, 2020)	None		6
Watercourse Feature Present (Pool, Riffle, Erosion and Deposition, Inside and outside bend)	None	No watercourse features present	-
Lakes or Wetlands (Appendix 3 - NRAR Guidelines, 2020)	No		-
Change in Vegetation Present to Indicate Wetlands (Appendix 7 - NRAR Guidelines, 2020)	No	No change in vegetation indicating wetlands.	-
High Bank (Appendix 8 - NRAR Guidelines, 2020)	No		-
Ground-truthed Waterfront Land present?	No	The survey did not identify a defined bed and bank, or watercourse features as described in Appendix 6 of the Waterfront Land Tool. This survey point does not constitute waterfront land.	6
Ground-truthed Numbering to Determine VRZ	N/A	Not applicable	6

Task – Waterland Tool (2020)	Assessment	Comments (provide evidence)	Figures
Controlled Activity Approval Required (Y / N)	N/A	WFL does not occur at this survey point.	-
Vegetated Riparian Zone Required (m)	No	Not applicable	-
Comments	Survey Point 14.1 is occupied by managed grassland. Rural development has likely altered the hydrological and geomorphological characteristics of the landscape through pastural land use and construction of farm dams and drainage lines. No WFL features, such as a defined bed and bank or a change in vegetation indicating a wetland. Survey Point 14.1 does not constitute waterfront land.		

Site Photos – Survey Point 14.1

Survey Point 14.1 – mapped downstream

4.1 Summary of Results

Desktop assessment indicated the presence of two (2) 1st order, two (2) 2nd order and one (1) 3rd order stream mapped within the Subject Site, and an additional six (6) 1st order streams and two (2) 2nd order streams mapped within the Study Area.

However, field surveys identified no WFL features at Segments 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, and 14. API and historical review identified urban and rural development has likely resulted in the modification at the location of these segments, and consequently are not considered WFL or tributaries as defined under the WM Act.

WFL features were observed at Segments 7, 11 and 13 and these Segments were determined to be WFL.

Under **Schedule 2** of the WM Act, Order 1 was allocated to Segment 7 for the purpose of a CAA and determining the appropriate VRZ within the Subject Site. Consequently, a 10m VRZ is required.

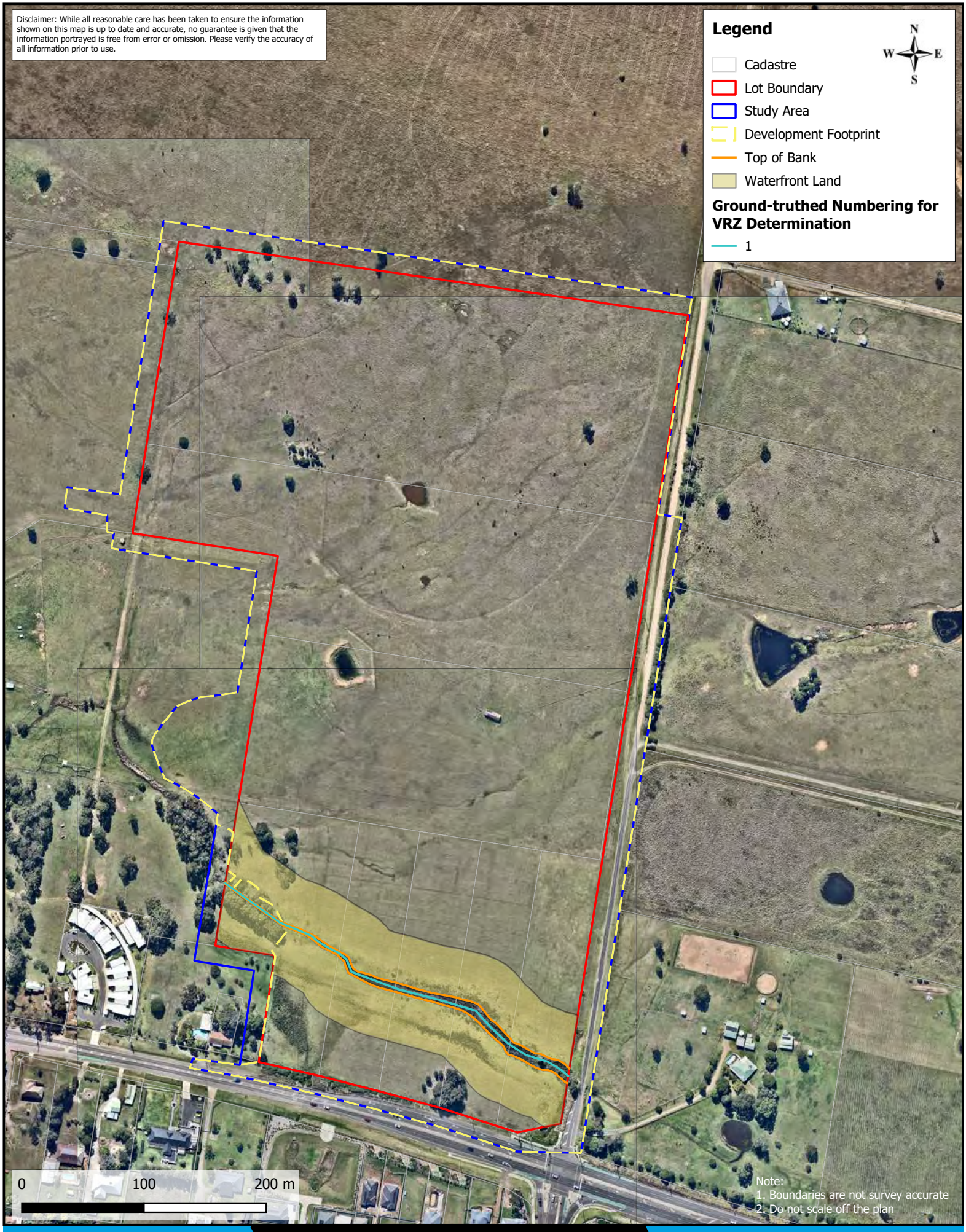
The results of the assessment are provided in **Figure 6** to inform CAA requirements for appropriate works, in accordance with **Table 14**, and based in the current ground-truth conditions.

Table 14 outlines the works and activities that can occur on WFL and in riparian corridors under the WM Act (note approvals may be required under other legislation). **Figure 7** provides the location of the stream re-alignment of Segment 7. A Biodiversity Management Plan (BMP) has been created to support the CAA and rehabilitate works that disturb or modify the riparian corridor, including regeneration an area of freshwater wetland (**Appendix B**).

Table 14 - Riparian Corridor Matrix (DPI Water, 2018)

Stream Order	VRZ	RC Offsetting for non-RC uses	Cycleways and pathways	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	Yes	Yes	Yes	Yes	Yes	**Yes**	Yes	-	-
2nd	20m	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-
3rd	30m	Yes	Yes	Yes	-	Yes	-	-	Yes	Yes
4th+	40m	Yes	Yes	Yes	-	Yes	-	-	Yes	Yes

Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, the NRAR may determine that the watercourse is not waterfront land for the purpose of the WM Act.



AEP

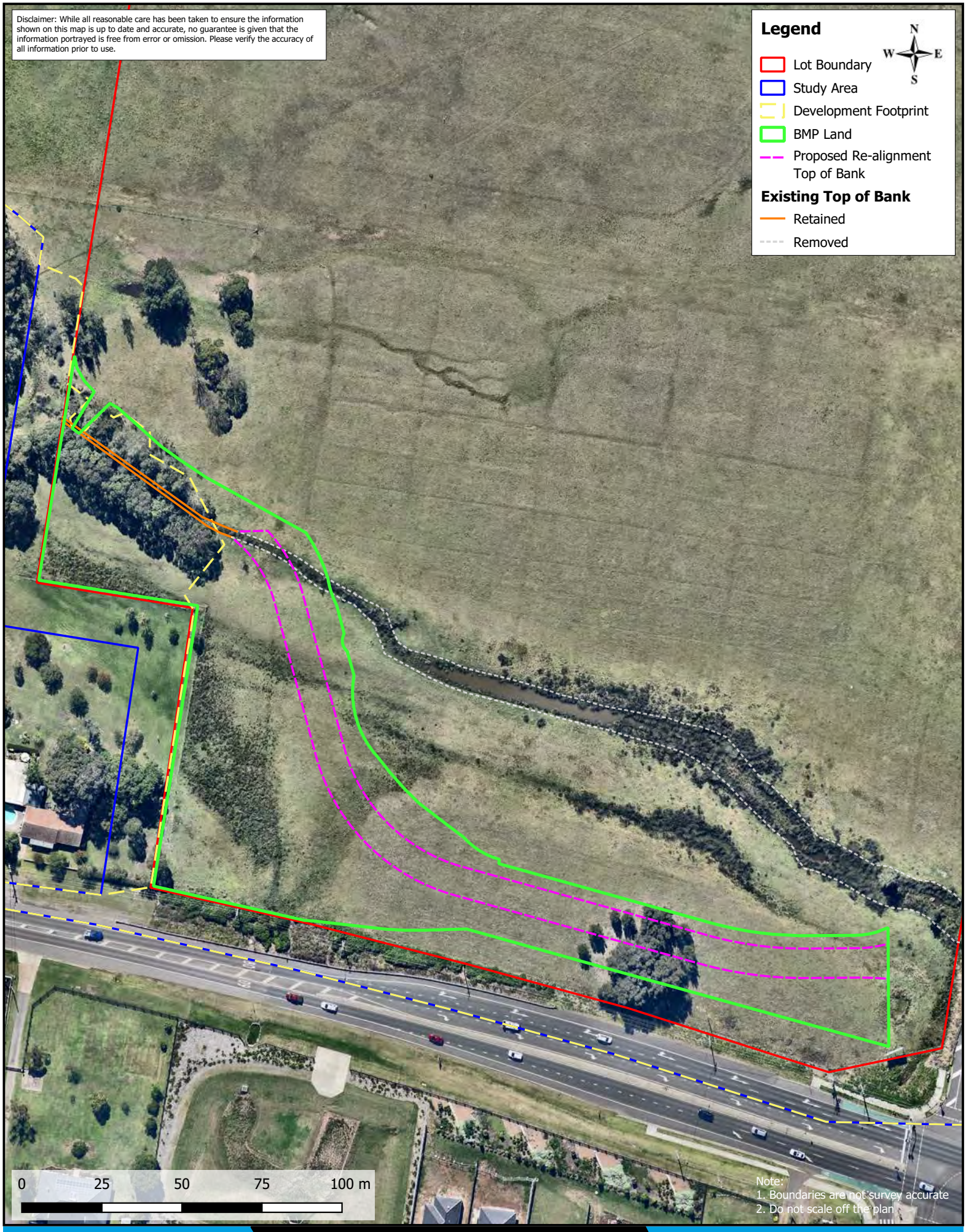
Figure 6 - Ground-truthed WFL Assessment

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699



AEP

Figure 7 - Stream Re-alignment

Date: July 2024

Location: New England Hwy and Wyndella Rd, Lochinvar

Client: Lochinvar Developments Pty Ltd

AEP ref: 2699

5.0 Conclusion

No WFL features were identified at Segment IDs 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, and 14, and these Segments do not constitute waterfront land, or tributaries under the Strahler ordering system, as defined under the WM Act.

WFL features were observed at Segments 7, 11, and 13 and these Segments were determined to constitute waterfront land as defined under the WM Act. Under **Schedule 2** of the WM Act, Order 1 was allocated to Segment 7 for the purpose of a CAA and determining the appropriate VRZ within the Subject Site. Consequently, a 10m VRZ is required.

Works will occur within Waterfront Land and a CAA will be required to accompany any Development Application (DA) for works that occurs within 40m of top of bank.

A number of controlled activities can occur within the VRZ, including the proposed stream re-alignment. A CAA application will require riparian vegetation is rehabilitated within the VRZ to reconstruct natural function of the riparian corridor. A 5-year BMP has been provided to fulfill this requirement.

6.0 References

Department of Planning, Industry and Environment (2020) Natural Resources Access Regulator Waterfront Land Tool https://www.dpie.nsw.gov.au/nrar/how-to-apply/controlled-activities/tools accessed June 2024.

Department of Primary Industries Office of Water (2018) Guideline for Riparian Corridors on Waterfront Lands, https://www.industry.nsw.gov.au/__data/assets/pdf_file/0003/160464/licensing_approvals_controlled_activities_riparian_corridors.pdf, accessed June 2024.

New South Wales Office of Water (2012) Controlled activities on waterfront land - Guidelines for riparian corridors on waterfront land. Department of Primary Industries.

NSW Government (2018) Determining Stream Order Fact Sheet; https://www.industry.nsw.gov.au/__data/assets/pdf_file/0020/172091/Determining-Strahler-stream-order-fact-sheet.pdf accessed June 2024.

NSW Government (2021) Water Management (General) Regulation 2018 Hydroline spatial data, https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=07b967fd0bdc4b0099fc5be45b6d1392 accessed June 2024.

NSW Government (2022) SEED Portal Geocortex Viewer. Accessed June 2024.

Strahler, A.N. (1952) Dynamic basis of geomorphology. Geological society of America bulletin, 63(9), pp.923-938.

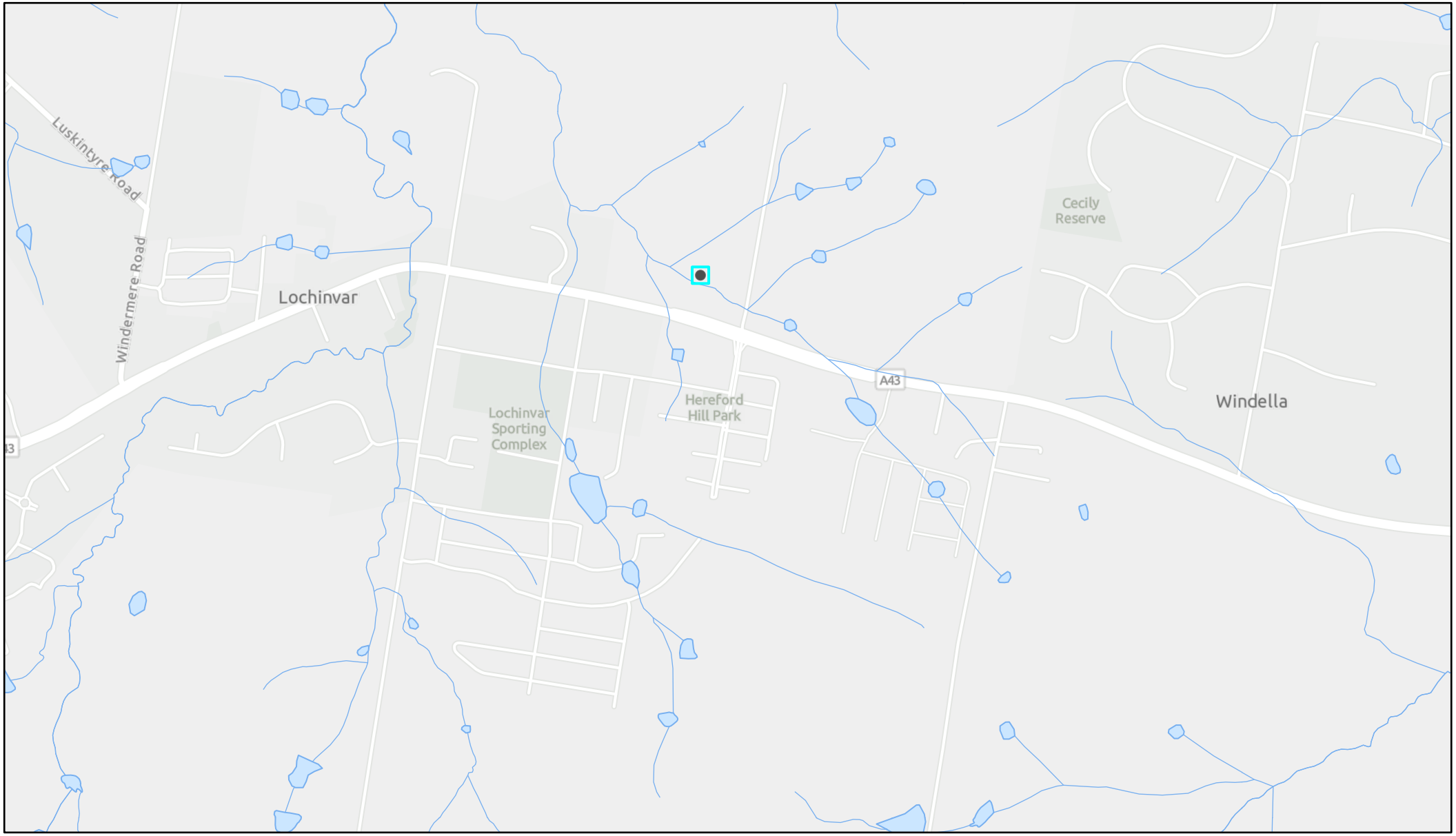
Texas Parks & Wildlife (n.d.) *Glossary of River Terminology*. https://tpwd.texas.gov/landwater/water/habitats/rivers/glossary.phtml#P accessed April 2024.

Thwaites, R. & Brooks, A. (2021) *A gully is not a stream channel. How do we tell the difference and why does it matter?* In WELCOME TO THE 10TH AUSTRALIAN STREAM MANAGEMENT CONFERENCE, p. 524.

Water Management (General) Regulation 2018, NSW Government (2018), Current version for 29 April 2022, Schedule 2 Stream order of a watercourse https://legislation.nsw.gov.au/view/html/inforce/current/sl-2018-0480#sch.2 accessed June 2024.

Appendix A – NRAR Hydroline Spatial Data

2018 Hydroline spatial data 1.0



7/12/2024, 2:55:02 PM

1:18,056

0 0.13 0.25 0.5 mi

0 0.2 0.4 0.8 km

Esri Community Maps Contributors, Maitland City Council, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS

Water Management (General) Regulation

NSW Department of Industry | Lands and Water | Water

Appendix B – Biodiversity Management Plan

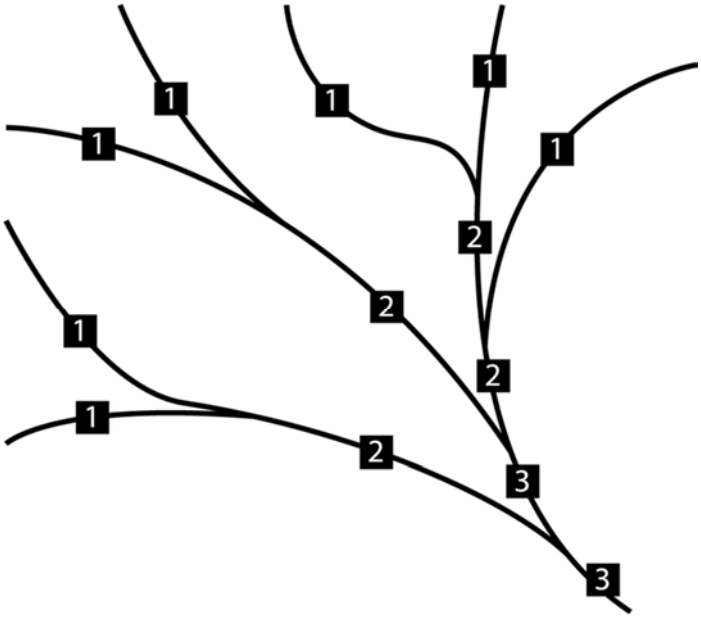
Appendix C – Glossary of Terms

Activity Approval	A controlled activity approval or an aquifer interference approval.
Alluvial	Deposited by running water.
Alluvium	A general term for detrital deposits made by stream processes on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during times of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.
Anabranch	A diverging branch of a river that re-enters the main stream.
Aquatic Vegetation	A plant characteristically growing wholly or partly submerged in water.
Aquifer	A geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water.
Aquifer Interference Activity	means an activity involving any of the following— (a) the penetration of an aquifer, (b) the interference with water in an aquifer, (c) the obstruction of the flow of water in an aquifer, (d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, (e) the disposal of water taken from an aquifer as referred to in paragraph (d).
Bank	The side slopes of a channel between which the streamflow is normally confined.
Bed	The bottom of a channel.
Channel	An area that contains continuously or periodically flowing water that is confined by banks and a streambed.
Coastal Lake	A large open body of saline or brackish water which has a relatively narrow permanent or intermittent connection to the sea.
Construct a Work	includes install, maintain, repair, alter or extend the work.
Controlled Activity	As defined in the Dictionary of the *Water Management Act, 2000:* (a) the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or (b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or (c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or (d) the carrying out of any other activity that affects the quantity or flow of water in a water source.
Deposition	The laying down of sediment carried by wind, flowing water, the sea or ice.
Drainage Work	means a work (such as a pump, pipe or channel) for the purpose of draining water from land, including a reticulated system of such works, and includes all associated pipes, sluices, sluicegates, valves, metering equipment and other equipment, but does not include— (a) any sewage work (within the meaning of Part 2 of Chapter 6), or (b) any work declared by the regulations not to be a drainage work.
Environment	includes all aspects of the surroundings of human beings, whether affecting them as individuals or in their social groupings.

Erosion	Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.
Estuary	As defined in the Dictionary of the Water Management Act, 2000 (a) any part of a river whose level is periodically or intermittently affected by coastal tides, or (b) any lake or other partially enclosed body of water that is periodically or intermittently open to the sea, or (c) anything declared by the regulations to be an estuary, but does not include anything declared by the regulations not to be an estuary.
Flood Channel	Low sinuosity subsidiary channel. Entrance height approximates bankfull stage. Commonly observed at valley margins. Floodchannel depth tends to increase down-pocket with the basal section of the floodchannel elevated above the low flow channel
Flood Work	A work (such as a barrage, causeway, cutting or embankment)— (a) that is situated— (i) in or in the vicinity of a river, estuary or lake, or (ii) within a floodplain, and (b) that is of such a size or configuration that, regardless of the purpose for which it is constructed or used, it is likely to have an effect on— (i) the flow of water to or from a river, estuary or lake, or (ii) the distribution or flow of floodwater in times of flood, and includes all associated pipes, valves, metering equipment and other equipment, but does not include any work declared by the regulations not to be a flood work.
Floodplain	an area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.
Floodplain Pocket	Narrow, discrete floodplain typically on the bank of valley confined channel.
Floodplain Vegetation	Vegetation that is seasonally or irregularly flooded by changes in river level, hence can tolerate inundation for periods of time. It is noted that the tolerance to inundation reduces with the distance from the waterfront land
Flora Stratum	Vertical layering of vegetation in the riparian zone and the classification of its layers and height of growth including trees, heath/shrubs or a ground layer consisting of grasses or sedges.
Gravel Bed	An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these.
Groundwater	Water contained under the ground's surface, located in the spaces between soil particles and in the cracks of sand, gravel, and rock; a natural resource and source of water for drinking, irrigation, recreation, and industry.
Gully	a. is not a 'stream channel' (or watercourse); b. is a persistent erosional feature, with active head or walls on average > 0.5 m deep, and has multiple modes of expansion, but always including headward retreat into an otherwise un-dissected landscape; c. erodes unconsolidated materials and saprolite, but not bedrock; d. must have an active head scarp or head wall at the upslope limit of the gully (which may or may not be a clear nick point): e. sometimes a series of head scarps may occur; • a 'scalded' or desiccated area (i.e. an area stripped of its topsoil with degraded vegetative cover) may often fringe the upslope area of the head scarp and head walls;

	• has an erosional gully wall scarp, or clear erosional cut. • some exceptions, such as the expanding, shrink-swell, cracking clays (i.e. Vertosols† and friable Black Dermosols, or 'blacksoil', and 'reactive clays') that may have convex walls and a head 'ramp' need considering for evidence of other active erosion present in these cases, e.g. piping, tunnels or slumping; • has the head (head scarp, head wall), or heads, marking the upstream boundary of concentrated water flow and sediment transport between definable banks; f. has a cross-sectional shape (U-shaped, V-shaped, trapezoidal, slot, or tiered‡) that is permanently recognizable without flow; g. has a straight bed long-profile, rather than a curved one (of stream channels); h. has a dominant proportion of a 'hard margin' (a comparatively sharp break of slope from the unbroken land surface to the incisional feature, that represents a gully head scarp and wall scarp of active erosion, commonly referred to as a rim, edge or scarp), active or otherwise, or equivalent; i. has active erosional walls of at least moderately steep gradient (~ 30o; ~ 60 %), and gully walls are dominantly bare soil materials; j. are autonomous – having the active sediment source predominantly within the gully (a clear autocthonous, or 'internal', erosional zone); k. may have land upslope of the head, or beyond, that may be a drainage depression (swale), or marshland in keeping with the incisional caveats above; l. k. is typically driven by proximal ephemeral flows (i.e. associated with rainfall directly in the gully and in the gully catchment).
Headwater	Source of a river of stream.
High Bank	The upper most extent of the bank.
Inside Bend	Inside bank of a meander subject to deposition from slow flow.
Instream Habitat	Any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component.
Lake	(a) a wetland, a lagoon, a saltmarsh and any collection of still water, whether perennial or intermittent and whether natural or artificial, and (b) any water declared by the regulations to be a lake, whether or not it also forms part of a river or estuary, but does not include any water declared by the regulations not to be a lake.
Land	includes any water source, and also includes the land on or in which any water source is situated.
Levee	Raised elongate asymmetrical ridge that borders the channel. Composed almost entirely of suspended load sediments (dominantly silt, often sandy).
Meander	The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.
Outside Bend	Outside bank of a meander subject to erosion from high flow.
Overland Flow	4A Meaning of "overland flow water" (1) In this Act, overland flow water means water (including floodwater, rainfall run-off and urban stormwater) that is flowing over or lying on the ground as a result of— (a) rain or any other kinds of precipitation, or (b) rising to the surface from underground, or (c) any other process or action of a kind prescribed by the regulations.

	(2) Water is flowing over the ground for the purposes of subsection (1) even if it flows over the ground by means of artificial structures such as roads, canals or road gutters. (3) However, subsection (1) does not include— (a) water that is collected from a roof (including water collected from a roof using a rainwater tank), or (b) water that is flowing over or lying on the bed of a river, lake or estuary, or (c) water flowing over or lying on the ground in such circumstances as may be prescribed by the regulations.
Oxbow	An abandoned meander in a river or stream, caused by cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.
Pools	A reach of a stream that is characterized by deep, low-velocity water and a smooth surface.
Riffles	Topographic highs along an undulating reach-scale longitudinal profile.
Rip Rap	Run of quarry rock placed over a bedding layer of cobbles used to stabilise and rehabilitate disturbed areas including topsoil, revegetation and regeneration. Must be able to withstand the velocities of runoff or discharge from site.
Riparian Corridor	A riparian corridor (RC) forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse (aquatic environment). Riparian corridors perform a range of important environmental functions
Riparian Vegetation	The plants growing on the water's edge, the banks of rivers and creeks and along the edges of wetlands
River	As defined in the Dictionary of the *Water Management Act, 2000:* (a) any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and (b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows, and (c) anything declared by the regulations to be a river, whether or not it also forms part of a lake or estuary, but does not include anything declared by the regulations not to be a river.
Bar	Deposited sediment accumulation from altered in-stream flow due to variation in channel geomorphology.
Segment ID	Assigned segment identification number to potential watercourse.
Snag	Term used to describe large woody debris from trees and shrubs, including whole fallen trees, broken branches and exposed roots that have fallen or washed into a waterway and are now wholly or partially submerged by water.
Study Area	The Study Area comprises applicable land, any mapped hydrolines that occur within that land, any mapped upstream tributaries, and waterfront land associated with the mapped hydrolines.
Subject Site	The Subject Site comprises the mapped hydrolines and associated waterfront land that occurs within the applicable land boundary.
Survey Point	The location of a watercourse assessment with the Waterfront Land Tool.
The Strahler System	As defined in *Schedule 2* - Water Management (General) Regulation 2018: The method of determining the stream order of a watercourse shown on a topographic map is the Strahler system. The Strahler system is as follows—

	(a) Any watercourse that has no other watercourses flowing into it is classed as a first order stream. (b) If 2 streams join, the resulting stream is— (i) the same order as the highest order of the 2 streams, or (ii) if the 2 streams are of the same order, the order greater than that of the 2 streams. For example, in the diagram below— (a) If 2 first order streams join, the stream becomes a second order stream (2). (b) If a second order stream is joined by a first order stream, it remains a second order stream. (c) If 2 second order streams join they form a third order stream (3). (d) If a third order stream is joined by a first or second order stream, it remains a third order stream. (e) If 2 third order streams join they form a fourth order stream. 
Vegetated Riparian Zone	The required width of the VRZ measured from the top of the high bank on each side of the watercourse.
Vegetation Management Plan	Details how the restoration or rehabilitation of the riparian corridor will be carried out. The main objective of a VMP is to provide a stable watercourse and riparian corridor which will emulate local native vegetation communities.
Water Source	means the whole or any part of— (a) one or more rivers, lakes or estuaries, or (b) one or more places where water occurs on or below the surface of the ground (including overland flow water flowing over or lying there for the time being), and includes the coastal waters of the State.
Waterfront Land	Land within 40m of a river, stream, creek, wetlands, estuary
Waterfront Land	As defined in the Dictionary of the *Water Management Act 2000*: (a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or

	(a1) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or (a2) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or (b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters, where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that falls into 2 or more of the categories referred to in paragraphs (a), (a1) and (a2) may be waterfront land by virtue of any of the paragraphs relevant to that land.
Waterfront Land Maps	CAA exemptions can only apply within certain waterfront land shown in maps that include shaded areas such as: • Botany Bay and Georges River area, • Brisbane Water area, • Hunter River area, • Lake Macquarie area, • Lake Mulwala area, • Port Hacking area, • Port Jackson (Sydney Harbour) area, • Port Stephens area, • Tuggerah Lakes area, and, • Wallis Lakes area These can be found within the WFLT.
WaterNSW	WaterNSW is a State-Owned Corporation established under the *Water NSW Act 2014* and operates under an Operating Licence.
Western Land Map	NRAR Map – Western land map within the WFLT that includes shaded local government areas in inland NSW areas.
Wetlands	Includes marshes, mangroves, swamps, or other areas that form a shallow body of water when inundated intermittently or permanently with fresh, brackish or salt water, and where the inundation determines the type and productivity of the soils and the plant and animal communities.
Woody Debris	Consists of large masses of trees or shrubs that have fallen or been washed into rivers and streams, and onto floodplains. Once instream, they become waterlogged and rest in the streambed providing both habitat and refuges for aquatic fauna

Appendix D – Waterfront Land eTool

From: Google Forms
To: Brendon Young
Subject: Waterfront land e-tool
Date: Friday, 12 July 2024 2:58:56 PM

Google Forms

Thanks for filling in Waterfront land e-tool

Here's what was received.

Edit response

Waterfront land e-tool

Version 1 - 2020

Email *

brendon@andersonep.com.au

Is this the right e-tool for me?

This waterfront land e-tool has been developed to help controlled activity applicants and consultants determine if a controlled activity approval is required under the provisions of the Water Management Act 2000. The tool can be used to help identify:

• if there is waterfront land
• the location of top of bank of the waterfront land and
• if an exemption applies for works within certain mapped areas under clause 36 of Schedule 4 of the
Regulation

The e-tool is recommended for use by people who are familiar with environmental assessment and suitably qualified consultants. Members of the general public who are planning works near waterfront land should seek professional advice.

The e-tool must be completed separately for each individual mapped or visible watercourse on, or near, your property. If you have multiple

properties or multiple watercourses on or near your property, submit your response for the first assessment and then re-start the tool from the beginning to assess another watercourse or property. This will ensure each property and watercourse receives its own separate emailed result outcome that you can keep as a record.

Using the tool

Some of the questions in this e-tool can be answered using materials online. Depending on your circumstances, you may also need to the visit the site of the proposed work in person to gather supporting evidence.

There is a PDF version of the tool available that you can download and take into the field at: https://water.nsw.gov.au/__data/assets/pdf_file/0009/367272/waterfront-land-tool.pdf

The e-tool must be completed separately for each individual mapped or visible watercourse on the property. Each watercourse assessed with the e-tool will then receive a separate emailed result outcome.

Stopping and returning

You can choose to exit the tool at certain questions where field work is recommended. You will be asked if you wish to exit, and, if you agree, be emailed a link that you can use to return to the tool later to complete the rest of the questions.

If you close the tool anywhere else - without completing it and clicking the 'Submit' button - your data will not be retained. Please ensure you only close the tool when prompted if you wish to retain your answers.

Supporting evidence

When you complete the tool, you will receive email confirmation containing your answers, which you must keep as a record of your decision-making. You must also keep all reference material and information used–including maps, photos and observations to answer the tool questions. You will be prompted throughout the tool about what information to keep.

NSW Department of Climate Change, Energy, the Environment and Water may request copies of the Waterfront land tool answers and supporting documents from landholders where works are carried out without a controlled activity approval under the Water Management Act 2000.

The Waterfront land e-tool will store your email address so you can be emailed a record of your answers on completion. It will also record your answers but it will not identify your location or any other personal details. If you do not wish to supply your email address, please use the hard copy version of the tool at:
https://water.nsw.gov.au/__data/assets/pdf_file/0009/367272/waterfront-land-tool.pdf

More information

• about this e-tool, contact NSW Department of Climate Change, Energy, the Environment and

Water via email:
waterlicensing.servicedesk@dpie.nsw.gov.au
• about controlled activity approvals, visit
https://water.dpie.nsw.gov.au/licensing-and-trade/controlled-activity-approvals

Disclaimer

• This tool is intended for guidance purposes only and cannot be used as evidence of compliance with the Water Management Act 2000.
• Users of this tool will be responsible for making their own assessment of the material and should verify all relevant representations, statements and information with their own professional advisers.
• This tool only applies controlled activities on waterfront land—it does not apply to water access licences or water supply work and/or water use approvals.
• This is not an approval to undertake work on waterfront land and you will still need to obtain relevant approvals as required under the Water Management Act 2000 (WM Act).
• The use of this tool does not remove the obligation to obtain approval under any other relevant legislation.
• Users should also refer to the disclaimer on the department's website at:
https://www.industry.nsw.gov.au/disclaimer

Description or Reference

Please enter a description or reference number below for the property or watercourse you are going to assess. This will allow you to easily identify this assessment from any other assessments you undertake using the tool. *

2699 Lochinvar

Question 1 - Department of Planning and Environment—Water waterfront land maps

After answering the question, click next at the bottom of the screen.

Is your property located on a watercourse, lake or estuary within the area marked in orange in any of the Department of Planning and Environment—Water waterfront land maps below? *

- ◯ Yes, Botany Bay

- ○ Yes, Brisbane Water
- ○ Yes, Hunter River
- ○ Yes, Lake Macquarie
- ○ Yes, Lake Mulwala
- ○ Yes, Port Hacking
- ○ Yes, Port Jackson
- ○ Yes, Port Stephens
- ○ Yes, Tuggerah Lakes
- ○ Yes, Wallis Lakes
- ◉ No, none of the above

Using the maps below

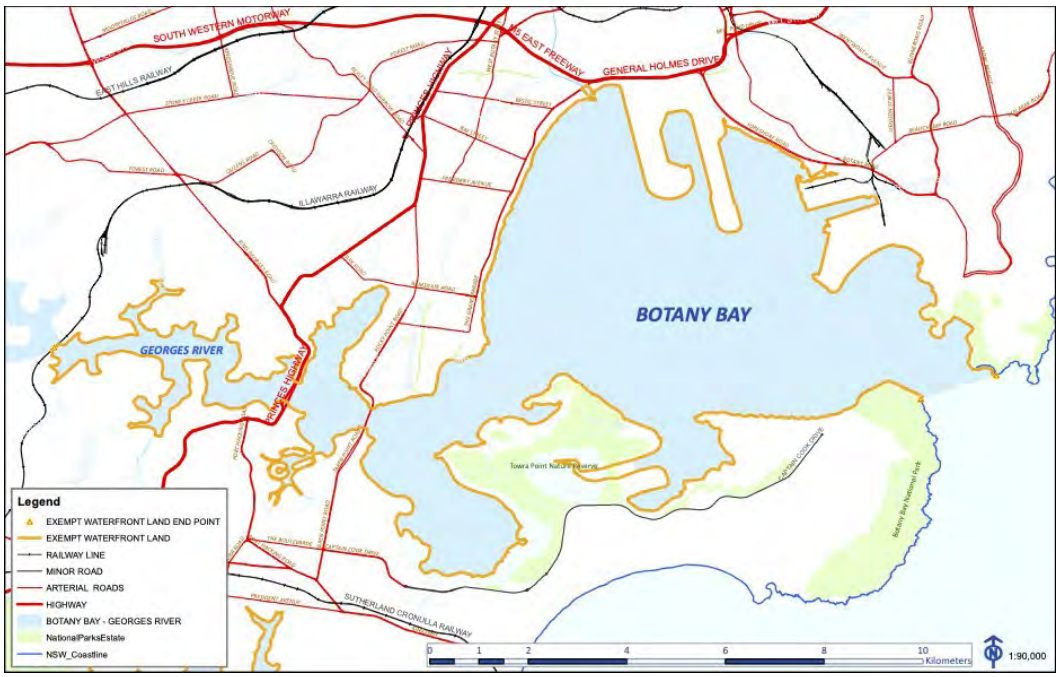
Using your browser zoom in to any of the maps below to help you identify the location of your property.

Alternatively you can access the maps at the below link:
https://www.dpie.nsw.gov.au/water/licensing-and-trade/controlled-activity-approvals/controlled-activity-exemptions

What supporting evidence do I need?

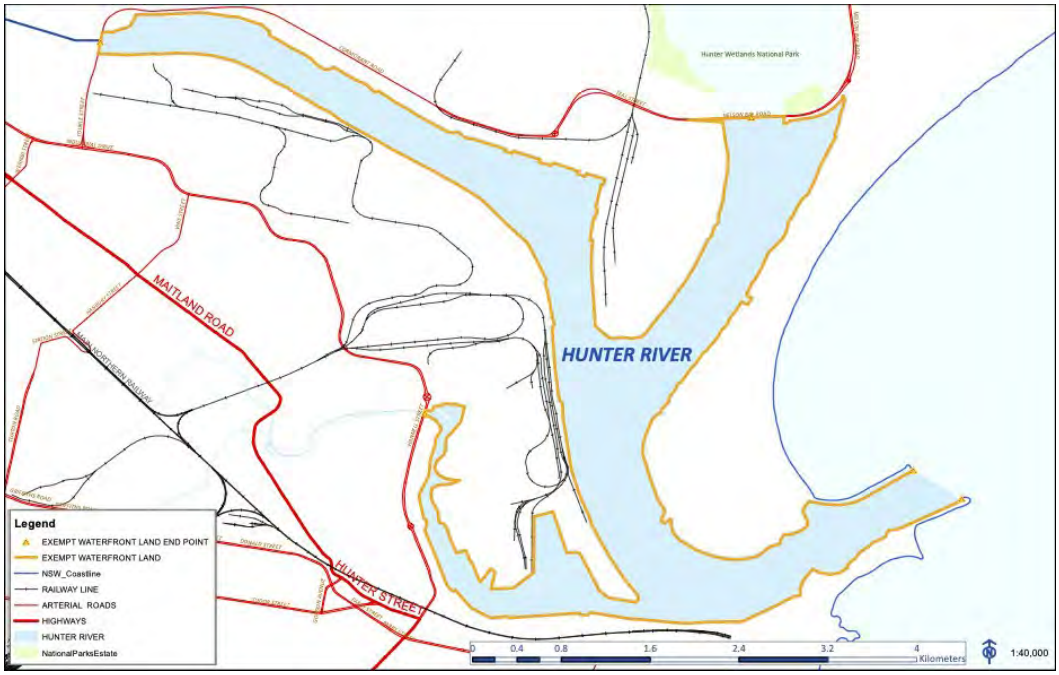
• Saved or printed screenshot of aerial photo of your property
• Saved or printed copy of any maps to identify property boundary
• Saved or printed screenshot of the location of your property on the waterfront land map

Botany Bay



Brisbane Water

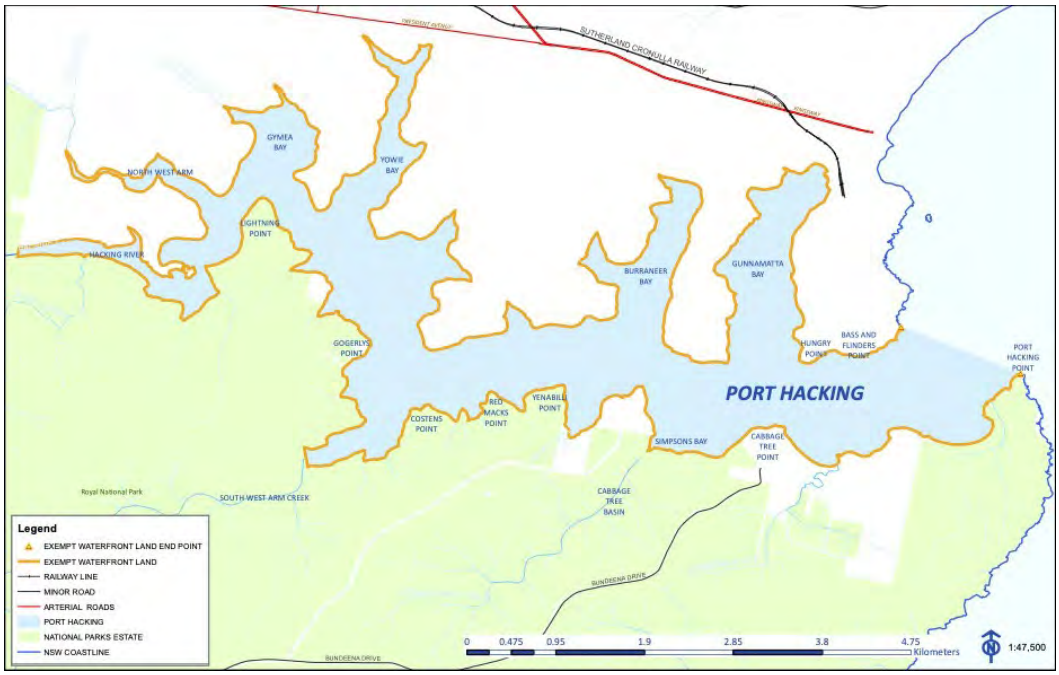
Hunter River



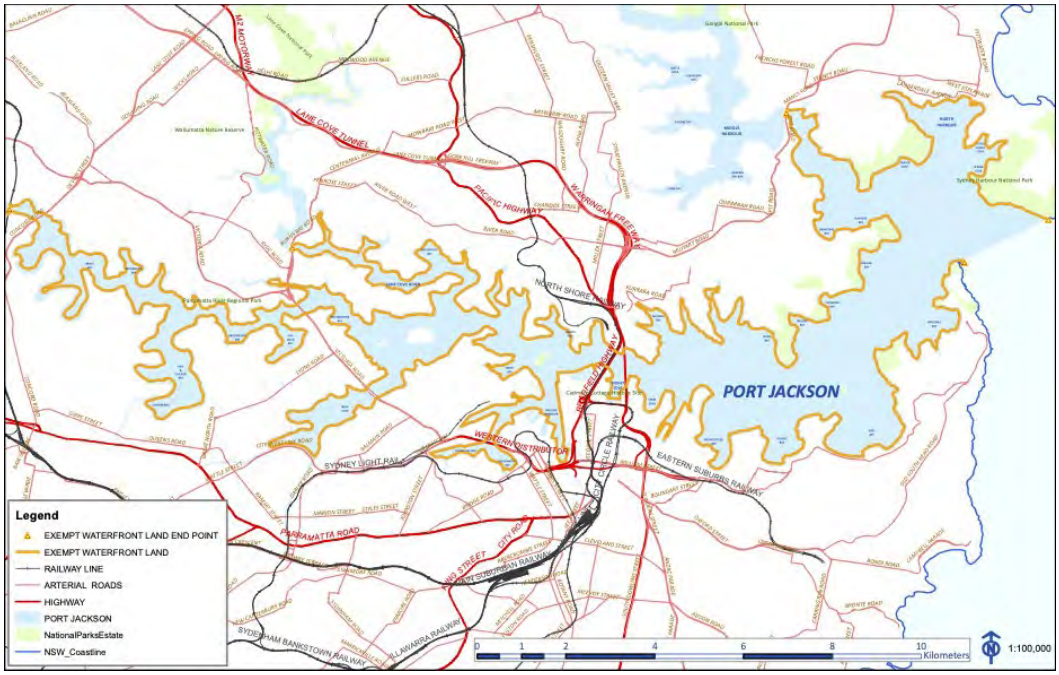
Lake Macquarie

Lake Mulwala

Port Hacking



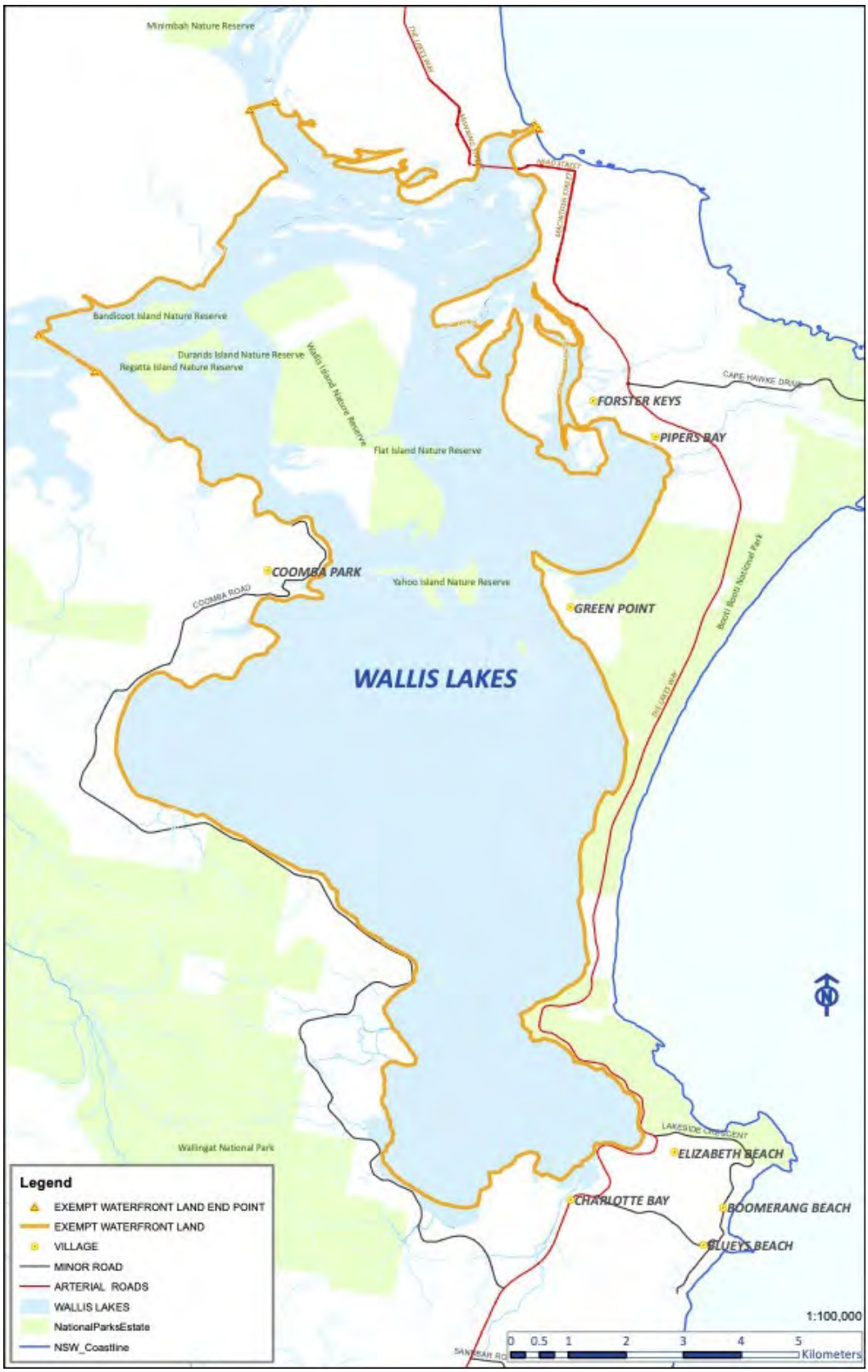
Port Jackson



Port Stephens

Tuggerah Lakes

Wallis Lakes



Question 2a - Hydro Line spatial data map

Open the link provided below for the Hydro Line spatial data map and

enter your property address.

Is there a blue line on your property or within 40m of the proposed work? *

- (●) Yes
- ( ) No

What supporting evidence do I need?

- Saved or printed screenshot of aerial photo of your property
- Saved or printed copy of any maps to identify property boundary
- Saved or printed screenshot of the location of your property on the Hydro Line spatial data map

The Hydroline spatial data is used to determine the Strahler stream order of a watercourse.
https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=07b967fd0bdc4b0099fc5be45b6d1392

Collecting evidence in the field

For this part of the tool, you may need to go to your site to collect evidence and answers.

What to take into the field

The following equipment will be required to complete field work:
- Digital camera
- Note taking equipment - notebook or computer
- Measuring tape or equipment able to measure 50m
- Saved or printed screenshot of aerial photo of your property and the watercourse

If you can't do the field work right now, you can save your answers

To save your answers so far in the e-tool, select 'Yes, save my answers' below and click 'Submit' on the next page.

You will then be emailed a copy of the answers and a link you can use to return to the e-tool when in the field or after your field work is completed.

The link is at the top of the email 'Edit response'.

This is the only point in the tool where you can stop and return to your answers

If you close the tool anywhere else - other than the final 'Submit' page - the data you have entered so far will not be retained.

Can't take this tool into the field?

A PDF version is available at:
https://water.nsw.gov.au/__data/assets/pdf_file/0009/367272/waterfront-land-tool.pdf

Would you like to save your answers? *

- ○ Yes, save my answers so I can return here later
- ◉ No, keep going, I'm ready to answer the field-based questions

Question 3 - Determining stream order

Read the Determining stream order fact sheet at the below link.

Then open the link below to the Hydro Line spatial data map.

Zoom out from your property on the map to work out the stream order of your watercourse.

What is the stream order? *

- ○ 1st or 2nd order stream
- ◉ 3rd order or greater stream

Determining Strahler stream order fact sheet

https://www.industry.nsw.gov.au/__data/assets/pdf_file/0020/172091/Determining-Strahler-stream-order-fact-sheet.pdf

The Hydro Line spatial data is used to determine the Strahler stream order of a watercourse
trade.maps.arcgis.com/apps/webappviewer/index.html?id=07b967fd0bdc4b0099fc5be45b6d1392

What supporting evidence do I need?

- Saved or printed screenshot of aerial photo of your property
- Saved or printed copy of any maps to identify property boundary
- Saved or printed screenshot of the location of your property on the Hydro Line spatial data map
- Saved or printed screenshot of annotated Hydro Line spatial data map showing the determination of Strahler stream order

Question 8 - Determining the high bank

Using the photos and diagrams below, locate the high bank of the watercourse type identified in Question 4b.

Are the proposed works within 40m of the high bank? *

- (●) Yes
- ( ) No

After answering the question, click next at the bottom of the screen.

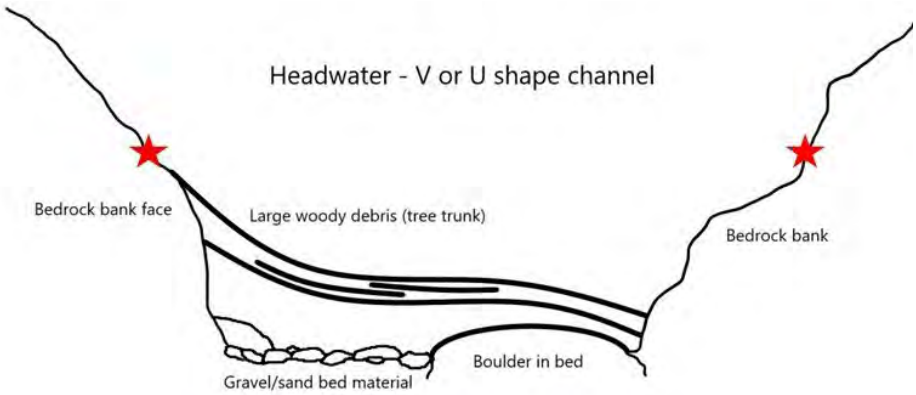
Using photos and diagrams below
Use your browser to zoom in to the photos and diagrams below.

What supporting evidence do I need?

- Record of the measurement from high bank to the nearest location of the proposed works
- Annotated aerial photo of the property showing:
  - o location of the proposed works
  - o location of the watercourse, lake or wetland, and
  - o measured distance to the high bank.
- Current site photos looking up and downstream. Photos should be taken within one month of completing this tool and include a date stamp or metadata and

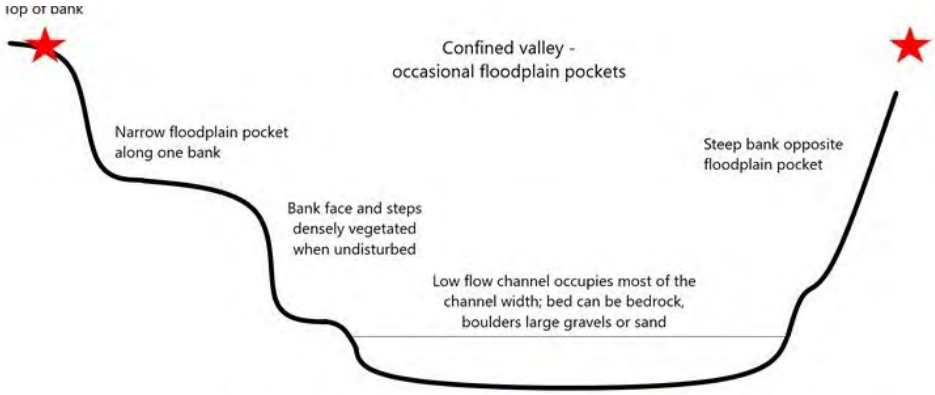
a short location description.
• Saved or printed screenshot of the watercourse type from the Department of Planning and Environment—Water Guide— Determining the high bank of a watercourse
• Written observations of the watercourse including bed, bank and erosion features and flow conditions
• Saved or printed screenshot of aerial photo of your property and the watercourse

Type 1 - Confined Valley Headwater



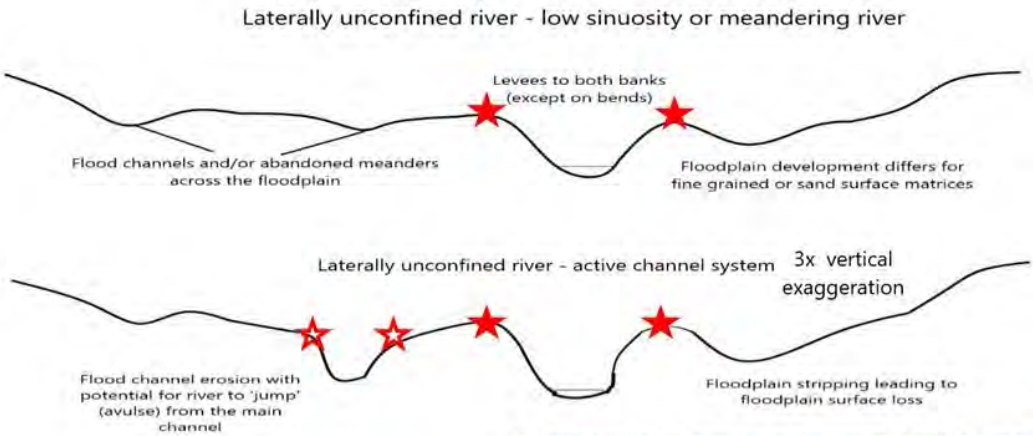
★ Top of High Bank

Type 2 - Confined Valley Floodplain Pockets



★ Top of High Bank

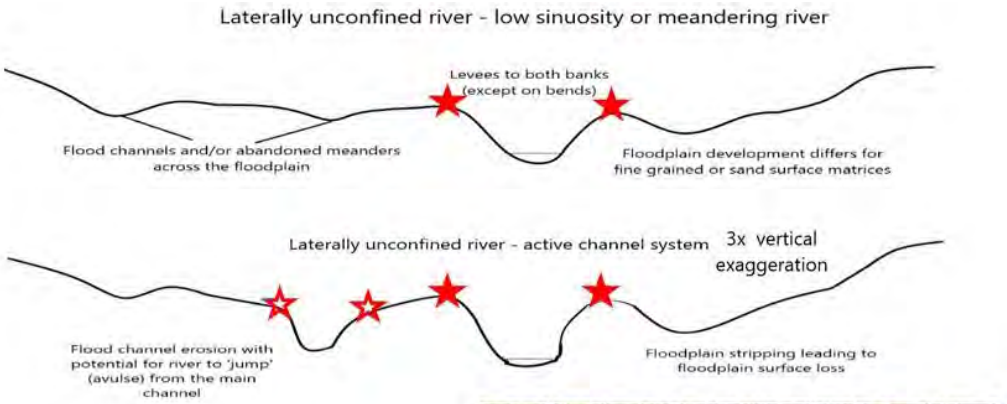
Type 3a - Laterally Unconfined Continuous - Bank Confined



★ Top of High Bank

☆ Top of High Bank when the flood channel has regular flows and/or, river features and/or is a mapped watercourse.

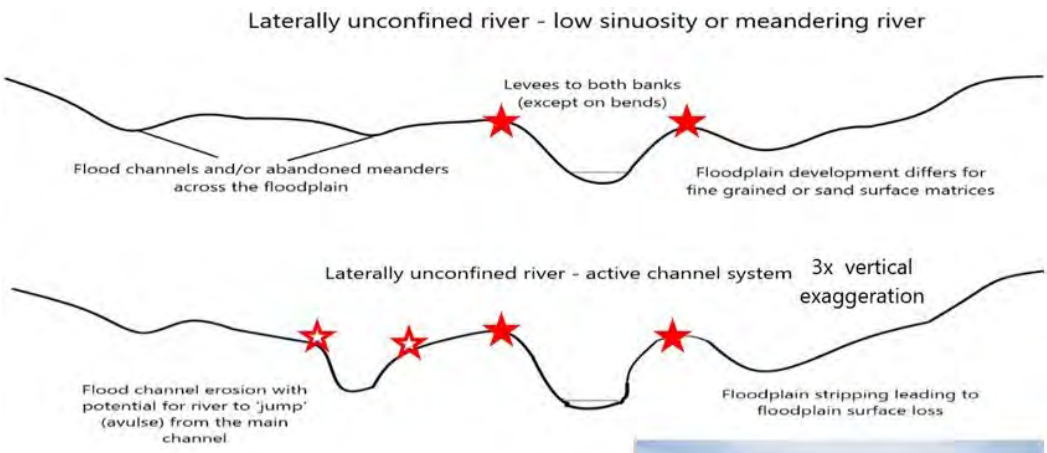
Type 3b - Laterally Unconfined Continuous - Low Sinuosity



★ Top of High Bank

☆ Top of High Bank when the flood channel has regular flows and/or, river features and/or is a mapped watercourse.

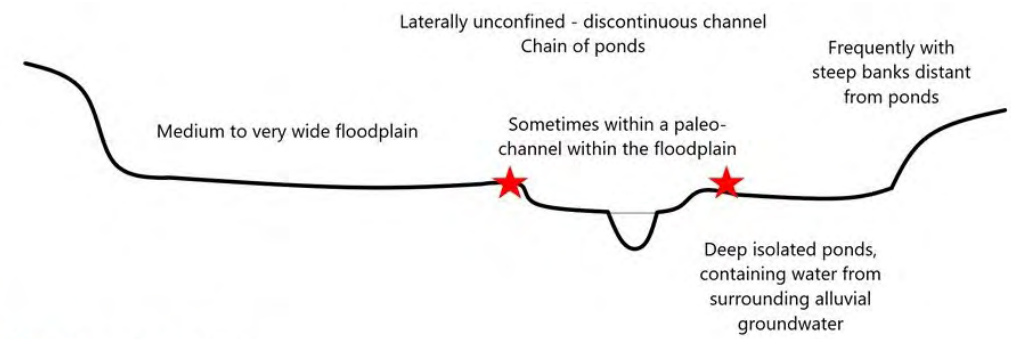
Type 3c - Laterally Unconfined Continuous - Meandering



★ Top of High Bank

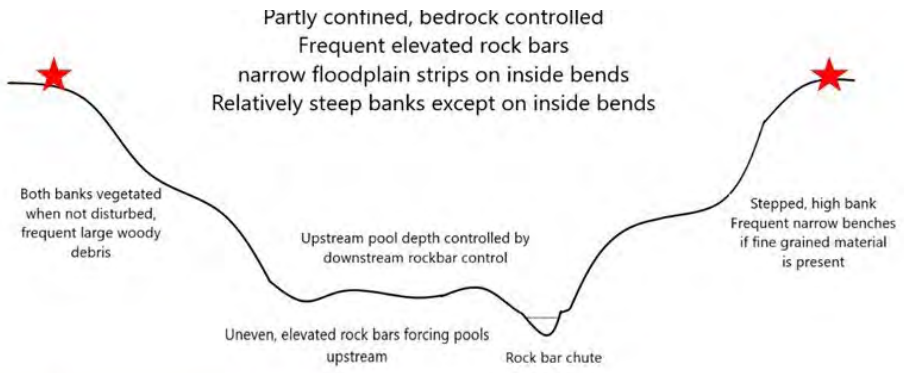
☆ Top of High Bank when the flood channel has regular flows and/or, river features and/or is a mapped watercourse.

Type 4 - Laterally Unconfined Discontinuous



★ Top of High Bank

Type 5 - Partly Confined Valley



★ Top of High Bank

Lakes

★ Top of High Bank is defined by the Mean High Water Mark (MHWM). This is determined by survey.

Wetlands

★ Top of High Bank is defined by the edge of the frequently wet area. This can be identified by a shore area, a change in vegetation type or soil type.

Result 14 - Controlled activity approval likely required

Based on your answers, the result is:

CONTROLLED ACTIVITY APPROVAL LIKELY REQUIRED

Statements

When completing the e-tool you provided the following answers:

- One or more of the following features are on this property or a neighbouring property:
    - o watercourse
    - o lake
    - o wetland
    - o mapped Strahler 3rd order or greater hydro line as defined by the Hydro Line spatial data map
- The proposed works are located within 40m of the high bank of the watercourse

Are ALL of the above statements correct? *

- (●) Yes
- ( ) No (restart tool)

Record keeping and Disclaimer

Please ensure you keep the electronic and/or printed copies of all supporting evidence required for questions answered in this tool and the confirmation email you receive after clicking submit.

NOTE:

- The results given by this tool are generated using the answers you have provided. If any answers are incorrect or incomplete, the result produced may be incorrect.
- This tool is intended for guidance purposes only and cannot be used as evidence of compliance with the Water Management Act 2000.
- Users of this tool will be responsible for making their own assessment of the material and should verify all relevant representations, statements and information with their own professional advisers.
- This is not an approval to undertake work on waterfront land and you will still need to obtain relevant approvals as required under the Water Management Act 2000 (WM Act).
- The use of this tool does not remove the obligation to obtain approval under any other relevant legislation.
- Users should also refer to the disclaimer on the department's website at industry.nsw.gov.au/disclaimer.

If ANY of your assessments identify that a controlled activity approval is required for your proposed works, you must complete the following tasks:

- Confirm if an exemption applies to your site or proposed works by using the Department's Controlled activity exemption e-tool at: https://forms.office.com/pages/responsepage.aspx?id=IYjvljkqHEe4mmewgz3TuaJ8VvZiyYZKiR3x1NniFCZUQ0lWTUZRUVpWMFhHTlBEM05aNFVOVlFSOC4u or refer to exemption

information here: https://www.dpie.nsw.gov.au/water/licensing-and-trade/controlled-activity-approvals/controlled-activity-exemptions

• For matters requiring a development application (DA) from Council, you should lodge your DA as Integrated Development.

• For matters NOT requiring a DA, please refer to the Department of Planning and Environment—Water website for instructions on how to apply for a Controlled Activity Approval: https://www.dpie.nsw.gov.au/water/licensing-and-trade/controlled-activity-approvals/how-to-apply

You MUST click Submit to be emailed a copy of your answers and your result.

Reminder: The e-tool must be completed separately for each individual mapped or visible watercourse on, or near, your property. If you have multiple properties or multiple watercourses on or near your property, submit your response for the first assessment and then re-start the tool from the beginning to assess another watercourse or property. This will ensure each property and watercourse receives its own separate emailed result outcome that you can keep as a record.

Feedback

Please let us know whether you found this tool helpful and what we could do to make it better. Your comments will help us to improve the tool further.

Thankyou for your feedback.

How helpful was this tool?

Very helpful

Additional feedback about this tool

.....

If you have a question or require further information regarding your specific circumstances, please email waterlicensing.servicedesk@dpie.nsw.gov.au

If you wish to undertake another assessment, please click 'Submit' below and then select 'Submit another response'.

Appendix E – Author CVs

BRENDON YOUNG

Project Manager

Profile Summary

Brendon works with AEP in the role of Project Manager and Ecologist/Aquatic Ecologist. He graduated with a Bachelor of Applied Science (Fisheries w/Honours), a Masters in Environmental Management and Graduate Certificate in Fish Conservation and Management. Brendon has previously worked in large retail operations in staff and budget/data management, reporting and quality assurance which adds to the experience that he currently contributes to the AEP team.

Academic Qualifications

Charles Sturt University

- Master of Environmental Management (Water Resources) 2022
- Graduate Certificate of Fish Conservation and Management

University of Tasmania

- Bachelor of Applied Science (Fisheries) with Honours

Training, Licences and Professional Memberships

- NSW Class C Driver's Licence
- WHS NSW Construction Induction White Card
- First Aid (Provide First Aid HLTAID011)

Professional Experience

Project Manager/Aquatic Ecologist Anderson Environment & Planning Newcastle NSW	Jan 2024 – Present
Project Lead/Ecologist Anderson Environment & Planning Newcastle NSW	Oct 2023 – Jan 2024
Ecologist Anderson Environment & Planning Newcastle NSW	Sept 2022 – Oct 2023
Department Manager Woolworths Pty Ltd	2013 - 2022
Produce Quality Control Officer Woolworths Pty Ltd	Mar 2019 - Oct 2019

Relevant Project Experience

Ecological Surveys

- Watercourse Assessment with the NRAR Waterfront Land Tool in Huner Valley, Central Coast, Midcoast and Dubbo regions.
- Key Fish Habitat surveys at Karuah River Port Stephens, Hunter River Lochinvar and Chisholm, Manning River Tibbuc and Lachlan River Stubbo.
- Dip netting for *Mogurnda adspersa* in Lochinvar, Tibbuc, Chisholm and Stubbo.

- Seagrass and Mangrove surveys in Port Stephens.
- Targeted, systematic transects for threatened flora species.
- Deployment of Camera Traps, Songmeter and Anabats across central Coast and Hunter Valley regions for targeted survey.
- Spot Assessment Technique surveys: Halloran, Windella, Ourimbah, Chisholm.
- Weed mapping: Taree, Ourimbah, Hunter Valley.

University

- Training with aquatic sampling techniques such as seine nets, gill nets and fyke nets.
- Training in the use of mist netting, bat harp traps, Elliot traps, pitfall traps and camera traps.
- Identification of fish, reptiles, insects, and plants to species level through honours research and other projects while studying.

Ecological Assessment

- Riparian and watercourse assessment with the Waterfront Land Tool in the Hunter Valley, Central Coast, Sydney and Hastings regions.
- Preparation of Vegetation Management Plans in the Hunter Valley, Central Coast and Midcoast regions.
- Bushfire Threat Assessment in accordance with PBP 2019 at various sites across the Hunter Valley and Central Coast regions.
- Assist with Arborists assessments in Central Coast, Sydney, Mudgee and Hunter Valley Regions.

Ecological Monitoring

- Primary contributing author for Garden Suburbs Biodiversity Stewardship Site Assessment Report and associated Management Plan.

Publications

- Courtney, A.J., Schemel B.L., Wallace, R., Campbell, M.J., Mayer, D.G. and Young, B. (2005) *Reducing the impact of Queensland's trawl fisheries on protected sea snakes*. FRDC Project No. 2005/053. Queensland Government.

NATALIE BLACK

Senior Ecologist

Profile Summary

Natalie works with AEP in the role of Senior Environmental Manager. She has extensive knowledge in environmental management, environmental planning, fisheries, aquatic and riparian environments, and report writing and assessment. With a detail understanding of planning, catchment management, coastal management and rehabilitation. Natalie has had a successful career with both state and local government in conservation, planning and field investigation roles. Natalie has also gained extensive communication skills and project management through her previous career in lecturing in a range of course with a focus on environmental management and environmental legislation. Her background and experience in the ecological and planning fields is utilised in a diverse array of application in her current role.

Natalie Black is a conservation detection dog handler and is currently working with his purpose breed working English Springer Spaniel “Gus” who is currently trained to detect Koala scat, Forest Owl pellets and Cane Toads.

Academic Qualifications

- B.Sc (Hons) Sustainable Resource Management and Marine Science – University of Newcastle, 2001
- Master Planning – University of Technology Sydney, 2007
- Certificate IV Training and Assessment – TAFE, 2012
- BAM Assessor; accreditation number: BAAS19076

Training, Licences and Professional Memberships

- NSW Class C Driver’s Licence
- Provide First Aid HLTAID011
- Evidence Gathering and Legal Process, Australian Institute of Environmental Health
- Conflict Resolution Course (LGSA)
- Report Writing Course (LGSA).
- Powerful Presentation (LGSA)
- NSW Rural Fire Services Bush Fire Assessment
- Relocation of Threatened Species, Botanical Gardens Sydney
- Sustainable Home Assessment Reduction Revolution
- Flora and Fauna Survey Assessments Niche Environment and Heritage

Professional Experience

Senior Environmental Manager / Works Coordinator 2019 – Present

Anderson Environment & Planning

Newcastle NSW

Principal Environmental Planner 2010 - 2019

Black Earth

Newcastle NSW

Senior Lecture 2010 - 2019

Hunter TAFE

Range of Hunter Campuses

Natural Resource Manager and Development Assessment Officer	2003 - 2010
Lismore City Council	
Lismore NSW	
Fish Passage Expert	2002 - 2003
NSW Department of Primary Industries	
Ballina NSW	
Conservation Officer	2000 - 2002
NSW Department of Primary Industries	
Crows Nest, NSW	
Volunteer NSW Fisheries	1998 - 2000
Varied Roles	
Port Stephens, NSW	

Relevant Project Experience

Ecological Survey examples

- Target surveys for *Thelymitra adorata* Halloran; Wyee, Wadalba;
- Target surveys for *Melaleuca biconvexa* Mardi, , Halloran; Wyee, Wadalba
- Target surveys for *Tetratheca juncea* Hillsborough, Mardi, Thornton, Warners Bay;
- Target surveys for *Rhodamnia rubescens* Hillsborough, Mardi, Thornton, Stuarts Point, South West Rocks,
- Target Survesy for Cumberpalin Snail and Dural Snail, Rouse Hill
- Target Search for seagrass and threatened marine fauna, Stuarts Point, South West Rocks, Lake Macquarie, Peat Island,
- Powerful Owl nest locating and monitoring: Salamander Bay
- Spot Analysis Techniques surveys: Lismore, Wallsend, Salamander Bay, North Arm Cove, Warnervale, Hamlyn Terrace, Wyee, Charlestown, Chisholm, Gillieston Heights, Mount Vincent, Hillsborough;
- Surveys for Squirrel Glider (*Petaurus norfolcensis*) Wadalba, Rouse Hill, Claremount Meadows, Wyee, Hillsobourgh, South West Rocks, Stuart Point;
- Frog Surveys: Lismore, Wallsend, Salamander Bay, North Arm Cove, Warnervale, Hamlyn Terrace, Wyee, Charlestown, Chisholm, Hillsborough Rouse Hill, Kariong, Wadalba,

Ecological Assessment examples

- Accredited Assessor for approved Biodiversity Development Assessment Reports:
  - Teraglin Village, Chain Valley Bay;
  - Railway Road, Warnervale;
  - McFarlane's Road, Chisholm;

- Fairlands Road, Medowie;
- Raymond Terrace Road Chishlm,
- Annangrove Road, Rouse Hill
- Richmond Road, Marsden Park,
- Claremount Meadows,
- Newcastle Golf Course, Fern Bay,
- Newell Highway, Gilgandra
- Narromine Road, Dubbo

- Ecological Assessment Report for Proposed Modification to Approved Western Rail Coal Unloader At Pipers Flat;
- Infrastructure Ecology Reports;
  - Wyee Water Main;
  - Mardi Water Main;
  - Wyee Rising Main;
  - Mardi Rising Main;
- Summerhill Waste Facility Recycling Plant

Ecological Offsets and Monitoring

- Biodiversity Stewardship Agreements including:
  - Hillsborough
  - Blueys Beach,
  - Allandale,
  - South-West Rocks.
- Biodiversity Management Plans / Vegetation Management Plan / Wildlife Management Strategies
  - VMP for Proposed Modification to Approved Western Rail Coal Unloader At Pipers Flat;
  - VMP / WMS / Dewatering Plan for Wyee for 23ha Offset lands
  - VMP Rouse Hill Commercial Development.
  - BMP – Claremount Meadows Commercial Development.

Planning – Approved Review of Environmental Factors

- South West Rocks Installation of Seawall,
- Lake Macquarie upgrade of carpark, boat ramp and jetty,
- Demolition of two (2) jetties Peat Island,
- Stuart Point upgrades to caravan park including boat ramp.
- Wyee Rising Main
- Anambah Recycling Facility

Bushfire Threat Assessments

- Kempsey Correctional Facility for upgrade
- Stuarts Point Caravan Park for upgrades
- Claremount Meadows for a Commercial development included Daycare, and service station
- Batlow for a Service Station
- Lovedale for a change of use to Brewery

Appendix C – Stormwater Management Plan (ADWJ 2024)

STORMWATER MANAGEMENT PLAN

STAGED RESIDENTIAL SUBDIVISION

LOTS 2, 3, 4, 5, 6, & 9 DP747391 & LOTS 12 & 13 DP1219648 CNR NEW ENGLAND HIGHWAY & WYNDELLA ROAD LOCHINVAR

LOCHINVAR DEVELOPMENTS

JUNE 2024

adw johnson

HUNTER OFFICE
7/335 Hillsborough Road,
Warners Bay NSW 2282
(02) 4978 5100

CENTRAL COAST OFFICE
5 Pioneer Avenue,
Tuggerah NSW 2259
(02) 4305 4300

SYDNEY OFFICE
Level 35, One International Towers
100 Barangaroo Avenue,
Sydney NSW 2000
(02) 8046 7412

www.adwjohnson.com.au

Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	Preliminary Issue	21/03/23	Mitchell Knox & Christian Langley	Lincoln Gibbs
B	Minor Amendments	21/04/23	Mitchell Knox & Christian Langley	Mitchell Knox
C	Council Comments	28/06/2024	Mitchell Knox	Mitchell Knox

Executive Summary

ADW Johnson has been engaged by Lochinvar Development Pty Ltd to prepare a Stormwater Management Plan addressing the stormwater management requirements for a proposed subdivision of Lots 2-6 and 9 DP 747391 and Lots 12-13 DP 1219648 at Lochinvar ('the site'). This report accompanies a development application for the residential subdivision which shall create 258 lots and supporting infrastructure.

This report has been updated to reflect the amended layout that has been prepared in response to Council's initial review of the development application.

Consistent with existing conditions, the proposed development drains to two legal points of discharge. A majority of the site reports to an existing tributary of Lochinvar Creek, whilst a smaller catchment in the site's north reports to Lot 2 1299958 in the location of a future road extension (by others).

Hydrologic modelling was undertaken to compare peak site discharges under existing and proposed conditions. Modelling confirmed that the detention basin proposed on the site's southern catchment is sufficiently sized to ensure that peak flows do not exceed predeveloped magnitudes for all design events up to the 1% AEP. There are no stormwater detention warrants on the site's northern catchment.

1-dimensional flood analysis has confirmed that all proposed lots are provided with adequate freeboard to the 1% AEP local design flood. Modelling confirmed no downstream impact on local flood extents up to the 1% AEP and minor improvements to upstream flood extents owing to proposed cross-drainage structure upgrades. Modelling confirmed that all proposed lots will facilitate dwellings which are outside of the Lochinvar Creek tributary's Probable Maximum Flood (PMF) envelope.

A stormwater quality treatment train has been developed comprising of rainwater tanks, Gross Pollutant Traps and bioretention basins. MUSIC modelling has confirmed that the proposed treatment train meets Council's objectives in relation to runoff quality improvement.

To ensure downstream waters and adjacent properties are protected, appropriate erosion and sediment controls are to be undertaken during construction. Controls are to be implemented and monitored in accordance with Landcom's 'Blue Book' and Council's engineering guidelines.

Site investigations by AEP as part of a Riparian Assessment Report have determined that the Lochinvar Creek Tributary near the site's southern boundary is a first order watercourse. Subsequently, the proposed stormwater management system is compliant with stormwater and Water Sensitive Urban Design controls imposed by the Lochinvar Urban Release Area Development Control Plan, and with the Natural Resource Access Regulator (NRAR's) requirements for controlled activities on waterfront land.

The details and information presented in this Stormwater Management Plan confirm that the proposed development can satisfy Council's requirements in relation to peak flow management, flooding runoff quality, and soil and water management.

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LIST OF TABLES

1.0 Introduction

ADW Johnson has been engaged by Lochinvar Developments Pty Ltd to prepare a Stormwater Management Plan addressing the stormwater management requirements for a proposed subdivision of Lots 2-6 and 9 DP 747391 and Lots 12-13 DP 1219648 at Lochinvar ('the site'). This report accompanies a development application for the residential subdivision which shall create 258 lots.

The site is bounded by Wyndella Road to the east and the New England Highway to the south. Unimproved pastoral land exists to the site's western and northern boundaries, with a school and sparse rural-residential properties situated to the south-west. Site locality is presented in ***Figure 1.***

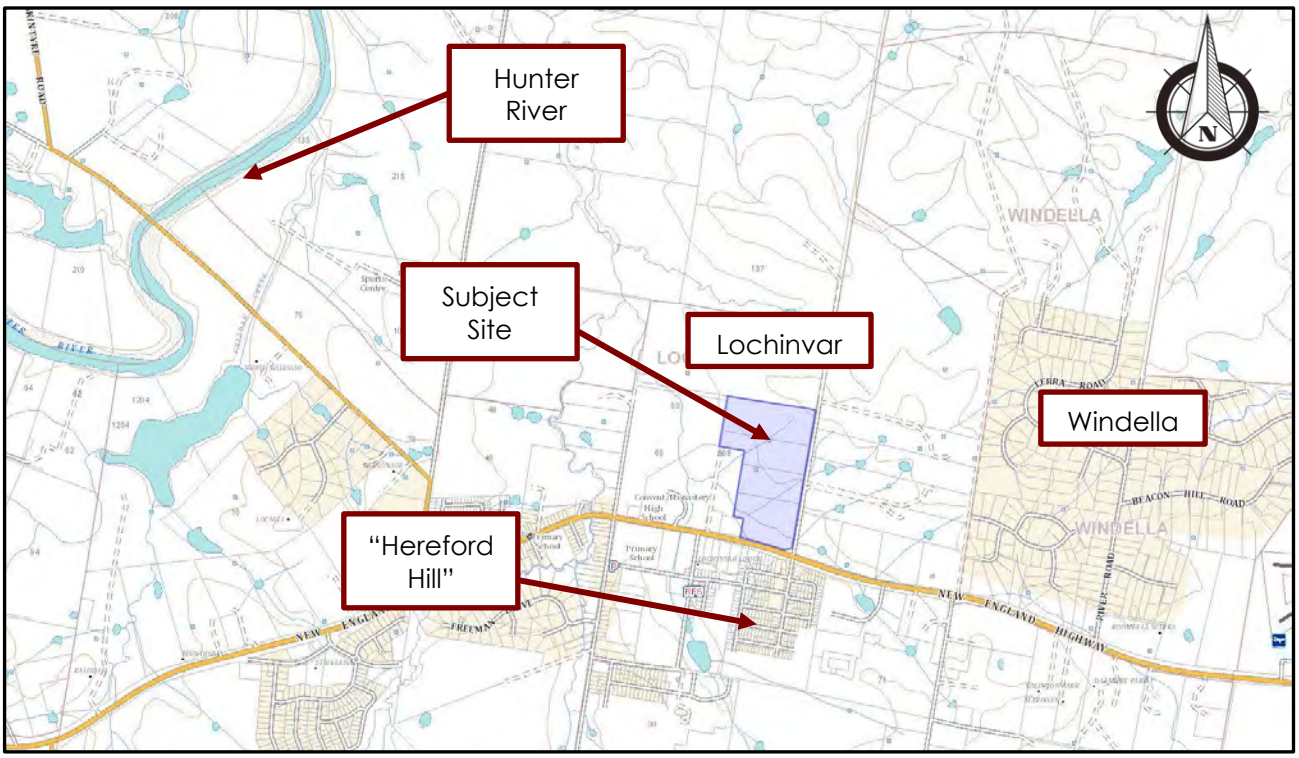

Figure 1 - Site Locality.
(Source: https://maps.six.nsw.gov.au/)

2.0 Site Description

2.1 EXISTING SITE

The site is located on Wyndella Road at Lochinvar within the Maitland LGA and comprises of approximately 22.5 ha of General Residential (R1) land.

The site is predominantly comprised of pastoral land and has been previously used for small-scale livestock grazing. Wooded vegetation is sparse, primarily existing in copses along the site's riparian corridor. Topography is generally undulating with slopes of up to ten percent directed towards a well-defined watercourse.

Existing access to the site is via Wyndella Road which is presently unsealed. Noting the exception of several farm dams and a barn, the site is devoid of improvements.

Adjoining land to the west consists of General Residential (R1) land. Adjoining land to the north consists of Primary Production (RU1) land. Adjoining land to the east consists of Rural Landscape (RU2) land. Adjoining land to the south primarily consists of the Hereford Hill residential development, being part of the Lochinvar Urban Release Area (URA).

Figure 2 presents an aerial photograph of the existing site.

Figure 2 – Existing Site.
(Source: https://maps.six.nsw.gov.au/)

The site is constrained by existing dual sewer rising mains (DN250 and DN375) running west to east across as seen in ***Figure 3***. Positive service location (potholing) indicates that depth to the proposed rising mains is variable, with minimum cover of approximately 0.8m. Importantly, the DN375 main's invert level is lower than the invert of the existing watercourse within the site's bounds. This requires piped drainage to cross over, rather than under, both mains.

Figure 3 - Existing Sewer Rising Main Alignment.
(Source: Hunter Water Corporation)

2.2 EXISTING GEOLOGY

Desktop review using the NSW DPIE's *eSPADE* confirms that the site is situated within the North Eelah (nex) and Lovedale (lvv) landscapes, as seen in ***Figure 4***.

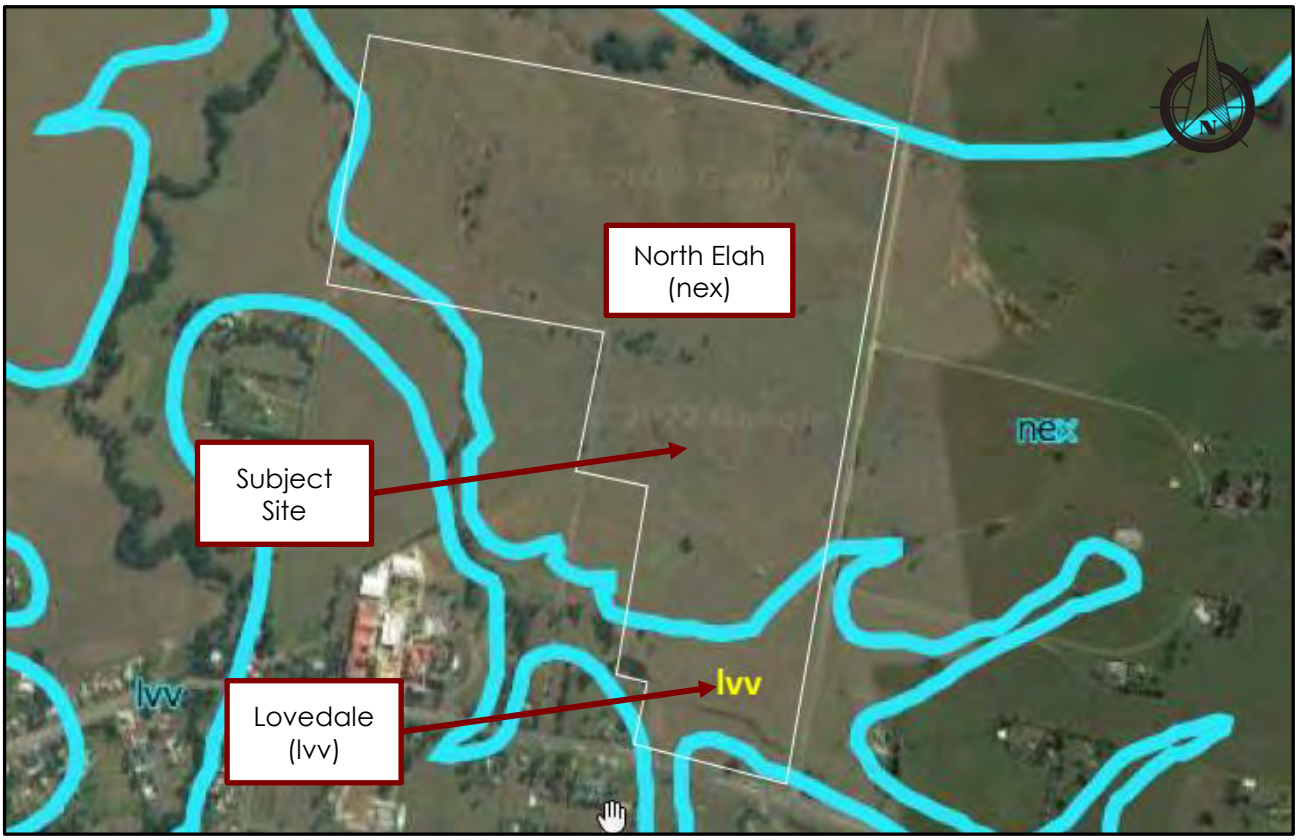

Figure 4 - Landscape Map Overlay.
(Source: NSW eSPADE)

From ***Figure 4*** it is seen that the northern area is mostly mapped as the North Elah Landscape, and is characterised by shallow soils, localised rock outcropping, and incised drainage lines.

The southern area is mapped as the Lovedale Landscape, and is characterised by alluvial fans, localised waterlogging and gently sloping drainage lines.

Qualtest attended site and from test pit investigation found that soil depths were variable but generally in the range of about 0.2m to 2.0m on the mid slopes, and generally greater than 2.0m on the lower / foot slopes. Rock outcrops were observed in the northern part of the site. The rock appeared to include Conglomerate and Pebbly Sandstone of estimated very high strength based upon limited surface observations.

Slow groundwater inflow was observed at TP09 (on the tributary watercourse) and TP50 (at the north-western corner of the site) at depths of 1.20m and 1.90m, respectively. No other groundwater inflows or water levels were encountered in the other test pits during testing.

2.3 EXISTING HYDROLOGY

As noted in ***Sections 2.1*** and ***2.2***, the site is typified by moderate slopes and well-defined watercourses. Subsequently, it is expected that the site's hydrologic regime is dominated by surface runoff into natural channels.

Initial desktop review by AEP using Department of planning, Industry and Environment (2020), Natural Resources Access regulator Waterfront Land e-Tool showed multiple tributaries of Lochinvar Creek converging within the subject site. Strahler ordering of DPE hydrolines is shown in ***Figure 5***.

Figure 5 – Desktop Hierarchy of Watercourses
(Source: 2699 Lochinvar New England Riparian Assessment Rev 01 20220909 – AEP)

However, following a ground-truthing survey, Riparian Assessment Report prepared by AEP determined that several mapped hydrolines did not meet the definition of a watercourse. This led to an updated Strahler hierarchy of watercourses, as shown in ***Figure 6.***

Figure 6 – Ground-truthed Hierarchy of Watercourses.
(Source: 2699 Lochinvar New England Riparian Assessment Rev 01 20220909 – AEP)

The site's existing drainage regime is presented in ***Figure 7*** and described below.

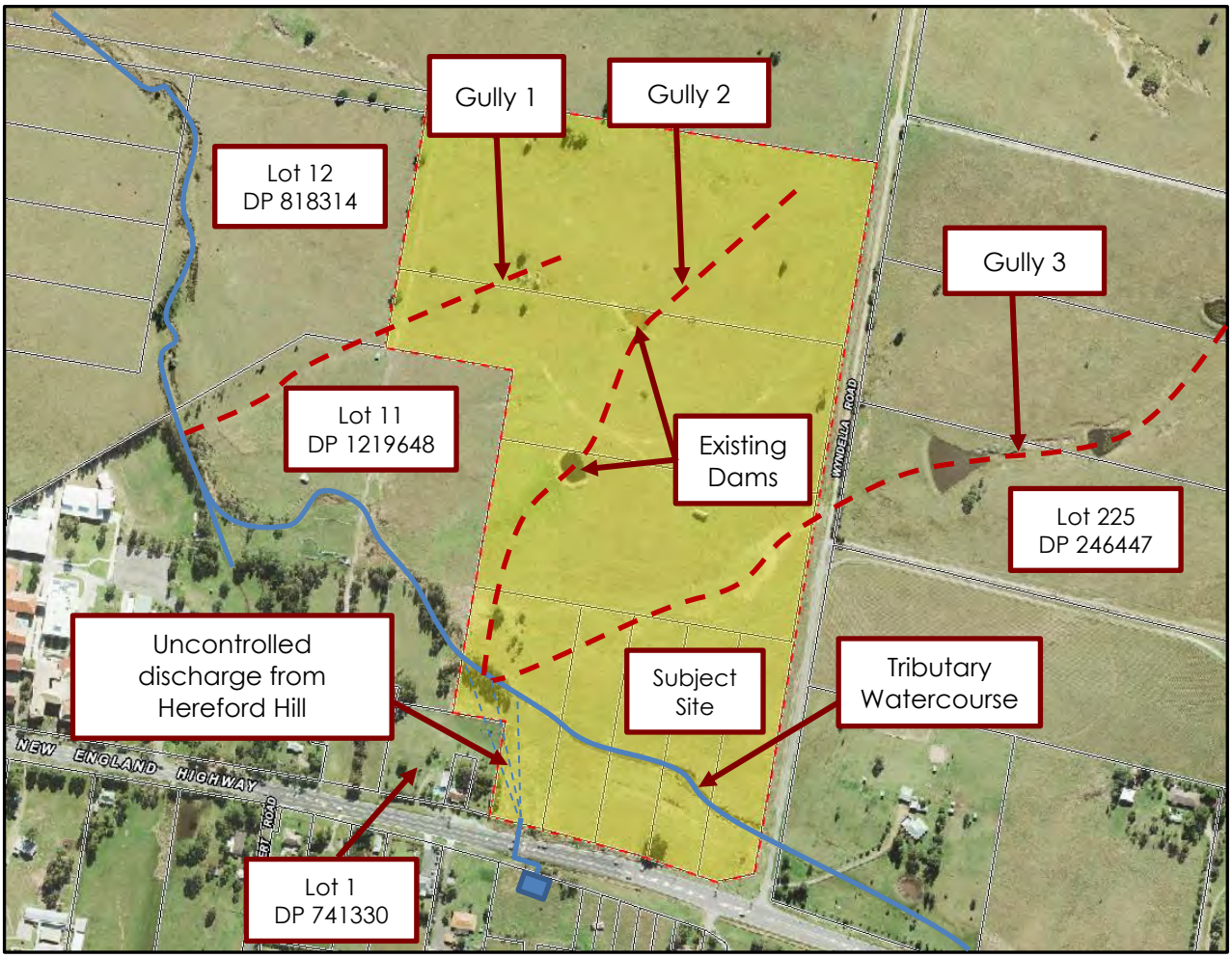

Figure 7 - Existing Hydrology.
(Source: https://maps.six.nsw.gov.au/)

A majority of the site's catchment drains southwest into the tributary watercourse within the site's south. The watercourse, which is a tributary of Lochinvar Creek, drains through Lot 11 DP 1219648 and ultimately reports to the Hunter River approximately 3 km north-east of the subject site.

Within this major catchment, runoff is concentrated in two existing gullies (Gullies 2 and 3 in ***Figure 7***) which ultimately report to the tributary watercourse. Two existing farm dams are located on Gully 2 and would be decommissioned by the proposed development.

A smaller catchment in the site's north drains to the site's westernmost corner via a defined gully (labelled as Gully 1 in ***Figure 7***). Gully 1 connects this catchment to the tributary watercourse downstream of the site.

An existing upstream catchment to the north-east discharges through the site via Gully 3. The gully receives a total upstream catchment of approximately 12.6 ha of pastoral land. Flows are conveyed beneath Wyndella Road via dual DN525 circular culverts depicted in ***Figure 8***.

Figure 8 - Circular culverts beneath Wyndella Road.
(Looking upstream)

The tributary watercourse draining through the site also receives an upstream catchment. The upstream catchment comprises of both rural and residential land to the southeast of the subject site, amounting to approximately 84 ha. Flows are conveyed beneath Wyndella Road via three (3) DN1050 circular culverts depicted in ***Figure 9***. Whilst the watercourse is known to be ephemeral, a baseflow was observed at time of inspection.

Figure 9 - Circular culverts beneath Wyndella Road.
(Looking downstream)

A separate upstream catchment enters the development from the south. This upstream catchment comprises of approximately 17.5Ha of residential land which is dominated by the adjoining Hereford Hill subdivision. Inflows report to a basin at the north of the Hereford Hill development before being discharging into the New England Highway Road reserve. As shown in ***Figure 10***, two circular culverts (DN450 and DN600) pass under the New England Highway and enter to subject site in an uncontrolled fashion.

Figure 10 - Circular culverts beneath the New England Highway.
(Looking upstream)

Ground-truthing from inspection of the subject site found the south-western corner of the subject site and the north-eastern corner of the adjoining property (Lot 1 DP 741330) were soft underfoot, suggesting this area is subject to overbank flows from the upstream catchment discharge in the site. This is consistent with AEP 2022 which identifies to affected land as an "overland dispersion area" which, if unresolved, is "highly likely to become a wetland in the future".

2.4 PROPOSED DEVELOPMENT

The site is intended for residential subdivision creating 258 lots in 13 stages. This development will form part of the Lochinvar Urban Release Area (URA) and comprise of typical urban residential elements such as residential lots, roads, footpaths and cycleways, parks, water and sewer reticulation and other services.

The stormwater drainage system will incorporate a piped drainage network, with the road network providing overland flowpaths. Runoff will be controlled by stormwater basins in relation to both runoff quality and peak flow attenuation.

Wyndella Road will require upgrade works to facilitate increased traffic demand from development. Whilst this report gives consideration to cross-drainage structures, the Wyndella Road/New England Highway intersection is beyond the scope of this assessment.

The proposed development is shown conceptually in ***Figure 11.***

Figure 11 – Proposed Development.
(Source: ADW Johnson 2024)

3.0 Council Requirements

Maitland City Council outlines the engineering requirements for stormwater management within their Manual of Engineering Standards. Specifically, Section 6 of their standards outline the relevant requirements for stormwater drainage.

3.1 ONSITE DETENTION

Council requires that the proposed development will not exceed the predevelopment runoff for all storm durations for all return periods ranging from 63.2% AEP to 1% AEP.

Council's requirement to not exceed predeveloped flow magnitudes is to be demonstrated at each of the site's legal points of discharge. RAFTS modelling of peak flows under existing and developed conditions is presented in ***Section 5***.

Council has advised that the stormwater detention assessment must consider the site in isolation of upstream catchments which drain through the site.

3.2 FLOOD STUDY

Council's *Manual of Engineering Standards* requires demonstration that a proposed development achieves a total system which does not adversely affect existing systems or properties within the flowpath or catchment.

Open channels forming part of the trunk drainage system must cater for the 100-year ARI peak flow with 0.3m freeboard within the channel and 0.5m to habitable floors.

Cross-drainage structures must cater for the 100-year ARI peak flow with 0.3m freeboard (including afflux).

Portions of the site are identified as being flood liable by regional flood studies. It must therefore be demonstrated that development of the subject land can be made compatible with the NSW Floodplain Development Manual (2005). The Floodplain Development Manual requires consideration of the total flood risk, being up to and including the Probable Maximum Flood (PMF).

Flooding outcomes are addressed in ***Section 6***.

3.3 STORMWATER QUALITY

The proposed development is to include water quality treatment devices within the site to reduce pollutant loads prior to discharging downstream. Council's stormwater quality targets for urban areas are shown in ***Table 1.***

Table 1 - Water Quality Targets (Maitland City Council, 2014)

Pollutant	Targets
Total Suspended Solids (TSS)	80% of average annual load
Total Phosphorus (TP)	45% of average annual load
Total Nitrogen (TN)	45% of average annual load
Litter	Retention of all litter greater than ϕ50mm for flow up to the 3-month ARI peak flow
Oil and Grease	90% of average annual load

Runoff quality improvement is addressed in ***Section 7*** of this report.

3.4 SOIL AND WATER MANAGEMENT

Soil and Water Management (SWM) is to be undertaken according to Landcom's *Blue Book* (2004) and Council's Manual of Engineering Standards, specifically Appendix B. The intent of this requirement is to mitigate erosion and prevent sediment-laden run-off from leaving the site during site preparation and construction. SWM is addressed in ***Section 8*** of this report.

3.5 PROTECTION OF RIPARIAN CORRIDORS

The Lochinvar URA DCP establishes an intent to minimise vegetation clearing within riparian corridors and preserve their long-term character and amenity. The Natural Resource Access Regulator defines acceptable activities within riparian zones on the basis of a stream hierarchy (DPE 2022).

Management of riparian corridors is addressed in ***Section 9***.

3.6 LOCHINVAR URA DCP

In relation to stormwater and water quality management, the objectives of the Lochinvar URA DCP (Part 9) are as follows:

1. To provide for an integrated and sustainable approach to the design and provision of open space and urban water management;
2. To protect and enhance the water quality, water quantity and habitat value of downstream waterways and environment; and
3. To prevent erosion and run-off during site preparation, construction and the ongoing use of the land to minimise cumulative impact on receiving waterways.

The DCP imposes 21 controls towards the referenced objectives. A DCP compliance table is provided in ***Section 10***.

4.0 Stormwater Strategy

As discussed in ***Section 2.1***, the existing hydrology is characterised by moderate slopes and a single well-defined watercourse flowing through the southern portion of the site. A focal point of this strategy was to formalise site run-on whilst respecting the site's existing drainage regime.

The proposed development will drain to two legal points of discharge, being:

1. The Lochinvar Creek tributary which conveys through the site; and
2. The existing drainage gully in Lot 2 1299958.

The southern catchment will be serviced by a conventional pit-and-pipe system draining to a bioretention basin in the south-western corner of the site, ultimately discharging to the tributary watercourse. The level of the basin is governed by the invert of the watercourse and the levels of the existing sewer rising main running through the middle of the site. The southern catchment's treatment train consists of a Gross Pollutant Trap (GPT) and bioretention basin in addition to rainwater tanks expected on each lot.

The smaller northern catchment's total area is reduced by the proposed development. This is owing to site regrading which redirects the catchment southwards towards the tributary watercourse. This catchment will be serviced by piped drainage reporting to a bioretention basin in the north-western portion of the site. The southern catchment's treatment train consists of a Gross Pollutant Trap (GPT) and bioretention basin in addition to rainwater tanks expected on each lot.

The northern bioretention basin has been designed to satisfy council's requirements, but is intended to be temporary only. This is on the basis that that future development of the western (downstream) lot would be supported by additional WSUD infrastructure which could cater for this small catchment, and consolidating stormwater infrastructure to avoid multiple assets for Council to maintain. This temporary basin will be removed once a future basin within the Lochinvar URA is constructed, accommodating of the site's runoff. The temporary basin will remain in the ownership of the developer along with the maintenance burden until this occurs.

As noted in ***Section 2.2***, flows from an existing upstream catchment are conveyed under Wyndella Road via a culvert crossing and continue through the site via an existing gully. Council has advised that routing this catchment via piped drainage along Wyndella Road is not supportable. An updated drainage design has been developed which more closely mimics existing conditions as follows:

- The existing culvert crossing will be upgraded and connected to the development's internal drainage network; and
- The low point in Wyndella Road will be retained, creating an overland flow path into the internal road network.

Previous submissions of DA/2023/415 were constrained by the existing Lochinvar Creek Tributary which bisects the site. Council's RFI dated 13th November 2023 identified several undesirable outcomes created by the watercourse, including location of the public park, lot access, connectivity of the southern cul-de-sac road, provision of drainage for the Hereford Hill catchment and arrangement of an acoustic mound on the southern boundary. Consistent with its stream order (1st), this revised application proposes to realign the watercourse along the site's southern boundary. This realignment allows the upstream Hereford Hill catchment to report directly to the watercourse and consolidates lots and open space on the northern side. Additionally, the watercourse's repositioning closer to the New England Highway creates exceptional outcomes in relation to access for maintenance and visual amenity.

The proposed stream realignment has created opportunities to establish a Biodiversity Management Plan over the watercourse and land on its southern overbank. The realigned watercourse will incorporate riparian vegetation and a meandering low-flow channel with pools and riffles in accordance with Biodiversity Management Plan by AEP. The watercourse's geometry has been defined to meet Council's freeboard requirements to top-of-bank and created lots.

Also noted in ***Section 2.2***, flows from the existing upstream Hereford Hill catchment are conveyed through a culvert crossing beneath the New England Highway and discharge to the subject site in an uncontrolled manner. Following advice from AEP to preserve and mimic existing site conditions, it is proposed that the existing 'dispersion area' be retained. Overflows from the dispersion area will report directly to the realigned watercourse, whilst the high-flow bank has been repositioned along the site's southwestern boundary to divert runoff away from Lot 1 DP741330.

The existing culvert crossing conveying the tributary watercourse beneath Wyndella Road will be upgraded as part of the New England Highway/Wyndella Road Intersection.

Stormwater strategy outcomes in relation to peak flow management, runoff quality, flooding, erosion and sediment control and riparian corridor management are provided from ***Sections 5*** to **9**.

5.0 Peak Flow Management

The proposed development will increase the catchment's impervious area and therefore contribute to additional stormwater runoff. InfoWorks ICM was used to compare peak flow magnitudes under existing and developed conditions to establish detention warrants for the proposed development in the context of Council's requirements.

5.1 MODELLING PARAMETERS

5.1.1 Rainfall Intensity

The Rainfall Intensity Frequency Duration (IFD) data adopted was sourced from the Bureau of Meteorology website (IFD 2019 application). AR&R 2019 procedures were adopted following Council advice. It is noted that the Lochinvar URA DCP and upstream Hereford Hill stormwater management planning were based on AR&R 1987 procedures.

5.1.2 RAFTS Parameters

The InfoWorks ICM model was developed using the RAFTS routing model.

Key RAFTS parameters used within the model are summarised in ***Table 2*** below.

Table 2 - RAFTS Modelling Parameters

Parameter	Pervious Area	Imperious Area
Manning's 'n'	0.035	0.014
Initial Loss (IL)	10.0mm	1.2mm
Continuing Loss (CL)	2.5mm/hr	0mm/hr

The parameters outlined in ***Table 2*** are consistent with the approved Stormwater Management Plan for the upstream Hereford Hill catchment developed by ADW Johnson (November 2017).

5.2 CATCHMENTS

Catchments and subcatchments were delineated by analysis of the field survey undertaken as well as the topographical survey information (LiDAR) and concept engineering plans. Predeveloped and developed catchment plans are provided in ***Appendix A***. Detailed catchment parameters are provided in ***Appendix B***.

Council has advised that peak flow assessment is to consider the subject site in isolation with a view to avoid 'sneaking the peak'. A theoretical model was therefore developed which excludes the upstream catchments reporting through the tributary watercourse, including the Hereford Hill Development. The site's northern upstream catchments were retained in the model as these directly enter the proposed development via the piped drainage network.

5.2.1 Predeveloped Catchments

Predeveloped catchments containing unimproved pastoral land (including the subject site) were assumed to be wholly pervious. A modest provision for the existing Impervious fraction of Wyndella Road was adopted based on Aerial imagery. ***Table 3*** summarises the predeveloped catchment parameters.

Table 3- Predeveloped Catchment Parameters

Catchment	Sub-Catchment	Area (ha)	% Impervious
Southern Catchment	PRE 2	17.88	2%
	PRE 3	12.55	0%
	PRE 4	3.27	7%
	Subtotal	33.70	2%
Northern Catchment	PRE 1	6.23	0%
	Subtotal	6.23	0%
	TOTAL	39.93	2%

5.2.2 Developed Catchment

Developed catchments were delineated utilising the proposed site grading plan and concept stormwater layout. Maitland City Council's Manual of Engineering Standards includes standard impervious fractions for different land uses as shown in ***Table 4***.

These values have been incorporated into the hydrologic model.

Table 4 - Fraction Impervious Rates for Land Uses

Land Use	Fraction Impervious
Residential Lot Size < 1000 m^2	0.6
Road Reserve	0.7
Public Recreation Areas (mowed and with improvements)	0.5
Parkland, Natural Public Reserve	0.5

Source: MOES 2014

A summary of developed catchment parameters is provided in ***Table 5.***

Table 5 - Developed Catchment Parameters

System	Catchment	Area (ha)	% Impervious
Southern Catchment	DEV 2	18.38	64%
	DEV 2 EXT	12.55	0%
	DEV 4	2.38	51%
	DEV 5	1.44	16%
	Subtotal	34.75	38%
Northern Catchment	DEV 1	1.94	64%
	DEV 1 EXT	3.21	0%
	Subtotal	5.15	23%
	TOTAL	39.90	36%

From ***Table 5*** it is seen that the northern catchment's total area is reduced by the proposed development. This is owing to site regrading which redirects the catchment towards the tributary watercourse. Reciprocally, a modest increase in the tributary watercourse catchment is reported. A modest reduction in the overall catchment area is accounted for by small batters and to the northwest of the site associated with the future regrading of Wyndella Road allowed for by the concept engineering plans.

5.3 STORMWATER DETENTION

A stormwater detention basin is proposed on the site's southern catchment, being Basin 1. Assumed basin parameters are presented in ***Table 6.***

Table 6 – Basin 1 Parameters

Basin Parameter	Detail
Levels	30.30m AHD - Invert Level
	32.30m AHD - Berm Level
Outlet 1	1200mm x 1200mm RGSIP
	IL 30.60m AHD
	2x 525mm RCP
	IL 30.00m AHD
Outlet 2	2400mm x 2400mm RGSIP
	IL 31.00m AHD
	2x 900mm RCP
	IL 30.00m AHD
Outlet 3	Emergency Spillway - 10m Length, 1:5 Sides - IL 32.00m AHD
1% AEP Storage Volume	3,180 m^3

It is noted that the proposed outlet configuration is conceptual. Alternate configurations (such as cut-out pits) are acceptable provided an equivalent stage-discharge relationship is adhered to.

5.4 PEAK FLOW RESULTS

The predeveloped and developed peak flows were estimated using InfoWorks ICM all design events up to and including the 1% AEP.

Peak flows at Node 2 (northern catchment) are presented in ***Table 7***.

Table 7 - Node 2 Modelling Results

Design AEP	Peak Flowrate (m^3/s)	
	Predeveloped	Developed
63%	0.362	0.303
10%	0.984	0.816
5%	1.288	1.037
2%	1.745	1.379
1%	2.106	1.662

From ***Table 7*** it is seen that the peak developed flows from the catchment are smaller than the related predeveloped flows. This is an expected result due to the reduction in catchment size after development. It follows that detention is not required at this discharge point.

Peak flows at Node 1 (southern catchment) are presented in ***Table 8***.

Table 8 - Node 1 Modelling Results

Design Average Recurrence (years)	Peak Flowrate (m^3/s)	
	Predeveloped	Developed (Detained)
63%	1.678	1.570
10%	4.857	4.766
5%	6.002	5.783
2%	7.859	6.498
1%	9.427	7.942

From ***Table 8*** it is seen that the proposed detention basin is appropriately sized to attenuate peak discharges to their predeveloped magnitudes. Peak stages within Basin 1 are presented in ***Figure 12***.

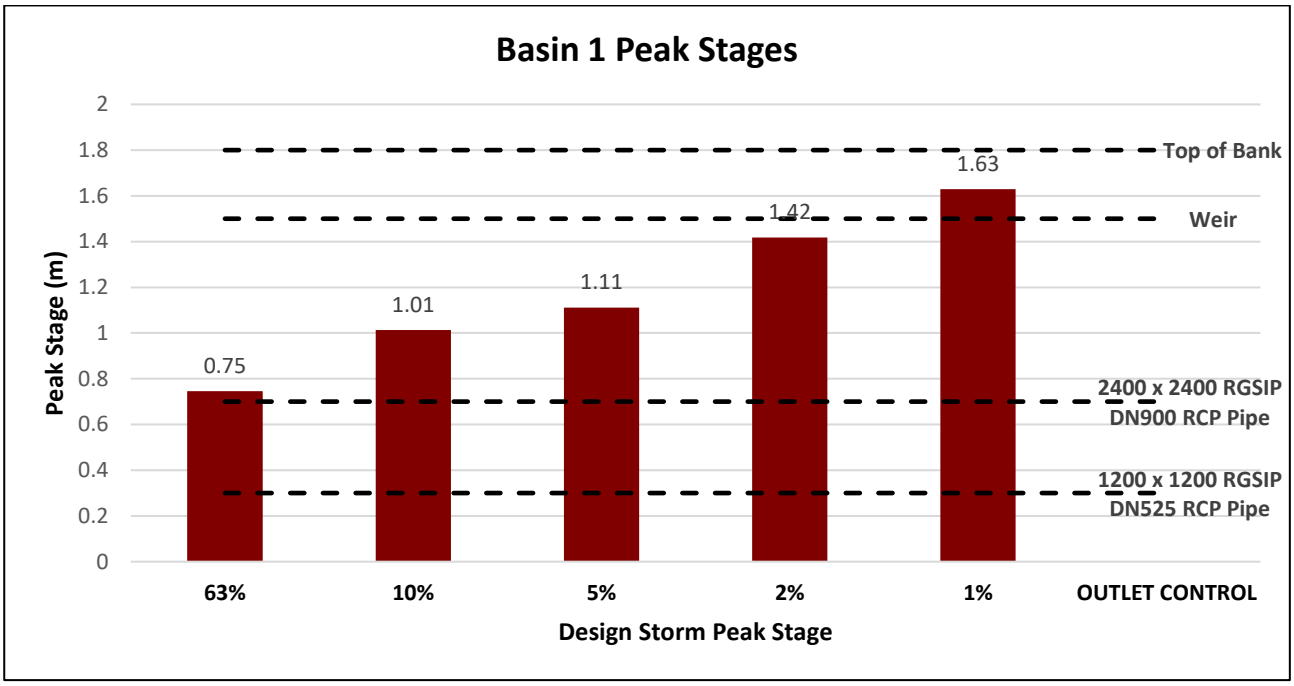

Figure 12 – Basin 1 Peak Stages.

From ***Figure 12*** it is seen that the proposed basin provides more than 150mm freeboard to the basin embankment during the critical 1% AEP design storm. Importantly, peak stage in the 5% AEP design event is less than 1.2m (MOES Stormwater Cl 8.1.5).

6.0 Flood Study

As noted in ***Section 2.2***, the site receives a significant upstream catchment via a tributary of Lochinvar Creek. A 1-dimensional flood study has been undertaken to verify that the proposed development is compatible with existing flood behaviour and the requirements of the NSW Floodplain Development Manual (2005).

The US. Army Corps of Engineers River Analysis System (HEC-RAS) software was used to compare flood extents under existing and developed conditions. Consideration was given to proposed cross-drainage structures and outcomes relating to extreme flood events. This section makes reference to existing flood studies within the Lochinvar Creek catchment.

6.1 PREVIOUS REPORTING

The Lochinvar Urban Release Area has been the subject of extensive flood reporting, as summarised below.

6.1.1 Lochinvar Flood Study (WMA Water, 2019)

The Lochinvar Flood Study (WMA Water, 2019) was adopted by Maitland City Council in 2019 and provides a comprehensive technical investigation of flood behaviour for the entire Lochinvar Creek Catchment. The report's scope addressed local flood behaviour for design events up to and including the Probable Maximum Flood (PMF). Consideration was given to hydraulic hazard categorisation and flood emergency response outcomes.

6.1.2 Lochinvar Urban Release Area Flood Study (ADW Johnson, 2015)

ADW Johnson was engaged by Maitland City Council to undertake a flood study in support of the Lochinvar URA Planning Proposal. The Lochinvar Urban Release Area Flood Study (ADWJ, 2015) was informed by 1-dimensional hydraulic modelling of the URA under existing and developed conditions. The report identified warrants for upgrades to an existing culvert in Wyndella Road.

6.1.3 Hunter River: Branxton to Green Rocks Flood Study (WMA Water, 2010)

Lochinvar Creek is a tributary of the Hunter River and is therefore modulated by regional flood behaviour. The Hunter River: Branxton to Green Rocks Flood Study (2010) provides a comprehensive analysis of Hunter River flooding for design events up to the Probable Maximum Flood. Lochinvar Creek was modelled as a backwater basin and its catchment was assigned to the Hunter River as an inflow hydrograph.

The Lochinvar Flood Study (WMA Water, 2017) adopted the 5% AEP Hunter River Flood Level as its downstream boundary condition, noting that significant local flooding can occur within the catchment in isolation of regional flooding.

6.2 MODELLING INPUTS

Watercourse networks were developed under existing and developed conditions in accordance with the existing hydrology (***Section 2.3***) and the proposed stormwater strategy. ***Appendix D*** presents network diagrams which clearly define the river and reach numbers of each modelled watercourse.

6.2.1 Inflows

Separate to the 'isolated' detention assessment presented in ***Section 5***, a standalone InfoWorks ICM scenario was developed which reintroduced upstream and downstream catchments. Peak 1% AEP and PMP design flows were obtained from the model at key locations.

Corresponding ICM subcatchments and HEC-RAS rivers are summarised in ***Tables 9*** and ***10***.

Table 9 - HEC-RAS Flow Inputs – Existing Conditions

HEC-RAS River/Reach	RAFTS Node	1% AEP Flow (m^3/s)
RIVER 1 CH 1566	PRE 5	16.18
RIVER 1 CH 1030	8.1 (Confluence of Hereford and Dev 4)	18.77
RIVER 1 CH 957	10.1 (Confluence of Pre 2 and Pre 4)	22.80
RIVER 1 CH 574	DS Break 1	49.05
RIVER 2 CH 638	PRE 3	4.10
RIVER 3 CH 357	DS 2	22.42

Note: Refer Appendix D for location of rivers and reaches.

Table 10 - HEC-RAS Flow Inputs – Developed Conditions

RAFTS Node	HEC-RAS River/Reach	1% AEP Flow (m^3/s)	PMP Flow (m^3/s)
RIVER 1 CH 574	DS BREAK 1	49.31	350.71
RIVER 2 CH 308	PRE 3	4.10	22.90
RIVER 3 CH 357	DS 2	22.16	159.90
RIVER 4 CH 996	PRE 5	16.18	112.31
RIVER 4 CH 437	8.1 (Confluence of Hereford and Dev 4)	17.52	131.66
RIVER 4 CH 284	10.1 (Confluence of Dev and Pre 4)	22.80	156.63

Note: Refer Appendix D for location of rivers and reaches.

6.2.2 Roughness

Modelled roughness values were adopted from WMA Water, 2017 and confirmed by way of field inspection. Modelling assumed the following Mannings 'n' values:

- 0.07 for lightly vegetated watercourses;
- 0.07 for the proposed realigned watercourse's main channel; and
- 0.04 for general overbank areas and unvegetated watercourses.

6.2.3 Boundary Conditions

Consideration was given to adopting the Hunter River regional flood level as a downstream boundary condition. However, with reference WMA Water, 2017, a lower value was adopted to not misconstrue local flood behaviour.

A fixed tailwater condition was applied to the Lochinvar Creek Tributary near the northern end of Cantwell Road. Known water surface levels were adopted from flood mapping appended the Lochinvar Creek Flood Study (WMA Water 2017) as follows:

- 100-year ARI – RL 24.0m AHD; and
- Probable Maximum Flood – RL 28.0m AHD.
-

6.3 EXISTING FLOOD BEHAVIOUR

Existing flood extents and levels are provided in ***Appendix C***. Extents are generally consistent with WMA Water, 2017.

Existing culvert structures in Wyndella Road were modelled without blockage. Modelling confirmed that Wyndella Road's northern culverts are undersized, with overtopping of Wyndella Road subject to the 1% AEP design flood. The existing DN525 culverts create a constriction which elevates upstream flood levels on Lot 225 DP 246447. This is an important result which identifies a need to address Wyndella Road's existing drainage regime.

Similarly, Wyndella Road's southern culverts were also found to overtop subject to a peak 1% AEP design flow. This is consistent with WMA Water, 2017 which observed that Wyndella Road South overtops in a 2% AEP event.

Runoff from the New England Highway's culverts was not modelled under existing conditions. As noted in ***Section 2.3***, the catchment's flowpath is poorly defined and not conducive to 1-dimensional flood assessment. Notwithstanding, modelling identified significant overbank flow into Lot 1 DP741330 which is consistent with anecdotal evidence and ground-truthing.

6.4 DEVELOPED FLOOD BEHAVIOUR

Developed flood extents and levels are provided in ***Appendix C***. From ***Appendix C*** the following outcomes are evident:

- The realigned tributary of Lochinvar Creek adequately contains the 1% AEP peak flood without overtopping of roads or embankments;
- All proposed lots have more than 500mm freeboard to the 1% AEP design flood. The realigned watercourse provides more than 300mm freeboard to the top of channel. ***Table 11*** presents design levels and freeboard for each waterfront lot.
- Upgraded culverts under Wyndella Road (south) serve to reduce upstream flood extents within Lot 223 DP 246447. This is an expected result given the existing culverts are undersized with respect to the design 1% AEP flowrate; and
- There is no observable impact to upstream or downstream flood extents or velocities up to the 1% AEP design flood.

Table 11 – Freeboard at Waterfront Lots

Lot	1% AEP Flood Level (m AHD)	Embankment Level (m AHD)	Embankment Freeboard (m AHD)	Lot Level[1] (m AHD)	Lot Freeboard (m AHD)
218	34.12	34.79	0.67	35.67	1.55
219	33.92	34.59	0.67	35.51	1.59
220	33.8	34.44	0.64	35.37	1.57
221	33.69	34.31	0.62	35.26	1.57
222	33.55	34.21	0.66	35.17	1.62
223	33.43	34.10	0.67	34.95	1.52
202	31.54	32.92	1.38	33.41	1.87
201	31.42	32.79	1.37	33.25	1.83

1. *Taken at the 5m front setback.*

These outcomes confirm that the proposed development is compatible with Maitland City Council's Manual of Engineering Standards and the NSW Floodplain Development Manual.

6.5 TRUNK DRAINAGE INFRASTRUCTURE

HEC-RAS flood modelling was used to size and analyse trunk drainage infrastructure. Consideration was also given to redirection of catchment from the existing northern Wyndella Road culverts vial proposed piped drainage infrastructure. These are detailed in ***Sections 6.5.1*** to ***6.5.2***.

6.5.1 Realigned Watercourse

HEC-RAS modelling was used to inform the typical section for the Wyndella Road Watercourse. Geometry for the watercourse is presented in ***Figure 13*** whilst key design parameters are presented in ***Table 12.***

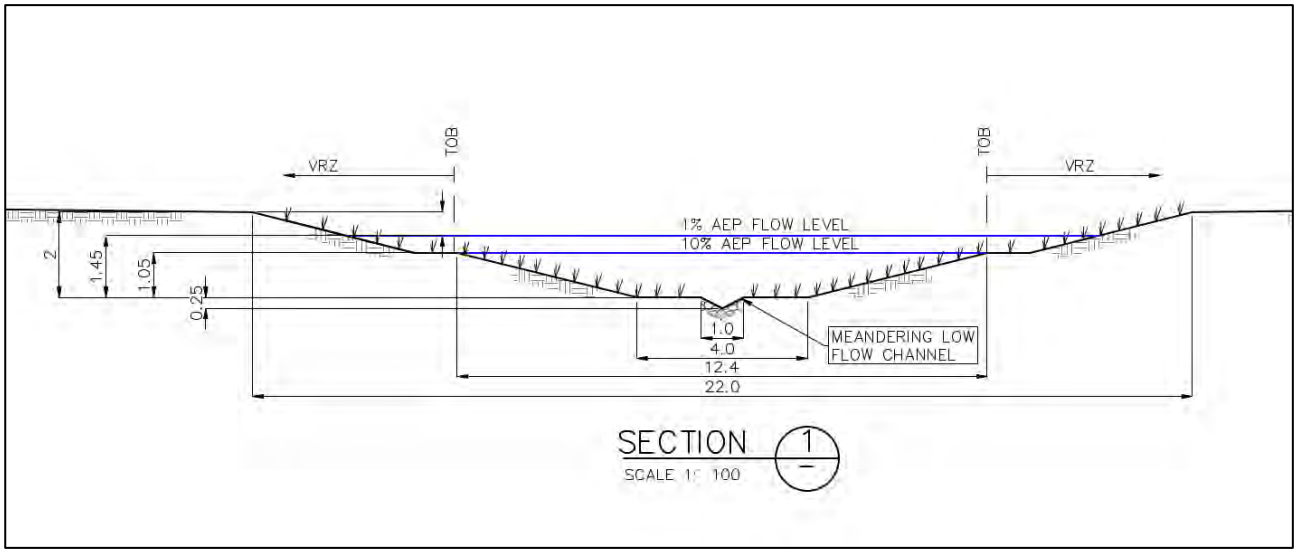

Figure 13 – Realigned Watercourse Typical Section.

Table 12 – Realigned Watercourse Typical Details

Parameter	Value
Base width (excluding low-flow)	4m
Batter slopes	1V:4H
Roughness	0.07 (between banks) 0.04 (overbank)
Channel slope	0.8%
1% AEP design flow	17.5 m^3/s

6.5.1 Wyndella Road Culverts (South)

Corroborated by this study, the Lochinvar Urban Release Area Flood Study (ADW Johnson, 2015) justifies upgrades to the existing circular culverts in Wyndella Road. HEC-RAS was used to size culverts to safely convey the 1% AEP peak flowrate as derived from RAFTS modelling (***Section 5***). The design blockage factor for each structure was deemed to be 0.25 in accordance with Australian Rainfall & Runoff's *Blockage of Hydraulic Structures* (2019). Blockages were directly applied uniformly from the culverts' invert within HEC-RAS.

Table 13 presents indicative sizing and hydraulic performance of the proposed Wyndella Road Culverts.

Table 13 – Wyndella Road Culvert Details

Property	Value
1% AEP peak flow	16.18 m^3/s
Design Levels	33.30m AHD (upstream invert)
	35.00m AHD (roadway)
Culvert configuration	7 x 1.5m (W) x 0.9m (H) RCBC
Tail Water Level	34.60 m AHD (proposed)
	34.92 m AHD (existing)
Freeboard (m AHD)	0.40m (to carriageway)

It noted that the culvert sizing reported herein is illustrative only. It is recommended that sizing is reviewed at detailed design, subject to confirmation of roadway levels and watercourse hydraulics. It is evident from ***Table 13*** that the culvert sizing is governed by freeboard to the Wyndella Road carriageway. There is clear justification for smaller culverts should there be scope to lift Wyndella Road (for instance through detailed design of the future AURA intersection upgrade).

Similarly, it is noted that a bridge structure or alternate culvert configuration should not be precluded subject to hydraulic capacity assessment.

6.5.3 Wyndella Road North Catchment

As noted in ***Section 4***, Wyndella road will be regraded southwards to render the existing northern culverts obsolete. The existing culverts receive a catchment of approximately 12.6 Ha corresponding to a 1% AEP peak flow of 4.10 m^3/s. This catchment is to be integrated with the development's internal drainage network.

The Wyndella Road drainage inlet was assessed using Henderson's *Open Channel Flow* stage-discharge relationships. Modelling assumed a 1.5 x 3.0m RGSIP positioned in the existing low point with a blockage factor of 50%. Hydrologic and hydraulic analysis confirmed that the proposed inlet can accept the 1% AEP peak flow with allowance for blockage.

The low point in Wyndella Road has been retained. An inverted verge is proposed at the sag to allow an overland flow path into the site, consistent with existing conditions. A parallel internal road (MC09) has been provided as an overland flow path to direct runoff through the site. Piped drainage will be sized such that bypass flows are safely conveyed within the road network.

To provide further contingency, a drainage channel is proposed on the eastern side of Wyndella Road consistent with Maitland Standard Drawing SD003. The intent of this channel is to protect the Wyndella Road pavement from a small rural upstream catchment.

6.6 RARE AND EXTREME FLOOD EVENTS

Probable Maximum Precipitation (PMP) is defined by the World Meteorological Organization (1986) as '*the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year*' (BOM 2003). The PMP does not represent a realistic event, with an estimated exceedance probability of one-in-ten million for a catchment of the subject's size (Lauenson and Kuczera 1999). However, it is of interest in the context of flood emergency and response planning, as well as risk assessment.

The PMP rainfall for the subject site was estimated using the Bureau of Meteorology's *Generalised Short-Method (GSDM)* for durations ranging from fifteen minutes to six hours. XPRAFTS was used to estimate peak PMP flows. The PMP catchment loss model was consistent with ***Section 6.2*** as statistically-dependent loss models are generally discouraged (AR&R 2019).

PMF extents were modelled in HEC-RAS by routing the estimated PMP flows through the developed terrain model. Predicted PMF extents are presented in ***Appendix C***. Key outcomes in relation to rare and extreme flooding are summarised in ***Section 6.6.1*** to ***6.6.2***.

6.6.1 Flood Affectation

From ***Appendix C*** it can be seen that all lots are free of the PMF envelope with the exception of several batters within the 5m front setback. This is an important result which confirms that refuge-in-place is possible for all dwellings.

Modelling of PMF flows through the road and piped drainage network is beyond the scope of this assessment.

6.6.2 Flood Emergency Response

As noted in ***Section 6.6***, the PMF is conventionally used as a tool for emergency response planning. Flood Emergency response planning was examined by the Lochinvar Flood Study (2019). WMA Water Identified that, under existing conditions, Wyndella Road and sections of the New England Highway would be inundated by the PMF.

The Lochinvar Flood Study does not identify the New England Highway as being cut off to the east of Wyndella Road, providing an evacuation route to the east (***Figure 14***).

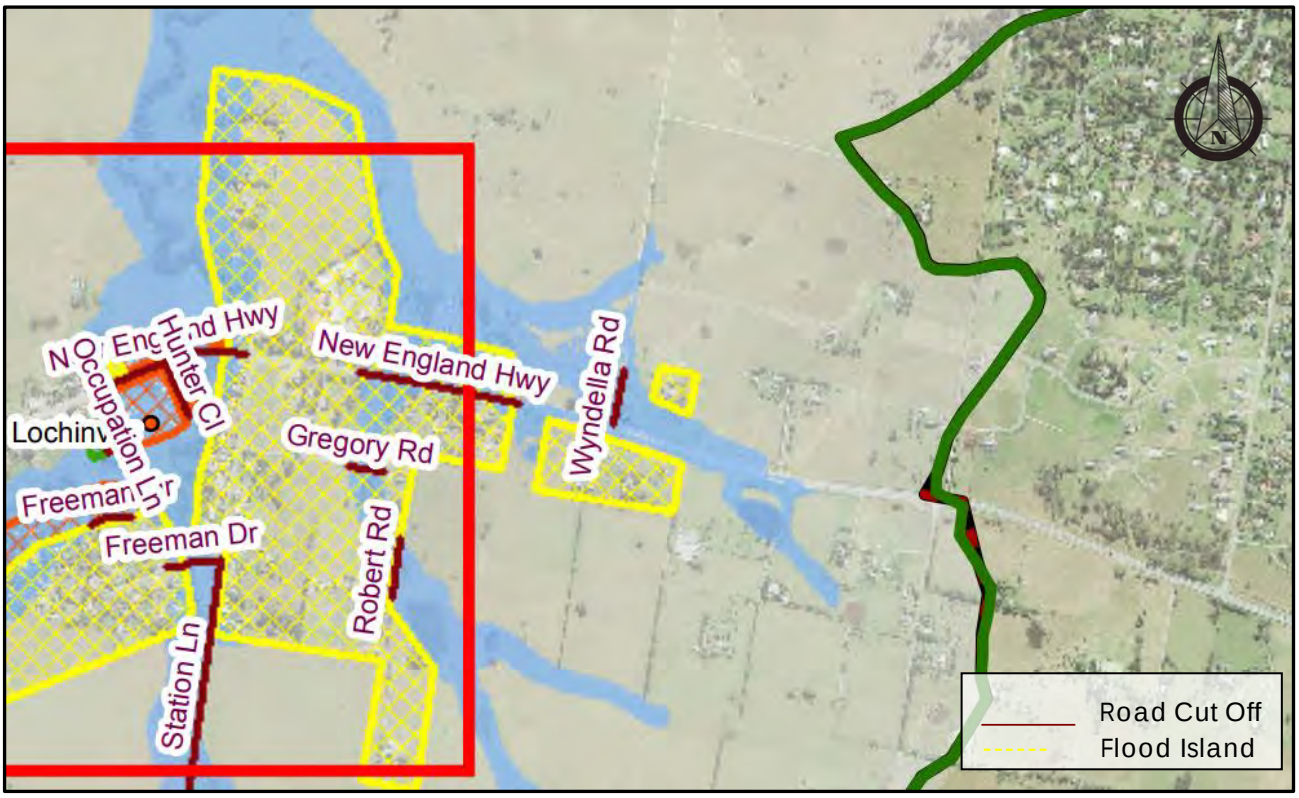

Figure 14 - Emergency Response Classification.
(Source: WMA Water, 2019)

Whilst no lots are liable to the PMF, each of the site's north-south roads may be utilised as a rising escape route. Wyndella Road is also considered to provide a rising escape route to the north.

7.0 Water Quality

The quality of the stormwater discharging from the development was determined using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). The MUSIC model was used to simulate pollutant source elements for the proposed development and the treatment of the pollutant loading using treatment devices.

7.1 MUSIC MODELLING PARAMETERS

7.1.1 Rainfall and Evapotranspiration

Rainfall data from Tocal, Paterson weather station was input into the MUSIC model. Paterson is situated 30km west of the subject site and suitably reflects local conditions. Six-minute rainfall information for the year of 1989 was analysed and deemed to be a reasonable representation of the average yearly rainfall and rainfall event distribution. A comparison of Paterson's 1989 rainfall with the long-term averages for Paterson is presented in ***Table 14*** below.

Table 14 – Comparison of Paterson Rainfall Data

Data suite	Paterson1989	Paterson Long-term Average
Annual rainfall (mm)	904.6	940.3
Annual days of rainfall	89	89.9

It can be seen from ***Table 14*** that the rainfall and number of rainfall days for Paterson in 1989 was comparable with the annual averages taken for the 50-year period from 1967 to 2018. The annual rainfall and evapotranspiration time series graph for Paterson in 1989 is shown in ***Figure 15.***

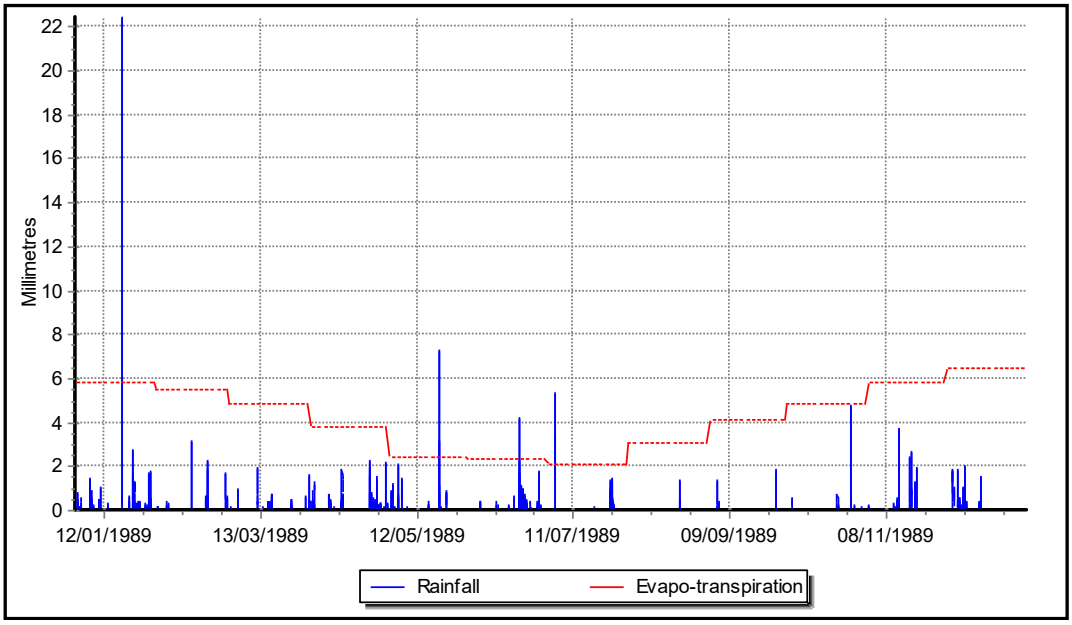

Figure 15 – Rainfall and Evapotranspiration Graph.

7.1.2 Catchments and Land Use

The developed catchment was delineated according to their treatment trains and points of discharge. Catchments were generally consistent with those used for peak flow estimation, noting there is no obligation to consider upstream catchments which bypass treatment.

Each catchment was broken down according to surface type as identified from the site masterplan. The MUSIC model incorporated the following surface types:

The MUSIC model defined the following land uses:

- Roof (Urban) – This land use defines the impervious roof area of each lot. Rooves are assumed to account for 50% of each lots area and are100% impervious;
- Lots (Urban) – This land use defines the lot area after the removal of the roof area. Lots were modelled in MUSIC using residential source nodes. Lots were assumed to be 20% impervious and account for the remaining 50% of overall lot area;
- Road (Urban) – This land use defines the road reserve area. Roads were assumed to be 70% impervious which is consistent with MOES 2014;
- Open Space (Urban) – This land use defines future parks and stormwater management facilities. Open space was represented in MUSIC using residential source nodes and were assumed to be 50% impervious; and

Summation of roof and lot areas equates to an impervious fraction of 60% for total lot areas. Impervious fractions for each land use are in accordance with MOES for residential lots of less than 1000m^2.

Table 15 summarises the area and composition of each MUSIC subcatchment. A MUSIC catchment plan is provided as ***Appendix E***.

Table 15 - MUSIC Catchment Areas

Catchment	Total Area (Ha)	Lot (Ha)	Roof (Ha)	Road (Ha)	Open Space (Ha)
DEV 1	1.69	0.52	0.52	0.65	0.00
DEV 2	16.36	5.36	5.36	5.21	0.44
DEV 3	1.45	0.25	0.25	0.44	0.50
TOTAL	19.50	6.13	6.13	6.13	0.94

It is noted that DEV 3 drains towards the south and discharges into the realigned watercourse. The treatment train for this catchment comprised of rainwater tanks located on each lot.

7.1.3 Rainfall-Runoff Parameters

Surface parameter inputs and pollutant concentrations were obtained from the *'NSW MUSIC Modelling Guidelines'* (BMT WBM, 2020) and checked for consistency against approved stormwater management plans in the Lochinvar URA.

Rainfall-runoff parameters are summarised in ***Table 16***.

Table 16 – Rainfall-Runoff Parameters

Parameter	Lot	Roof	Road	Open Space
Rainfall Threshold (mm/day)	1.0	0.3	0.5	1.0
Soil Storage Capacity (mm)	120			
Initial Storage (% of Capacity)	25			
Field Capacity (mm)	80			
Infiltration Capacity Coefficient - a	200			
Infiltration Capacity Exponent - b	1.0			
Initial Depth (mm)	10			
Daily Recharge Rate (%)	25			
Daily Baseflow Rate (%)	5			
Daily Deep Seepage Rate (%)	0			

7.2 TREATMENT DEVICES

A treatment train has been developed comprising of rainwater tanks, Gross Pollutant Traps (GPTs) and bioretention basins.

These treatment devices are described in detail in ***Sections 7.2.1*** to ***7.2.3***.

7.2.1 Rainwater Tanks

Rainwater tanks are at-source controls which harvest roof water and store it for on-site reuse. These controls are used on each lot as each dwelling is required to comply with BASIX requirements. A volume of 3000L for each tank has been conservatively adopted, the BASIX requirements is expected to yield in the range of 3000 – 4000L.

Table 17 outlines the rainwater tank parameters adopted for modelling purposes.

Table 17 - Rainwater Tank Parameters

Catchment	A
Volume Below Overflow Pipe (L)	3000
Depth Above Overflow pipe (m)	0.2
Surface Area (m^2)	3
Overflow Pipe Diameter (mm)	100
Daily Reuse (kL/day/dwelling)	0.324

The daily reuse was estimated from the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). Allowance was made for an average household of three people utilising harvested rainwater for toilets, laundry and outdoor use.

7.2.2 Gross Pollutant Traps

GPTs are utilised as conveyance controls of litter and heavy settlement. Modelling was based on the Humes 'Humegard' which has been implemented successfully throughout developments of similar scale. Pollutant removal efficiencies were obtained from Humes' website and are presented in ***Table 18***.

Table 18 - GPT Pollutant Removal Efficiencies

Pollutant	% Removal Efficiency
Total Suspended Solids	49
Total Phosphorus	40
Total Nitrogen	26
Gross Pollutants	90
Total Hydrocarbons	90

Source: Humes 2023

Two catchments – DEV 1 and DEV 2 – report to GPTs situated in the site's low points. Estimates for the 3-month ARI peak flowrate – taken as 50% of the 1-year ARI flowrate obtained from RAFTS modelling – were compared against treatable flowrates to ensure GPTs were appropriately sized. Modelled GPT sizes are summarised in ***Table 19***, however would be reviewed subject to detailed design.

Table 19 - GPT Sizing

Catchment	Humegard Model	Treatable Flowrate (L/s)
DEV 1	HG15	130
DEV 2	HG35	1540

7.2.3 Bioretention Basins

Biorention basins are utilised as end-of-line controls consisting of a sandy loam media and selective planting. They provide essential pollutant reduction through the filtration and chemical uptake through biologically active media.

Both the larger site catchment (Dev 2) and the smaller north-western catchment (Dev 1) will report to bioretention basins downstream of their respective GPTs. Basins have been positioned to intercept a majority of runoff and are located offline of the site's existing watercourse. A 1.5m wide access track has been allowed for at each basin's perimeter for access and maintenance.

Table 20 summarises the modelled parameters for each basin.

Table 20 - Bioretention Basin Parameters

Bioretention Basin	South	North
Catchments Served	DEV 2	DEV 1
Surface Area (m^2)	1250	46
Extended Detention Depth (m)	0.3	0.3
Exfiltration Rate (mm/hr)	0	0
Filter Area (m^2)	200	20
Filter Depth (m)	0.5	0.5
Saturated Hydraulic Conductivity	180	180
Base Lined	Yes	Yes
Underdrain Present	Yes	Yes
Submerged Zone	No	No

7.3 WATER QUALITY RESULTS

A network diagram of the constructed MUSIC model, showing catchment links and treatment devices, is provided as an appendix to this report (***Appendix F***). Pollutant reductions for each individual catchment are provided as ***Appendix G***.

Monitoring nodes were used to represent pollutant loading from each of the road's discharge points, enabling pollutant reductions to be compared with the targets defined in ***Section 3***. The average annual pollutant loads for each point of discharge is shown in ***Tables 21*** and ***22***.

Table 21 - Treatment Train Effectiveness (Northern Discharge Point)

Pollutant	Developed Untreated Load (kg/yr)	Developed Treated Load (kg/yr)	Reduction (%)
TSS	1600	9.36	80.7
TP	3.21	308	64.4
TN	22	11.4	48.2
GP	335	0	100

Table 22 - Treatment Train Effectiveness (Southern Discharge Point)

Pollutant	Developed Untreated Load (kg/yr)	Developed Treated Load (kg/yr)	Reduction (%)
TSS	15400	2980	80.7
TP	32.9	11.6	64.8
TN	224	104	53.5
GP	3460	208	94

From ***Tables 21*** and ***22*** it can be seen that the proposed treatment train satisfies Council's runoff quality improvement targets at each of the site's legal points of discharge. ***Table 22*** represents of the overall treatment train effectiveness for the southern catchment, comprised of DEV 2 and DEV 3 combined. Noting that a minimum 94% of gross pollutants were removed for the full simulation period, it is considered that Council's requirement in relation to litter control is met.

8.0 Soil and Water Management

Council requires the use of erosion and sediment controls to manage and contain pollutant runoff during construction. All erosion and sediment controls and practices are to be in accordance with Council's Manual of Engineering Standards Appendix B and Landcom's *Managing Urban Stormwater: Soils and Construction* (2004) ('the Blue Book').

Treatment devices will be utilised to contain the generated pollutants from the site during construction. These include but are not limited to:

- Silt Fencing;
- Strawbale and Geotextile Fencing;
- Kerb Inlet Controls;
- Sandbag Kerb Inlet Sediment Traps;
- Shaker Ramps; and
- Diversion Drains.

Any clean water entering the site from upstream catchments is to be diverted around the construction site where possible hence remaining clean. Runoff generated from within the site is to be treated and managed using a combination of the above stated treatment devices.

It is noted that development of the site will incur significant earthworks. Construction is proposed in stages to minimise the area of disturbed soil at any given time. Consideration will be given to the construction of temporary sediment basins which would be sized and configured during detailed design.

A preliminary Soil and Water Management Plan is presented within the associated concept engineering plans (240332-CENG) by ADW Johnson. The Soil and Water Management Plan is indicative only as another Soil and Water Management Plan will be provided as part of the construction certificate drawings and a further plan will be provided by the contractor to evolve during construction.

9.0 Riparian Corridors

A riparian zone is land immediately alongside a watercourse and, when managed appropriately, often represents the most fertile and diverse portion of the surrounding landscape (NRAR 2018). Riparian lands contribute to streambank stability and ecological productivity, but may be vulnerable to deterioration induced by human activities.

The Natural Resources Access Regulator prescribes minimum Vegetated Riparian Zones (VRZs) on either side of a recognised watercourse. Works within VRZs are restricted to certain activities which cause limited disturbance to the riparian corridor in accordance with the *Water Management Act 2000 (NSW)*. VRZ widths are a function of streamflow category as follows in ***Table 23***.

Table 23 - Recommended Riparian Corridor Widths

Stream category	VRZ width (from top of bank)
1st order	10 m
2nd order	20 m
3rd order	30 m
4th order	40 m

Where development encroaches onto a riparian corridor, the 'averaging rule' allows for development in the outer 50% of a VRZ provided offsets are created in the opposite corridor as shown in ***Figure 16*** below.

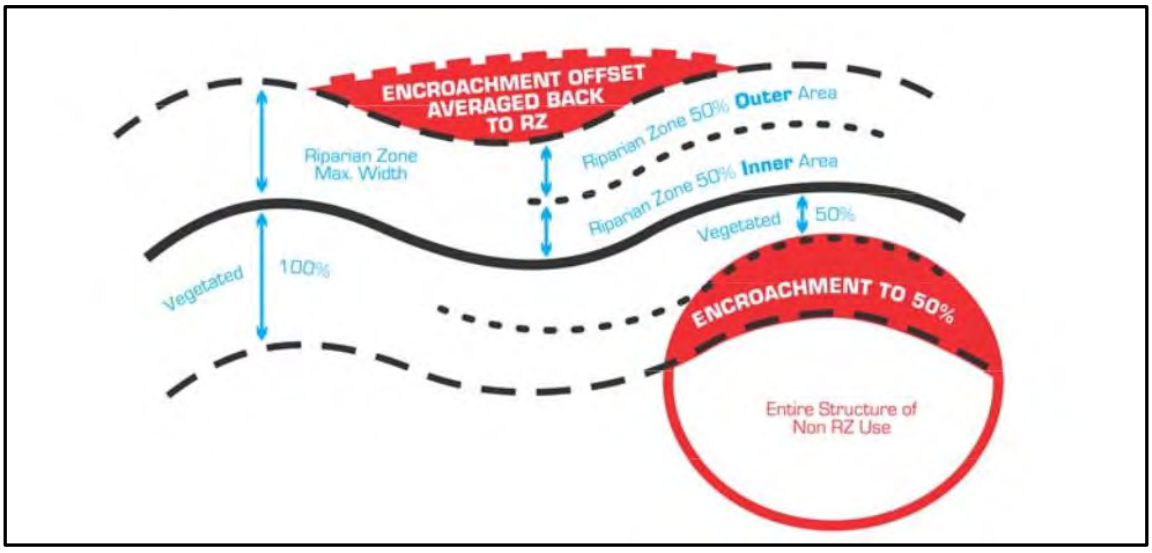

Figure 16 - Offset of Riparian Encroachment.
(Source: NRAR 2018)

The present tributary watercourse has been categorised in ***Section 2*** of this report and confirm that the site is subject to the controls of 1st order streams. Stream realignment is identified as an acceptable activity in the NRAR's *Riparian Corridor Matrix*. The watercourse's new alignment has been selected to maximise opportunities for establishing a riparian corridor.

Where necessary, the averaging rule will be applied to ensure that an adequate riparian corridor is retained. A plan of riparian corridor encroachments and offsets is provided as ***Appendix H*** and demonstrates that the requirements for controlled activities on waterfront land are met.

10.0 Development Control Plans

Section DC.3 of the Maitland Development Control Plan (Part C) relates to drainage, water quality and soil erosion controls. ***Table 24*** details each DCP requirement with commentary relating to the subject development.

Table 24 - Maitland DCP Controls

No.	Control	Response
DC.3.1	Existing topography and natural drainage lines should be incorporated into drainage designs for larger proposals, and enhanced through provision of additional landscaping, detention areas, artificial wetlands and the like.	The stormwater strategy respects the site's existing points of discharge and drainage regime. An existing watercourse, being a tributary of Lochinvar Creek, is to be retained as a key component of the site's stormwater management system. The watercourse will incorporate a Vegetated Riparian Corridor (VRZ) which will be improved by way of a Vegetation Management Plan. No artificial wetlands are proposed, however the proposed bioretention basins will incorporate landscaping and planting.
DC.3.2	Drainage from proposed lots should be consistent with the pre-development stormwater patterns. An analysis of the downstream drainage system, to the receiving area or waters, may be required.	Hydrologic modelling has been undertaken to compare peak site discharges under existing and developed conditions. Modelling has confirmed that the development will not intensify peak flows at either point of discharge, and that peak flows are well correlated to predeveloped magnitudes.
DC.3.3	Best management practices should be implemented to control runoff and soil erosion and to trap sediment on the subject land to ensure there is no net impact on downstream water quality. The quality of runoff water from the subject land should be the same or better than the quality of water prior to the subdivision taking place.	A stormwater quality treatment train has been developed comprising of rainwater tanks, Gross Pollutant Traps and bioretention basins. MUSIC modelling has confirmed that the proposed treatment train meets Council's load-based objectives in relation to runoff quality improvement.
DC.3.4	Where possible, design multiple use drainage and treatment systems incorporating gross pollutant traps, constructed wetlands and detention basins.	A stormwater quality treatment train has been developed comprising of rainwater tanks, GPTs, bioretention basins and buffer strips. No constructed wetlands are proposed.
DC.3.5	The subdivision should be designed so as to minimise disturbance of the subject land especially in circumstances where there are topographical constraints.	The proposed earthworks strategy has been optimised to existing site constraints including the existing watercourse, flood extents, presence of rock, existing services and the sightline from the New England Highway to the hillcrest. Topographically, existing high and low points have been respected.
DC.3.6	Adequate provision should be made for implementation of measures during subdivision construction to ensure that the landform is stabilised and erosion controlled.	Conceptual Soil and Water Management Plans are provided within the concept engineering plans. To ensure downstream waters and adjacent properties are protected, appropriate erosion and sediment controls are to be undertaken during construction. Controls are to be implemented and monitored in accordance with Landcom's 'Blue Book' and Council's engineering guidelines.

No.	Control	Response
DC.3.7	All trunk drainage is to be located in publicly owned land, (reserves), in open space land or in an appropriate easement.	Trunk drainage being the existing watercourse and the southwestern channel are to be dedicated as public drainage reserve.
DC.3.8	Where the drainage impacts of the subdivision proposal cannot be limited to pre-development stormwater levels by retention or other approved methods, drainage easements will be required over all necessary properties and watercourses. In such circumstances, the easement must be the subject of a signed agreement prior to issue of development consent. Such easements shall be created with, or prior to issue of the Subdivision Certificate.	Through the provision of stormwater detention facilities, modelling has confirmed that the development will not intensity peak flows at either point of discharge, and that peak flows are well correlated to predeveloped magnitudes. Hydraulic modelling has confirmed no affectation of upstream and downstream floods up to the 1% AEP.
DC.3.9	Where site topography in new residential subdivisions prevents discharge of storm water directly to the street gutter or a Council controlled pipe system, inter allotment drainage should be provided to accept run off from all existing or future parcels of land. The design and construction of the inter allotment drainage system should be in accordance with the requirements of Council's Manual of Engineering Standards.	The concept engineering plans show interallotment drainage and appropriate easements on all rear-draining lots.
DC.3.10	Where inter-allotment drainage is required, easements having a general minimum width of 1.5m are to be identified on plans submitted.	The concept engineering plans show interallotment drainage and appropriate easements on all rear-draining lots.
DC.3.11	A soil and water management plan (SWMP) should be prepared by a properly qualified practitioner with the aim of minimising erosion and maximising the quality of any water leaving the site. Applicants should refer to Council's Manual of Engineering Standards.	Conceptual Soil and Water Management Plans are provided within the concept engineering plans. To ensure downstream waters and adjacent properties are protected, appropriate erosion and sediment controls are to be undertaken during construction. Controls are to be implemented and monitored in accordance with Landcom's 'Blue Book' and Council's engineering guidelines.

From ***Table 24*** it is seen that Council's DCP requirements are met.

Due to its location within the Lochinvar URA, the development site is subject to requirements of the Lochinvar URA Development Control Plan. Section 1.5 of the Lochinvar URA DCP (Part 9) pertains to stormwater and WSUD controls. ***Table 25*** presents each DCP control with commentary relating to the subject development.

Table 25 - Lochinvar URA DCP Controls

No.	Control	Response
1.5.1	The stormwater and water quality management controls shall be consistent with the principles of Water Sensitive Urban Design (WSUD) Targets.	A WSUD treatment train has been developed which meets Council's pollutant reduction targets. Efforts have been made to 'disconnect' impervious surfaces, for instance by way of rainwater tanks.
1.5.2	The number and location of WSUD elements should be determined by modelling to develop the WSUD strategy for the site, and be integrated with the overall design and wider catchment.	MUSIC modelling has been undertaken to affirm the suitability of the proposed WSUD strategy.
1.5.3	Long-term maintenance costs are to be identified in the design of the WSUD elements and are to be submitted to Council for consideration prior to acceptance of the WSUD strategy.	The proposed treatment train is typical of Council's existing assets, the number of basins and GPTs has been minimised to reduce long-term maintenance costs.
1.5.4	Development Applications need to ensure that post-development stormwater flows do not exceed pre-development stormwater flows.	RAFTs modelling has confirmed that post-developed flows do not exceed predeveloped magnitudes at each point of discharge.
1.5.5	Development applications are to identify stormwater detention areas in accordance with the nominated locations identified in Figure 64, and supported by the flood Study prepared by ADW Johnson dated September 2015. It should be noted that the locations of the stormwater detention basins form part of the wider trunk drainage network, to which developers will be required to make contributions under the Lochinvar Section 94 Contributions Plan.	ADW Johnson 2015 does not propose any regional detention basins within the subject site. Upgrades to the Wyndella Road culverts (south) are identified under the Lochinvar Section 94 Contributions Plan and have been indicatively sized.
1.5.6	Stormwater calculations shall be based upon the ultimate development state of the catchment. The time of concentration is the time from the most remote part of the catchment to the catchment outlet. (i.e., from the top of Greedy Creek and Lochinvar Creek to the New England Highway).	Flood assessment modelling assumes full development of the subject site. The neighbouring Hereford Hill has been modelled under fully developed conditions. Consistent with Council advice, stormwater detention calculations have regarded the site in isolation.
1.5.7	No development can occur in the Greedy Creek or Lochinvar Creek catchments unless sufficient regional basin(s) are constructed to mitigate any impacts on Hunter Close catchment.	The proposed development is not upstream of the Hunter Close catchment.
1.5.8	Minimum road widths may need to be increased on account of WSUD features such as swales.	No swales are proposed to service the development's internal road network.
1.5.9	Swales may be accepted where it can be demonstrated that they will meet Council's performance and maintenance objectives and facilitate safe and effective movement of pedestrians and vehicles.	No swales are proposed to service the development's internal road network.
1.5.10	Swales may be considered on the outside of perimeter roads where no	No swales are proposed to service the development's internal road network.

No.	Control	Response
	residential access is provided. Swales shall not exceed 4% gradient.	
1.5.11	Flow control measures shall be used where grades in swales exceed 4%.	No swales are proposed to service the development's internal road network.
1.5.12	Where practical, WSUD elements may be incorporated in a centre depressed median of dual carriage roads.	No dual carriage roads are proposed by the subject development.
1.5.13	Wherever possible, existing natural drainage gullies should form part of a stormwater and runoff drainage management system. Detention basins and / or wetlands to alleviate stormwater peaks and retain pollutants can be considered on-line only for 1 stand 2nd order streams.	No online basins are proposed. The existing watercourse, whilst being realigned, remains an essential part of the stormwater management system.
1.5.14	Wetlands should be well-designed creating an attractive and safe amenity, and be highly visible for both the adjoining residents and passers-by.	No wetlands are proposed by the subject development. However, bioretention basins have been located prominently and are subject to landscape design. 1V: 5H internal batters are proposed for the southern basin for ease of egress.
1.5.15	Walking paths should have frequent contact adjacent to the wetland edge.	No wetlands are proposed by the subject development. However, a footpath is proposed around the perimeter of the site's main (southern) basin.
1.5.16	Vegetation should be designed such that generous unobstructed view of the wetland is available.	Refer landscape plans for detail.
1.5.17	Emergent macrophytes should be minimal and manageable.	Permanent waterbodies will be discouraged to minimise macrophyte growth.
1.5.18	Slopes surrounding wetlands should be gentle and offer convenient tractor mowing access.	No wetlands are proposed by the subject development. However, all batters are not steeper than 1V:4H and therefore considered mowable by a tractor.
1.5.19	Flat grassed areas that potentially may be water-logged should be avoided.	All open space areas are no flatter than 1% to promote surface runoff.
1.5.20	Gullies intended to be left in their natural state should be assessed, and if necessary enhanced to offset the need for maintenance.	The Lochinvar Creek tributary will be subject to a revegetation processes.
1.5.21	In general, grassed areas must be kept to a minimum for maintenance purposes, and wetland and gullies should offer a sense of ownership to the public.	Grassed areas have been kept to a minimum. No wetlands are proposed. Footpaths and a future park will front the Lochinvar Creek tributary to create a sense of public ownership.

From ***Table 25*** it is seen that Council's DCP requirements are met.

11.0 Conclusion

ADW Johnson has been engaged by Lochinvar Developments Pty Ltd to prepare a Stormwater Management Plan addressing the stormwater management requirements for a proposed subdivision of Lots 2-6 and 9 DP 747391 and Lots 12-13 DP 1219648 at Lochinvar ('the site'). This report accompanies a development application for the residential subdivision which shall create 258 lots and supporting infrastructure.

The site is characterised by moderate slopes falling towards a tributary of Lochinvar Creek which drains westward through the site. The tributary, being a first order watercourse, will be realigned by the proposed development with an appropriate VRZ. Whilst a majority of the site's catchment reports to this watercourse, a smaller catchment in the site's north reports to Lot 2 1299958 in the location of a future road extension (by others).

Hyrdologic modelling has been undertaken to compare peak runoff under existing and proposed conditions under existing and proposed conditions. RAFTS modelling confirmed that, owing to a redistribution of catchment under developed conditions, peak flows are not intensified at the site's (smaller) northern catchment. A detention basin has been sized to attenuate peak flows from the site's southern catchment to below their predeveloped magnitudes.

1-dimensional flood modelling was undertaken to compare 1% AEP flood extents under existing and developed conditions. Modelling confirmed that the proposed development does not adversely impact downstream flood affectation up to the 1% AEP design event. Upstream flood extents will be improved by the proposed development owing to the provision of upgraded culverts under Wyndella Road. All lots and proposed trunk drainage systems were confirmed to meet Council's minimum freeboard requirements.

HEC-RAS modelling of the Probable Maximum Flood (PMF) was undertaken to determine the site's full flood liability. Modelling found that all lots will accommodate dwellings above the PMF envelope. Robust emergency response outcomes exist by way of rising escape routes to the north.

A Water Sensitive Urban Design (WSUD) treatment train was developed comprising rainwater tanks, Gross Pollutant Traps and bioretention basins. MUSIC modelling confirmed that the proposed treatment train meets Council's runoff quality objectives at each of the site's legal points of discharge.

To ensure downstream waters and adjacent properties are protected, appropriate erosion and sediment controls are to be undertaken during construction. Controls are to be implemented and monitored in accordance with Landcom's 'Blue Book' and Council's Manual of Engineering Standards.

VRZ's have been identified along the Lochinvar Creek Tributary. Mapping of encroachments and offsets confirm that all requirements in relation to controlled activities on waterfront land are met. Realignment of the Lochinvar Creek Tributary is acceptable on the basis of its identification as a first order watercourse (AEP 2024).

The proposed stormwater management system and WSUD elements meet the specific controls imposed by the Lochinvar Urban Release Area Development Control Plan.

The details and information presented in this Stormwater Management Plan confirm that the proposed development is fit for purpose and satisfies Council's requirements in relation to peak flow management, flooding, runoff quality and erosion and sediment control.

12.0 References

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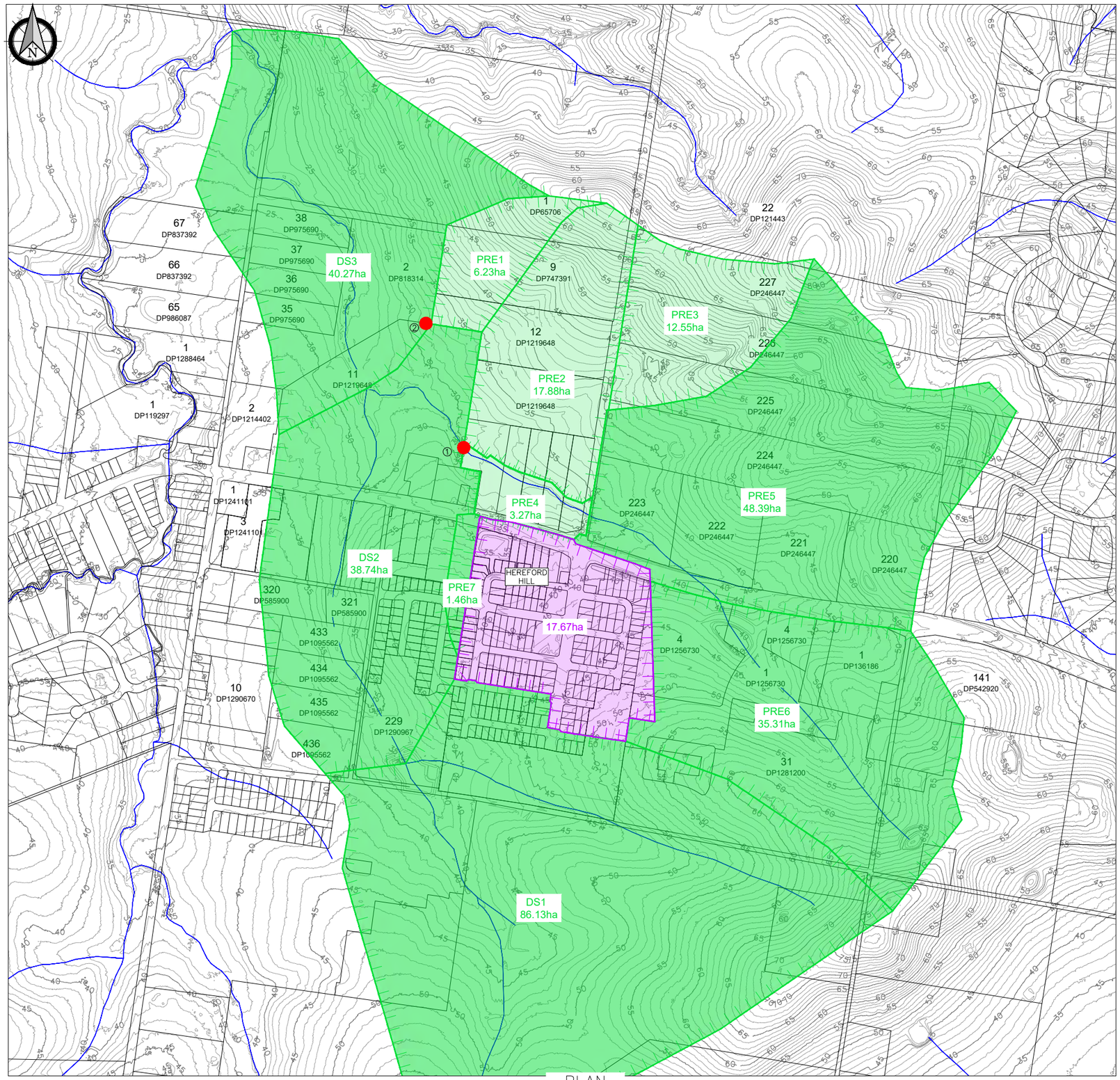
Appendix A

CATCHMENT PLANS

240332-ESK-004(B)

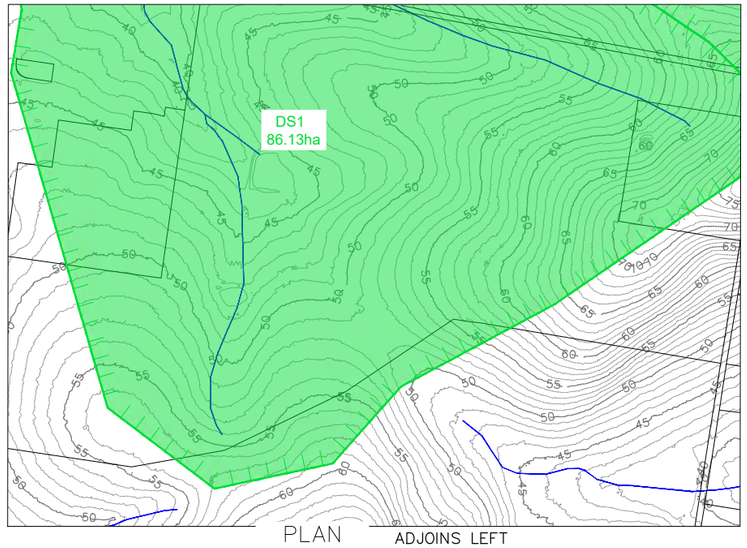


PLAN
SCALE 1:5000

GDA2020

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 18 FINISHED SURFACE CONTOURS
- EXISTING HEREFORD HILL DEVELOPMENT
- ISOLATED CATCHMENT (DETENTION ASSESSMENT)
- OVERALL CATCHMENT (FLOOD ASSESSMENT)
- EXISTING WATERCOURSE
- MONITORING NODE



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drawing title:

EXISTING CATCHMENT PLAN

location: NEW ENGLAND HIGHWAY, LOCHINVAR

council: MAITLAND CITY COUNCIL

dwg ref: 240332-ESK-004(B)

client: CPG ESTATES

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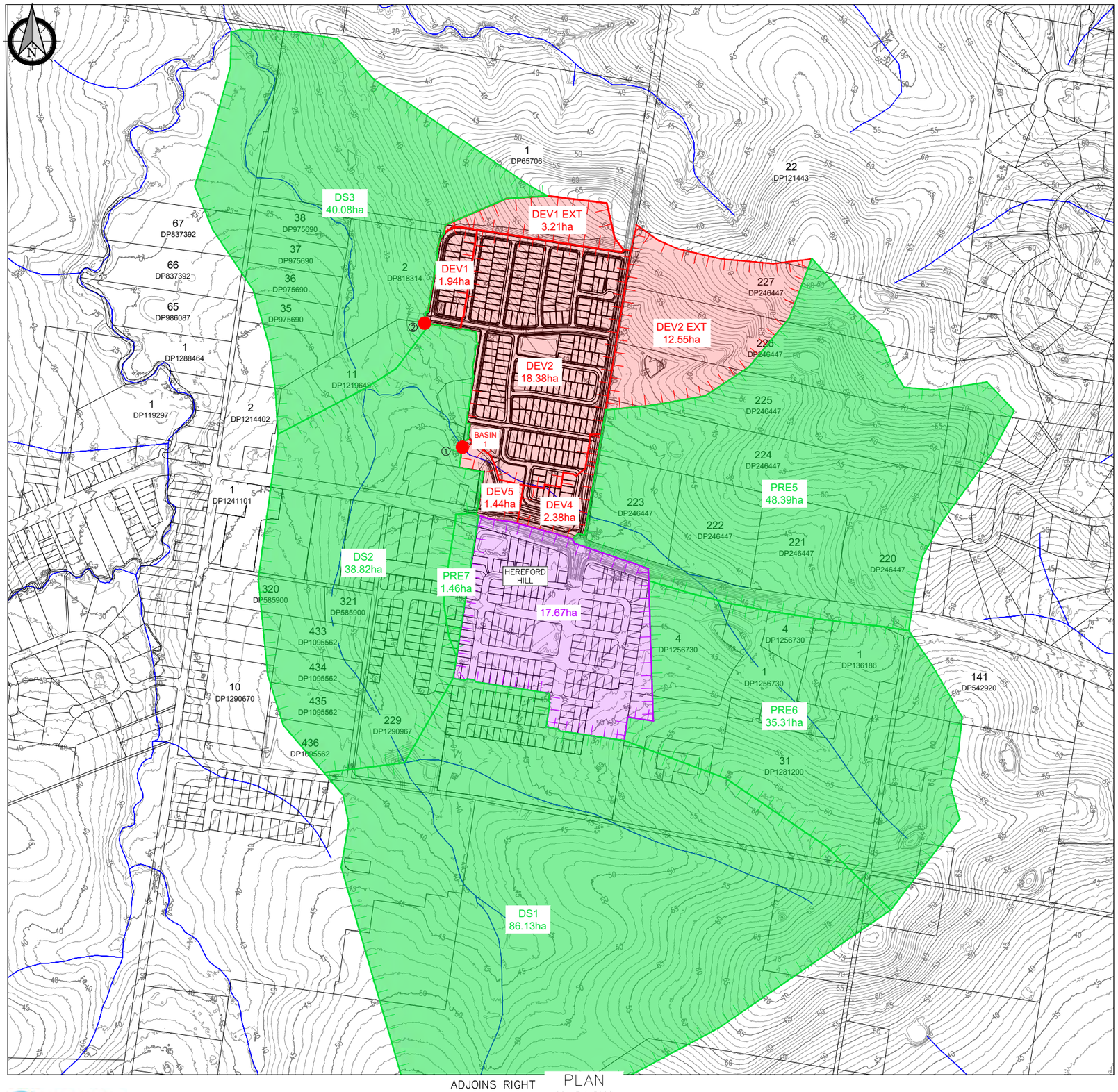
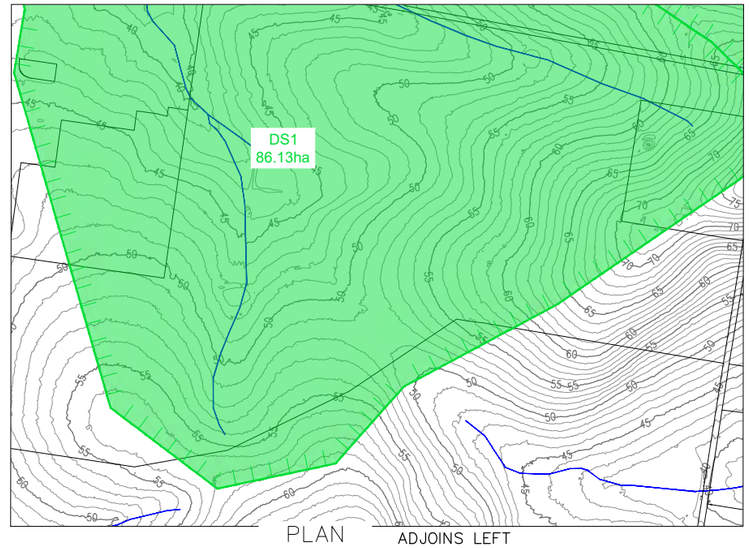
240332-ESK-005[C]



LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 18 FINISHED SURFACE CONTOUR
- ISOLATED CATCHMENT (DETENTION ASSESSMENT)
- EXISTING HEREFORD HILL DEVELOPMENT
- OVERALL CATCHMENT (FLOOD ASSESSMENT)
- EXISTING WATERCOURSE
- MONITORING NODE



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GDA2020

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drawing title:

DEVELOPED CATCHMENT PLAN

location: NEW ENGLAND HIGHWAY, LOCHINVAR

council: MAITLAND CITY COUNCIL

dwg ref: 240332-ESK-005(C)

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Appendix B

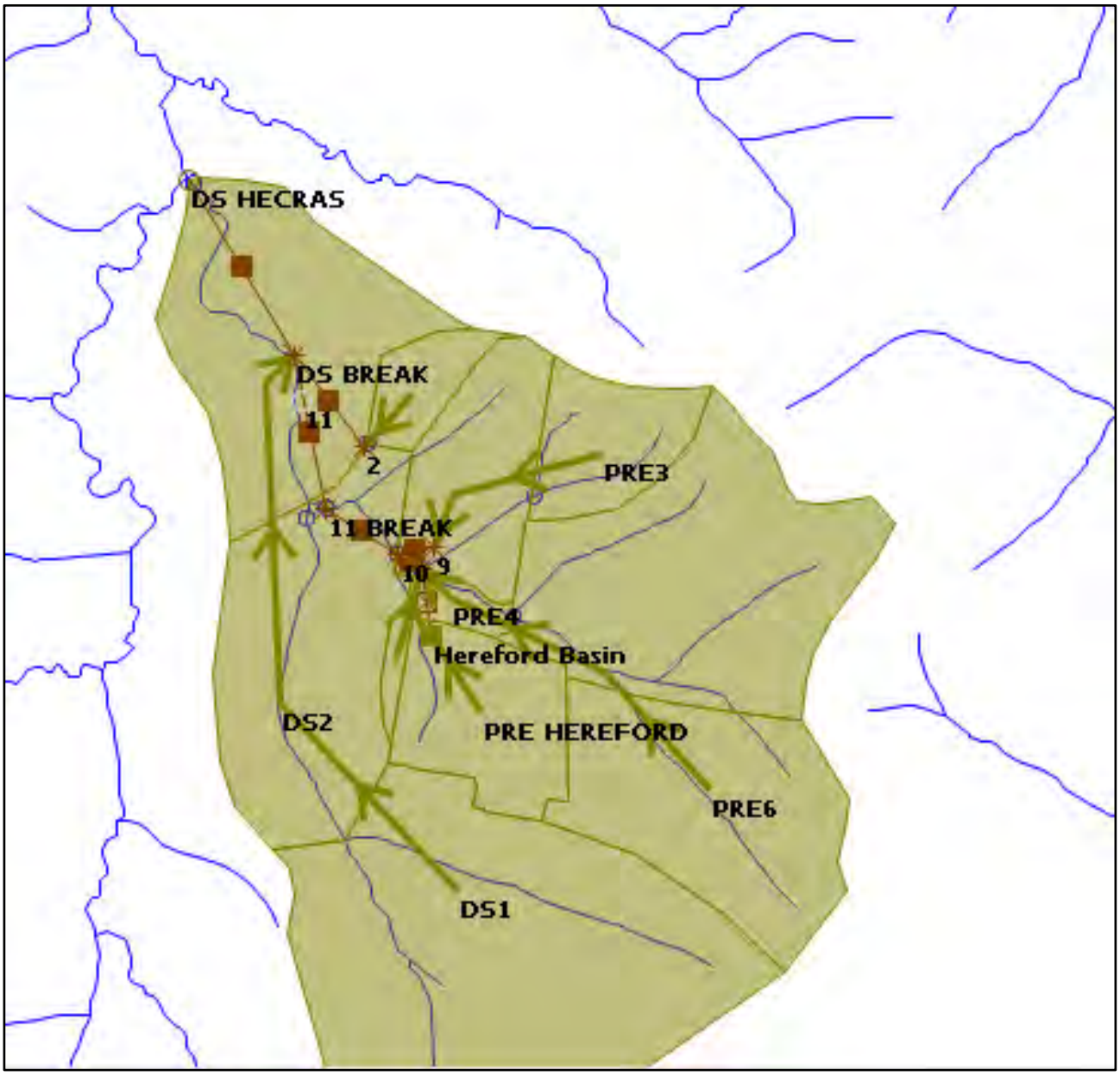
INFOWORKS ICM MODEL INPUTS

Predeveloped Model Inputs

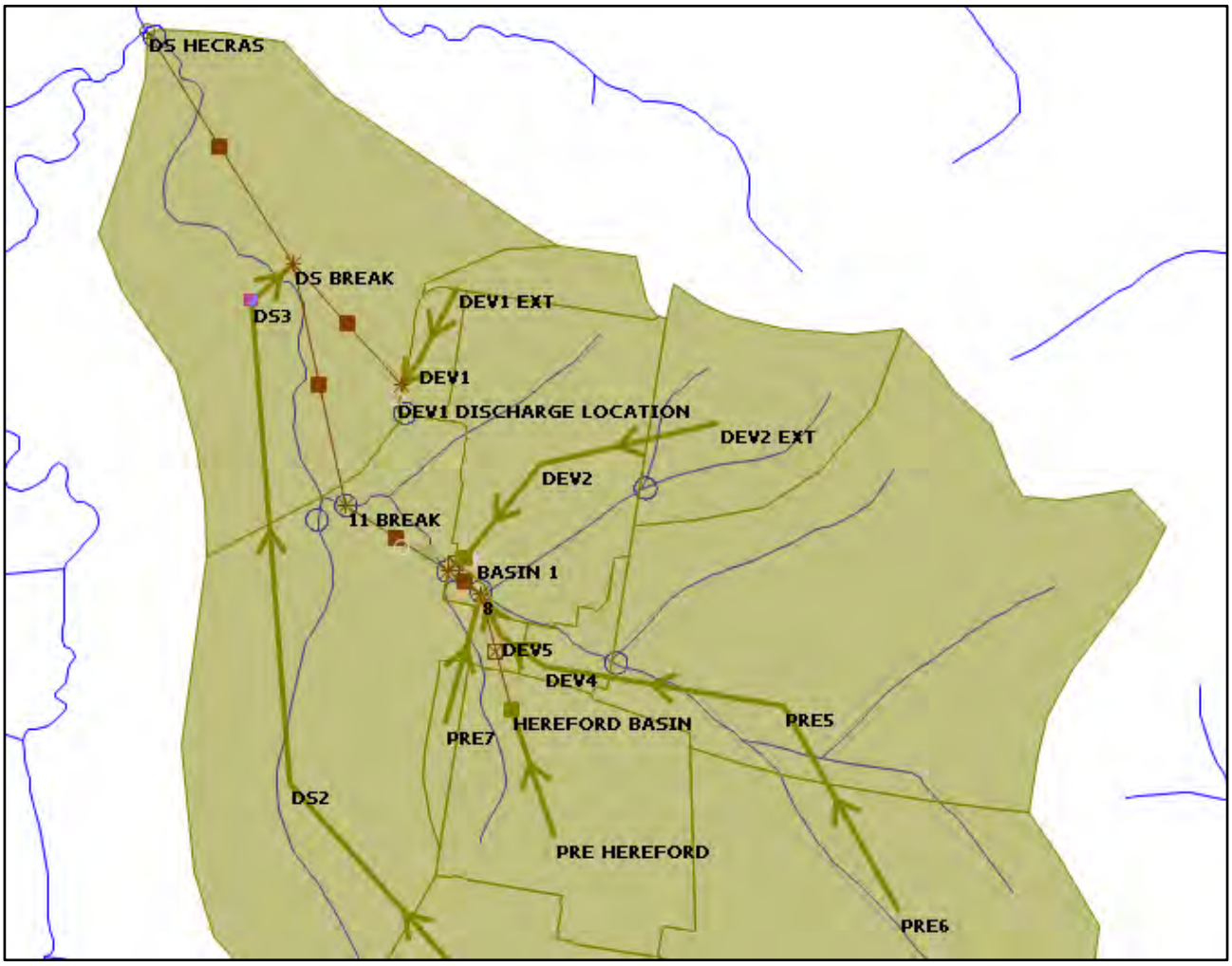
Catchment	Subcatchment Number	Total Area [ha]	Percentage Impervious [%]	Catchment Slope [%]	Catchment Mannings 'n'
PRE1	1	6.226	0	7	0.035
PRE2	1	17.510	0	6	0.035
	2	0.373	100	6	0.014
PRE3	1	12.554	0	8	0.035
PRE4	1	3.040	0	4	0.035
	2	0.233	100	4	0.014
PRE5	1	45.970	0	4	0.035
	2	2.419	100	4	0.014
PRE6	1	31.779	0	4	0.035
	2	3.531	100	4	0.014
PRE7	1	1.165	0	3	0.035
	2	0.291	100	3	0.014
HEREFORD HILL	1	7.775	0	3	0.035
	2	9.895	100	3	0.014
DS1	1	81.825	0	5	0.035
	2	4.307	100	5	0.014
DS2	1	34.870	0	5	0.035
	2	3.874	100	5	0.014
DS3	1	40.266	0	5	0.035
Total		307.903	8%		

Developed Model Inputs

Catchment	Subcatchment Number	Total Area [ha]	Percentage Impervious [%]	Catchment Slope [%]	Catchment Mannings 'n'
DEV1	1	0.706	0	5	0.035
	2	1.231	100	5	0.014
DEV1 EXT	1	3.207	0	7	0.035
DEV2	1	6.609	0	5	0.035
	2	11.774	100	5	0.014
DEV2 EXT	1	12.55	0	8	0.035
DEV4	1	1.175	0	4	0.035
	2	1.202	100	4	0.014
DEV5	1	1.21	0	4	0.035
	2	0.228	100	4	0.014
PRE5	1	45.97	0	4	0.035
	2	2.19	100	4	0.014
PRE6	1	31.779	0	4	0.035
	2	3.531	100	4	0.014
PRE7	1	1.165	0	3	0.035
	2	0.291	100	3	0.014
HEREFORD HILL	1	7.775	0	3	0.035
	2	9.895	100	3	0.014
DS1	1	81.825	0	5	0.035
	2	4.307	100	5	0.014
DS2	1	34.939	0	5	0.035
	2	3.882	100	5	0.014
DS3	1	40.084	0	5	0.035
Total		307.525	13%		



Predeveloped ICM Network Diagram



Developed ICM Network Diagram

Appendix C

FLOOD MAPS

240332-ESK-007(B)

LEGEND

- EXISTING LOT BOUNDARY
- SITE BOUNDARY
- 18 FINISHED SURFACE CONTOUR
- 1m FLOOD CONTOUR
- 100 YEARS EXISTING FLOOD EXTENTS
- RIVER X — HEC-RAS RIVER NAME- REFER STORMWATER MANAGEMENT PLAN

N

38 DP975690
37 DP975690
36 DP975690
35 DP975690
2 DP1214402
11 DP1219648
1 DP65706
2 DP818314
9 DP747391
12 DP1219648
13 DP1219648
2 DP747391
3 DP747391
4 DP747391
5 DP747391
6 DP747391
14 DP1219648
1 DP741330
1 DP1241101
3 DP1241101
4 DP1241101
2 DP1254351
1 DP742457
10 DP1218447
2 DP162193
3 DP162193
1 DP195915
5 DP998982
1631 DP1281458
22 DP121443
227 DP246447
226 DP246447
225 DP246447
224 DP246447
223 DP246447
222 DP246447
221 DP246447

CANTWELL ROAD
ROAD
RIVER 1-LOWER
RIVER 1-MID
RIVER 1-UPPER
RIVER 2
RIVER 3
NEW ENGLAND HIGHWAY
WYNDELLA

LIMIT OF FLOOD MODELLING
EXISTING CULVERTS OVERTOP
NEH CROSSING NOT MODELLED

GDA2020

PLAN
SCALE 1:2000

ver.	date	comment	drawn	pm	co-ordinate information	level information	scale (A1 original size)	notes
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drawing title:
EXISTING FLOOD EXTENTS 1% AEP

location: NEW ENGLAND HIGHWAY, LOCHINVAR
council: MAITLAND CITY COUNCIL
dwg ref: 240332-ESK-007(B)
client: CPG ESTATES

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Plotted By: Dipendra Neupane Plot Date: 27/06/24 11:46:50AM Cad File: N:\240332\DWG\ENGINEERING\ESK\240332-ESK-007(B).DWG

this plan includes coloured information. If you have a black and white copy you do not have all of the information. This note is coloured RED.

240332-ESK-008(C)

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 18 FINISHED SURFACE CONTOUR
- 1m FLOOD CONTOUR
- EXISTING 1% AEP FLOOD ENVELOPE REFER SHEET 007
- 100 YEAR DEVELOPED FLOOD EXTENTS
- RIVER X — HEC–RAS RIVER NAME– REFER STORMWATER MANAGENENT PLAN

N

1 DP65706

2 DP818314

38 DP975690

37 DP975690

36 DP975690

35 DP975690

2 DP1214402

11 DP1219648

14 DP1219648

1 DP741330

1 DP1241101

3 DP1241101

4 DP1241101

2 DP1254351

1 DP742457

1 DP195915

5 DP998982

1631 DP1281458

223 DP246447

222 DP246447

221 DP246447

226 DP246447

225 DP246447

224 DP246447

CANTWELL ROAD

WYNDELLA ROAD

NEW ENGLAND HIGHWAY

RIVER 1

RIVER 2

RIVER 3

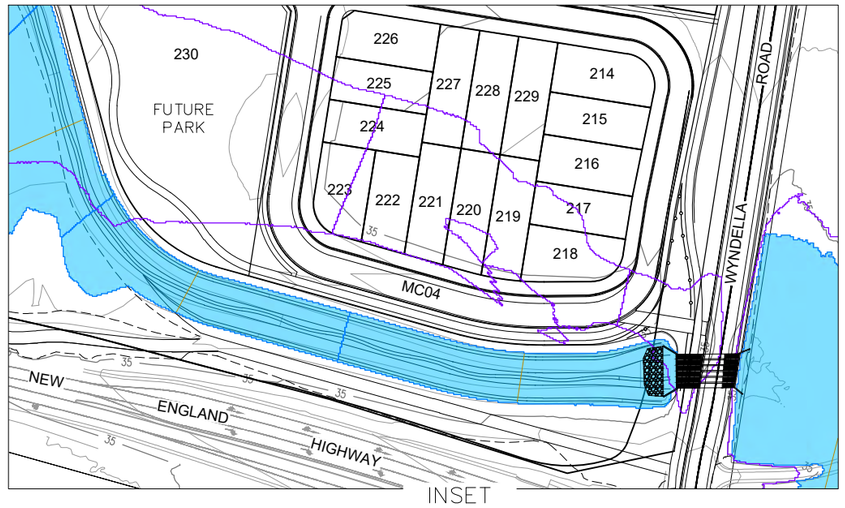
RIVER 4

LIMIT OF FLOOD MODELLING

NEH CROSSING NOT MODELLED

OVERLAND FLOW THROUGH ROAD NETWORK SUBJECT TO DETAILED DESIGN

INSET



INSET
SCALE 1:1000

PLAN
SCALE 1:2000

GDA2020

0 25 50m
SCALE: 1:1000 (FULL)

ver.	date	comment	drawn	pm	co-ordinate information	level information	scale (A1 original size)	notes
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drawing title:
DEVELOPED FLOOD EXTENTS
1% AEP

location: NEW ENGLAND HIGHWAY, LOCHINVAR
council: MAITLAND CITY COUNCIL
dwg ref: 240332-ESK-008(C)
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240332-ESK-009(C)

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 18 FINISHED SURFACE CONTOUR
- 1m FLOOD CONTOUR
- PMF FLOOD EXTENTS
- RIVER X — HEC-RAS RIVER NAME- REFER STORMWATER MANAGEMENT PLAN

N

LIMIT OF FLOOD MODELLING

38 DP975690
37 DP975690
36 DP975690
35 DP975690
2 DP1214402
1 DP65706
2 DP818314
11 DP1219648
14 DP1219648
1 DP741330
1 DP1241101
3 DP1241101
4 DP1241101
2 DP1254351
1 DP742457
1 DP195915
5 DP998982
1631 DP1281458
226 DP246447
225 DP246447
224 DP246447
223 DP246447
222 DP246447
221 DP246447

CANTWELL ROAD

RIVER 1

RIVER 2

RIVER 3

RIVER 4

OVERLAND FLOW THROUGH ROAD NETWORK SUBJECT TO DETAILED DESIGN

NEH CROSSING NOT MODELLED

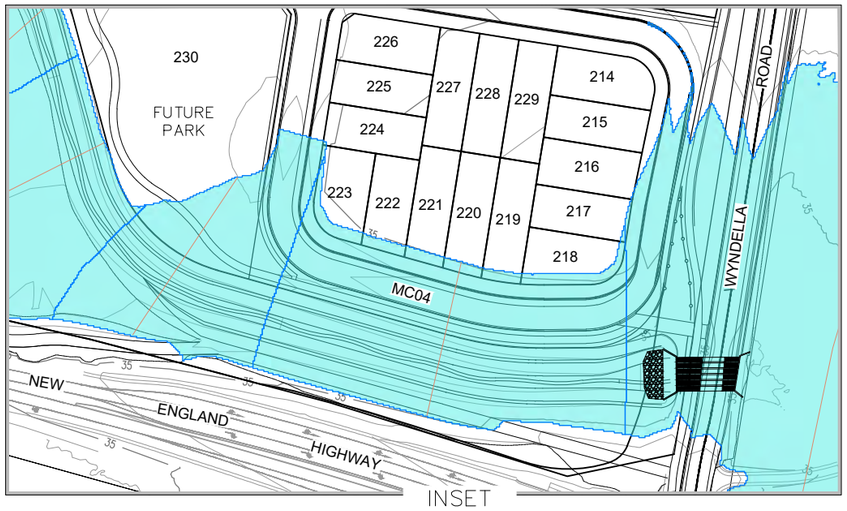
NEW ENGLAND HIGHWAY

WYNDELLA ROAD

INSET

LIMIT OF FLOOD MODELLING

PLAN
SCALE 1:2000



INSET
SCALE 1:1000

GDA2020

0 25 50m
SCALE: 1:1000 (FULL)

ver.	date	comment	drawn	pm	co-ordinate information	level information	scale (A1 original size)	notes
C	27/06/2024	MINOR ADJUSTMENTS	DN	ML	CO-ORDINATE SYSTEM: MGA56	DATUM: N/A CONTOUR INTERVAL: 1.0m	0 50 100m SCALE: 1:2000 (FULL)	REFER STORMWATER MANAGEMENT PLAN FOR DETAILS.

drawing title:
DEVELOPED FLOOD EXTENTS PMF

location: NEW ENGLAND HIGHWAY, LOCHINVAR
council: MAITLAND CITY COUNCIL
dwg ref: 240332-ESK-009(C)
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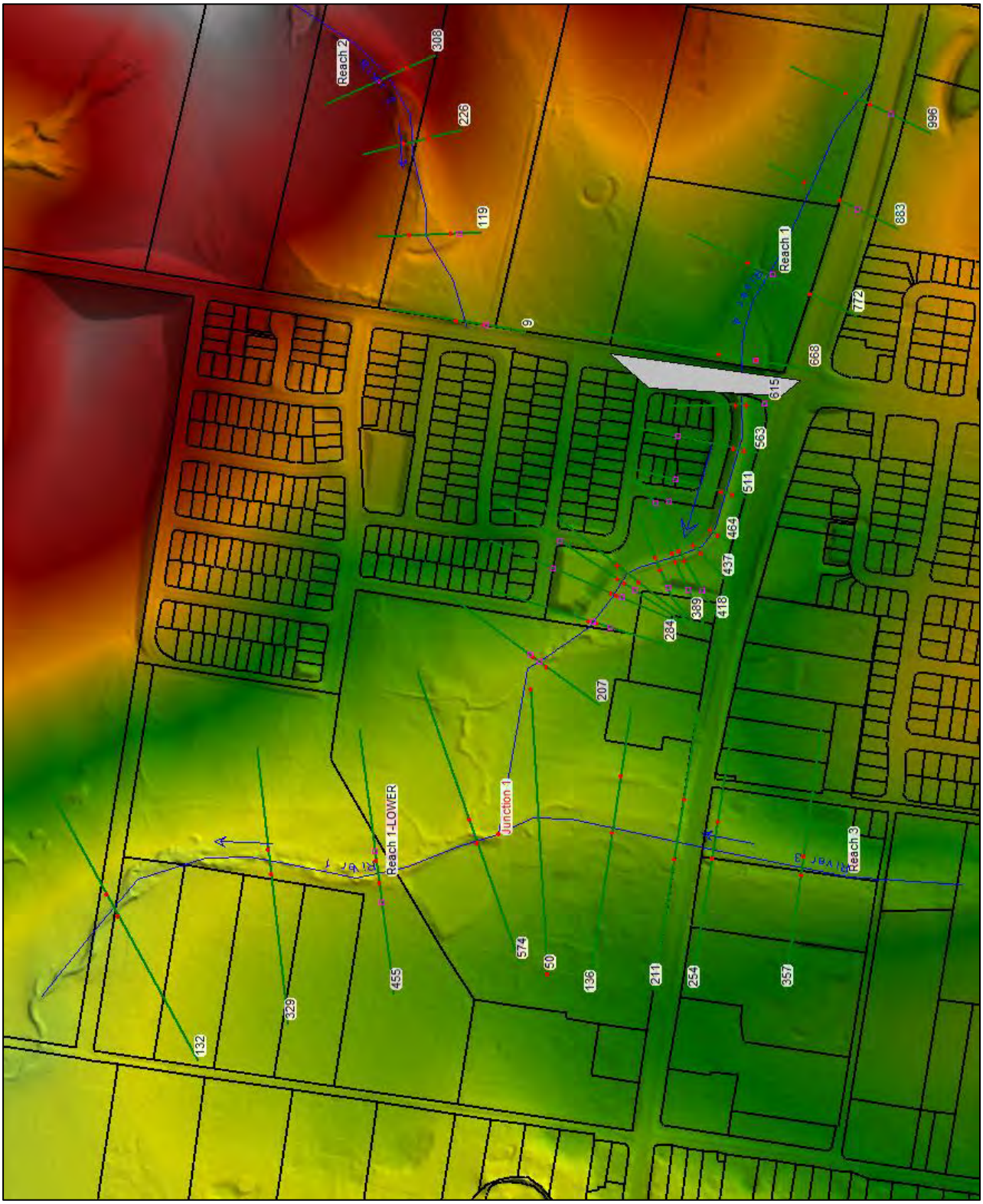
Appendix D

HEC-RAS PARAMETERS

Existing HEC-RAS Model



Developed HEC-RAS Model

1% AEP – Existing Conditions – Results Summary

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 3	Reach 3	357	PF 1	22.42	31.09	31.69		31.8	0.014574	1.53	14.67	40.67	0.81
River 3	Reach 3	253.6062	PF 1	22.42	30.42	31.03		31.07	0.004036	0.9	25.58	66.64	0.44
River 3	Reach 3	211.2043	PF 1	22.42	30.06	30.59	30.59	30.71	0.026373	1.51	14.9	69.58	1.01
River 3	Reach 3	136.0173	PF 1	22.42	28.74	29.42	29.26	29.48	0.00619	1.06	21.21	53.82	0.54
River 3	Reach 3	44	PF 1	22.42	27.59	28.42	28.42	28.59	0.016317	1.97	13.07	39.97	0.9
River 2	Reach 2	637.7348	PF 1	4.1	54.11	54.47	54.47	54.59	0.026699	1.48	2.76	12.6	1.01
River 2	Reach 2	556.1867	PF 1	4.1	48.29	48.64	48.64	48.75	0.025785	1.49	2.76	12.18	1
River 2	Reach 2	448.3484	PF 1	4.1	44.87	45.03	45.03	45.08	0.034691	1.02	4	38.78	1.02
River 2	Reach 2	338.3764	PF 1	4.1	39.44	40.17	39.78	40.18	0.000648	0.28	12.89	37.36	0.17
River 2	Reach 2	330		Culvert									
River 2	Reach 2	324	PF 1	4.1	39.26	39.51	39.51	39.59	0.027243	1.29	3.25	19.95	0.99
River 2	Reach 2	282.9475	PF 1	4.1	38.17	38.37	38.36	38.42	0.0249	1.02	4.04	30.89	0.9
River 2	Reach 2	188.3999	PF 1	4.1	35.47	35.67	35.67	35.72	0.03303	1.01	4.03	38.04	1
River 2	Reach 2	108	PF 1	4.1	33.26	33.68	33.49	33.68	0.000875	0.3	14.27	61.58	0.19
River 1	Reach 1-UPPER	1566.11	PF 1	16.18	37.85	38.47	38.36	38.55	0.022617	1.22	13.37	34.96	0.6
River 1	Reach 1-UPPER	1452.522	PF 1	16.18	36.77	37.46		37.49	0.004978	0.67	24.44	49.29	0.29
River 1	Reach 1-UPPER	1341.623	PF 1	16.18	35.47	35.95	35.95	36.08	0.073447	1.63	9.94	36.45	0.99
River 1	Reach 1-UPPER	1233.066	PF 1	16.18	33.72	34.92	34.33	34.92	0.000518	0.29	54.26	87.77	0.1
River 1	Reach 1-UPPER	1215		Culvert									
River 1	Reach 1-UPPER	1199	PF 1	16.18	32.53	33.7		33.77	0.008919	1.15	14.33	23.86	0.41
River 1	Reach 1-UPPER	1123.287	PF 1	16.18	31.81	32.77	32.55	32.87	0.016683	1.39	11.94	23.96	0.55
River 1	Reach 1-UPPER	1030.772	PF 1	18.77	31.07	32.17		32.2	0.004122	0.68	25.38	65.54	0.27
River 1	Reach 1-UPPER	1006	PF 1	18.77	31.16	32.01		32.06	0.008423	0.77	20.54	67.58	0.36
River 1	Reach 1-MID	956.717	PF 1	22.8	30.99	31.6		31.67	0.013262	0.59	21.44	83.45	0.41
River 1	Reach 1-MID	944	PF 1	22.8	30.7	31.43		31.49	0.013486	0.59	21.43	84.31	0.41
River 1	Reach 1-MID	933	PF 1	22.8	30.86	31.31		31.36	0.009847	0.54	24.43	89.08	0.36
River 1	Reach 1-MID	916	PF 1	22.8	30.25	30.95	30.94	31.05	0.038627	1.12	16.39	79.95	0.71
River 1	Reach 1-MID	883.0047	PF 1	22.8	29.79	30.65	30.46	30.67	0.005107	0.46	34.63	118.85	0.27
River 1	Reach 1-MID	807	PF 1	22.8	28.93	29.62	29.62	29.77	0.050537	1.73	13.15	43.21	0.88
River 1	Reach 1-LOWER	574	PF 1	49.05	26.33	27.67		27.73	0.003283	1.12	43.88	63.44	0.43

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 1	Reach 1-LOWER	454.8209	PF 1	49.05	25.9	27.04	27.04	27.12	0.008987	1.27	38.66	99.98	0.65
River 1	Reach 1-LOWER	328.8122	PF 1	49.05	24.69	25.99		26.11	0.005239	1.56	35.08	64.31	0.56
River 1	Reach 1-LOWER	131.5715	PF 1	49.05	22.33	24.01	24.01	24.35	0.0177	2.58	19.15	30.82	0.99

1% AEP – Developed Conditions – Results Summary

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 4	Reach 1	996	PF 1	16.18	37.85	38.47	38.36	38.55	0.022617	1.22	13.37	34.96	0.6
River 4	Reach 1	883	PF 1	16.18	36.77	37.46	37.15	37.49	0.004978	0.67	24.44	49.29	0.29
River 4	Reach 1	772	PF 1	16.18	35.47	35.95	35.95	36.08	0.073447	1.63	9.94	36.45	0.99
River 4	Reach 1	668	PF 1	16.18	33.89	34.7	34.4	34.71	0.003399	0.52	29.8	74.32	0.24
River 4	Reach 1	640		Culvert									
River 4	Reach 1	615	PF 1	16.18	32.92	34.23	33.75	34.3	0.007144	1.2	13.85	17.76	0.38
River 4	Reach 1	563	PF 1	16.18	32.49	33.82	33.37	33.9	0.008309	1.27	13.05	16.65	0.41
River 4	Reach 1	511	PF 1	16.18	32.05	33.38	32.94	33.46	0.008725	1.29	12.86	16.58	0.42
River 4	Reach 1	464	PF 1	16.18	31.66	32.92	32.54	33.01	0.010224	1.37	12.1	16.05	0.45
River 4	Reach 1	437	PF 1	17.52	31.43	32.59	32.36	32.69	0.01296	1.44	13	25.58	0.5
River 4	Reach 1	418	PF 1	17.52	31.27	32.25	32.25	32.38	0.022511	1.66	12.22	43.3	0.64
River 4	Reach 1	408	PF 1	17.52	31.19	32.07	31.97	32.15	0.013703	1.25	13.85	34.86	0.49
River 4	Reach 1	389	PF 1	17.52	31.02	31.81	31.65	31.89	0.012075	1.08	14.02	29.52	0.45
River 4	Reach 1	353	PF 1	17.52	30.72	31.37		31.43	0.013391	0.72	17.56	69.59	0.43
River 4	Reach 1	341	PF 1	17.52	30.69	31.19	31.16	31.24	0.016143	0.71	17.33	91.32	0.45
River 4	Reach 1	324	PF 1	17.52	30.4	30.92	30.88	31	0.011961	0.6	14.54	55.05	0.39
River 4	Reach 1	284	PF 1	22.8	29.82	30.7	30.52	30.73	0.004379	0.63	28.22	72.57	0.27
River 4	Reach 1	207	PF 1	22.8	29.09	29.76	29.76	29.94	0.045191	1.91	12.1	33.23	0.86
River 3	Reach 3	357	PF 1	22.16	31.2	31.68	31.63	31.8	0.014392	1.42	14.58	40.59	0.79
River 3	Reach 3	254	PF 1	22.16	30.42	31.03		31.07	0.004048	0.93	25.57	66.63	0.44
River 3	Reach 3	211	PF 1	22.16	30.06	30.59	30.59	30.7	0.026426	1.5	14.78	69.37	1.01
River 3	Reach 3	136	PF 1	22.16	28.74	29.44	29.27	29.48	0.005561	0.94	23.78	68.69	0.5
River 3	Reach 3	50	PF 1	22.16	27.57	28.46	28.46	28.61	0.023514	1.7	13.07	44.37	1
River 2	Reach 2	308	PF 1	4.1	54.11	54.43	54.47	54.6	0.050052	1.85	2.22	11.68	1.35
River 2	Reach 2	226	PF 1	4.1	48.29	48.54	48.64	48.85	0.10624	2.48	1.66	9.86	1.93
River 2	Reach 2	119	PF 1	4.1	44.87	45.03	45.03	45.08	0.034691	1.02	4	38.78	1.02
River 2	Reach 2	9	PF 1	4.1	39.44	40	39.78	40.02	0.002474	0.5	7.5	26.04	0.32
River 1	Reach 1-LOWER	574	PF 1	49.31	26.33	27.65	27.29	27.72	0.003388	1.32	42.64	62.75	0.45
River 1	Reach 1-LOWER	455	PF 1	49.31	25.9	27.04	27.04	27.14	0.007547	1.66	38.66	99.98	0.65
River 1	Reach 1-LOWER	329	PF 1	49.31	24.69	26	25.82	26.11	0.005285	1.64	35.46	64.48	0.56

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 1	Reach 1-LOWER	132	PF 1	49.31	22.33	24.01	24.01	24.35	0.017687	2.57	19.28	31.23	0.99

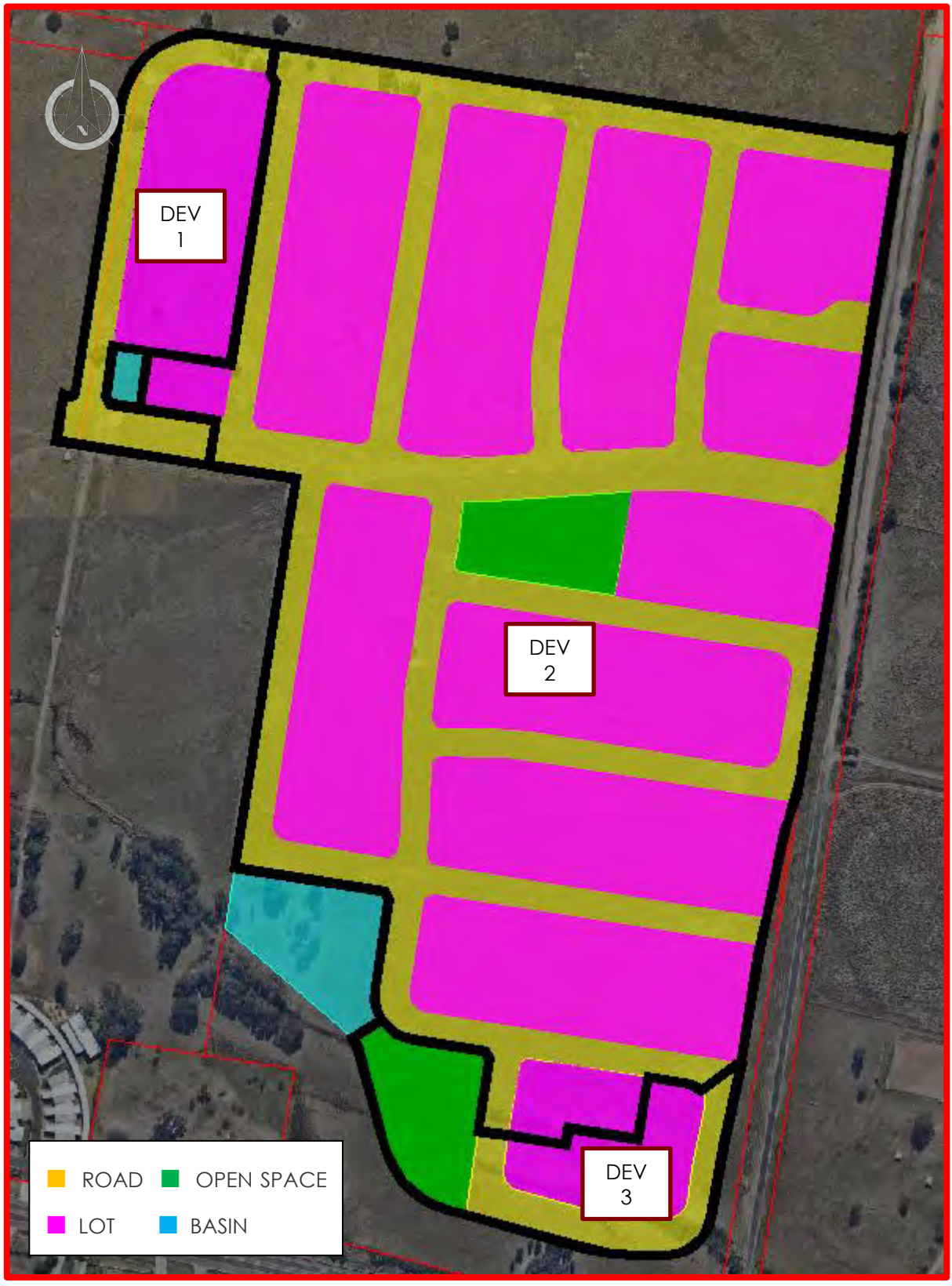
PMF – Developed Conditions – Results Summary

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 4	Reach 1	996	PF 1	112.31	37.85	39.38	39.09	39.62	0.014944	2.08	52.32	49.39	0.58
River 4	Reach 1	883	PF 1	112.31	36.77	38.35	37.79	38.46	0.006957	1.51	75.25	65.89	0.4
River 4	Reach 1	772	PF 1	112.31	35.47	36.48	36.48	36.76	0.054924	2.35	47.84	84.75	0.98
River 4	Reach 1	668	PF 1	112.31	33.89	35.91	34.92	35.93	0.001052	0.66	163.53	150.48	0.16
River 4	Reach 1	640		Culvert									
River 4	Reach 1	615	PF 1	112.31	32.92	35.46	35.12	35.64	0.007129	2.04	59.5	53.78	0.44
River 4	Reach 1	563	PF 1	112.31	32.49	35.04	34.76	35.25	0.008124	2.15	56.43	51.63	0.46
River 4	Reach 1	511	PF 1	112.31	32.05	34.68	34.34	34.86	0.006742	2	60.29	53.08	0.42
River 4	Reach 1	464	PF 1	112.31	31.66	33.99	33.98	34.36	0.016656	2.9	45	62.35	0.65
River 4	Reach 1	437	PF 1	131.66	31.43	33.39	33.39	33.81	0.022831	2.98	46.51	55.14	0.74
River 4	Reach 1	418	PF 1	131.66	31.27	33.2	32.94	33.46	0.009838	1.94	59.44	55.45	0.49
River 4	Reach 1	408	PF 1	131.66	31.19	32.81	32.81	33.31	0.020377	2.49	43.5	44.06	0.68
River 4	Reach 1	389	PF 1	131.66	31.02	32.66	32.66	32.83	0.006675	1.44	74.47	76.52	0.39
River 4	Reach 1	353	PF 1	131.66	30.72	31.69	31.87	32.27	0.04872	2.19	41.74	80.22	0.92
River 4	Reach 1	341	PF 1	131.66	30.69	31.77	31.59	31.91	0.008033	1.02	79.36	119.84	0.38
River 4	Reach 1	324	PF 1	131.66	30.4	31.75	31.32	31.82	0.002656	0.76	113.14	126.52	0.24
River 4	Reach 1	284	PF 1	156.63	29.82	31.52	31.11	31.67	0.004588	1.18	94.06	87.23	0.32
River 4	Reach 1	207	PF 1	156.63	29.09	30.59	30.59	30.96	0.024772	2.72	58.02	77.95	0.75
River 3	Reach 3	357	PF 1	159.9	31.2	32.27	32.44	32.92	0.030013	3.67	45.1	62.92	1.33
River 3	Reach 3	254	PF 1	159.9	30.42	31.72	31.51	31.94	0.006791	2.24	81.76	97.88	0.67
River 3	Reach 3	211	PF 1	159.9	30.06	31.18	31.18	31.51	0.015367	2.64	64.88	99.74	0.95
River 3	Reach 3	136	PF 1	159.9	28.74	30.07	29.92	30.3	0.00806	2.22	77.7	97.44	0.71
River 3	Reach 3	50	PF 1	159.9	27.57	29.57		29.67	0.006053	1.38	115.61	192.32	0.57
River 2	Reach 2	308	PF 1	22.9	54.11	54.78	54.92	55.25	0.050059	3.03	7.57	18.93	1.53
River 2	Reach 2	226	PF 1	22.9	48.29	48.85	49.09	49.66	0.098125	3.99	5.74	15.72	2.11
River 2	Reach 2	119	PF 1	22.9	44.87	45.25	45.25	45.4	0.023434	1.7	13.46	45.34	1
River 2	Reach 2	9	PF 1	22.9	39.44	39.97	40.16	40.59	0.105627	3.12	6.64	24.34	2.04
River 1	Reach 1-LOWER	574	PF 1	350.71	26.33	28.75	28.51	29.07	0.006381	3.08	151.33	140.03	0.71
River 1	Reach 1-LOWER	455	PF 1	350.71	25.9	28.06	27.76	28.33	0.005826	2.7	159.6	135.08	0.66

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River 1	Reach 1-LOWER	329	PF 1	350.71	24.69	27.07	26.95	27.48	0.007604	3.37	135.81	122.08	0.78
River 1	Reach 1-LOWER	132	PF 1	350.71	22.33	25.26	25.26	25.78	0.009745	3.78	124.93	121.22	0.87

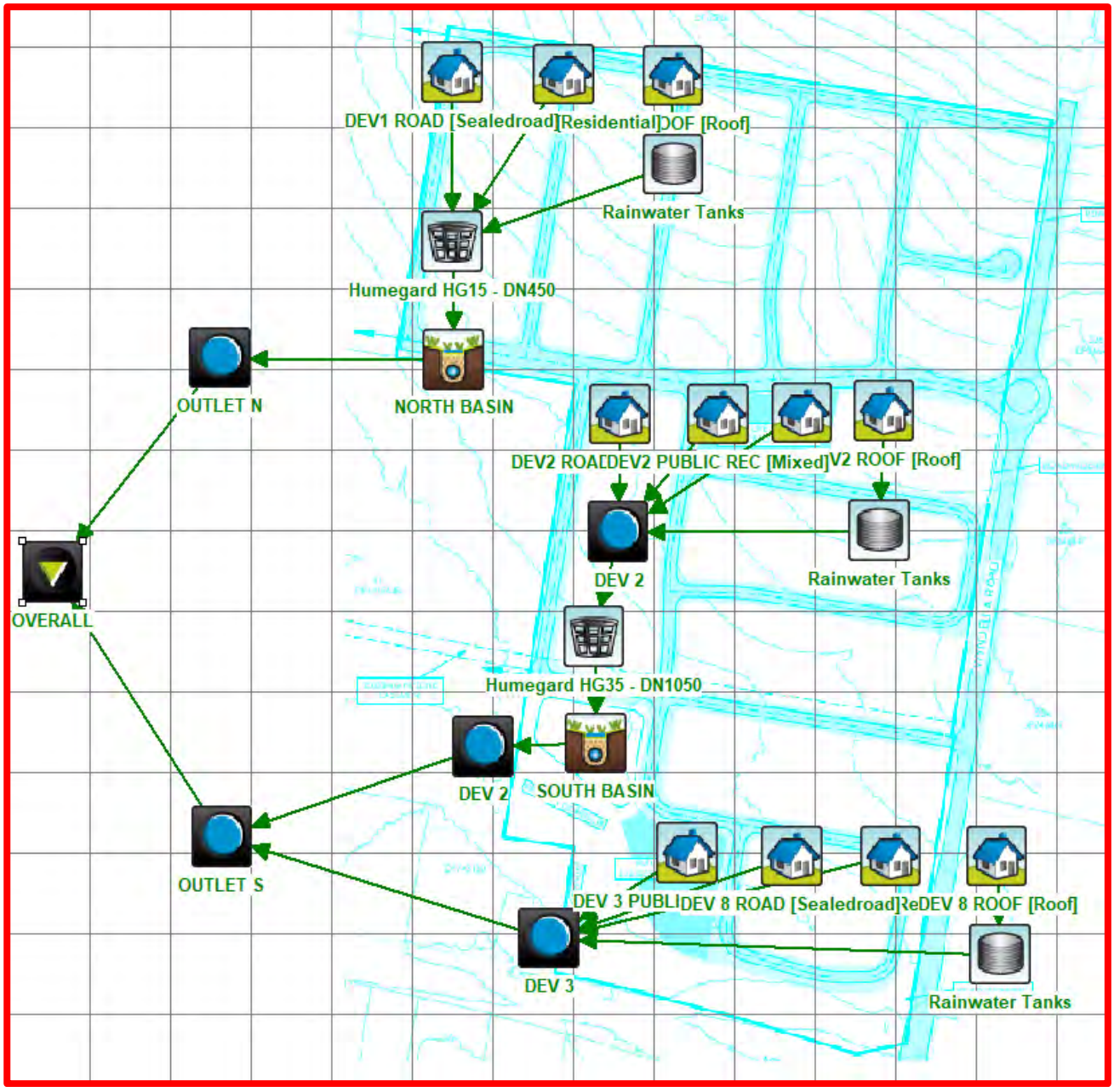
Appendix E

MUSIC CATCHMENT PLAN



Appendix F

MUSIC NETWORK DIAGRAM



Appendix G

MUSIC RESULTS BY CATCHMENT

DEV 1 Treatment Train Effectiveness

Pollutant	Developed Untreated Load (kg/yr)	Developed Treated Load (kg/yr)	Reduction (%)
TSS	1600	9.36	80.7
TP	3.21	308	64.4
TN	22	11.4	48.2
GP	335	0	100

DEV 2 Treatment Train Effectiveness

Pollutant	Developed Untreated Load (kg/yr)	Developed Treated Load (kg/yr)	Reduction (%)
TSS	13900	1480	89.3
TP	30	8.75	70.9
TN	206	86.5	57.9
GP	3190	0	100

DEV 3 Treatment Train Effectiveness

Pollutant	Developed Untreated Load (kg/yr)	Developed Treated Load (kg/yr)	Reduction (%)
TSS	1520	1500	1.4
TP	2.87	2.82	1.5
TN	18.3	17.6	3.6
GP	278	208	25.2

Appendix H

RIPARIAN SETBACK PLAN

240332-ESK-006(C)

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 18 FINISHED SURFACE CONTOUR
- EXISTING WATERCOURSE
- RIPARIAN CORRIDOR INNER 5m
- RIPARIAN CORRIDOR OUTER 10m
- RIPARIAN CORRIDOR AREA OFFSET
- RIPARIAN CORRIDOR OUTER 5m ENCROACHMENT

	TOTAL
RIPARIAN ENCROACHMENT AREA (m²)	1550
ENCROACHMENT OFFSET AREA (m²)	3250
SURPLUS OFFSET (m²)	1700

NOTES:
STREAM ORDER DESIGNATION IS BASED ON "RIPARIAN ASSESSMENT REPORT" REFERENCE 2699 BY AEP DATED JUNE 2024.

PLAN
SCALE 1:800

GDA2020

ver.	date	comment	drawn	pm	co-ordinate information	level information	scale (A1 original size)	notes
C	27/06/2024	MINOR ADJUSTMENTS	DN	ML	CO-ORDINATE SYSTEM: MGA56	DATUM: N/A CONTOUR INTERVAL: 0.5m	0 20.0 40.0m SCALE: 1:800 (FULL)	

drawing title:
RIPARIAN CORRIDOR PLAN

location: NEW ENGLAND HIGHWAY, LOCHINVAR
council: MAITLAND CITY COUNCIL
dwg ref: 240332-ESK-006(C)
client: CPG ESTATES

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working beyond expectations

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility • visualisation • urban design

Plotted By: Dipendra Neupane Plot Date: 27/06/24 2:16:31PM Cad File: N:\240332\DWG\ENGINEERING\ESK\240332-ESK-006(C).DWG

This plan includes coloured information. If you have a black and white copy you do not have all of the information. This note is coloured RED.

Appendix D – Biodiversity Management Plan

Draft Biodiversity Management Plan – 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar, NSW

Prepared For: Lochinvar Developments Pty Ltd

Prepared By: Anderson Environment and Planning

Date: July 2024

AEP Reference: 2699.04

Revision: 01

Plate 1 – Existing creek line north west of BMP lands

Plate 2 – Planted native vegetation resembles PCT 3433

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Appendices

1.0 Introduction

At the request of Lochinvar Developments Pty Ltd, on behalf of ADW Johnson Pty Ltd (the client) Anderson Environment & Planning (AEP) have undertaken the necessary investigations to inform the production of a Biodiversity Management Plan (BMP) to schedule rehabilitation measures associated with the development of land at 898 New England Hwy, 25 Wyndella road and 39 Wyndella Road Lochinvar, NSW, henceforth referred to as the Subject Site (**Figure 1**). As the proposed development will be impacting waterfront land, a BMP is required as part of the controlled activity approvals outlined below (DPI 2012):

> *Controlled activities carried out in, on or under waterfront land are regulated by the Water Management Act 2000 (WM Act). When a proposed controlled activity disturbs or substantially modifies the riparian corridor, its restoration or rehabilitation will be a requirement of the controlled activity approval. A vegetation management plan (VMP) details how the restoration or rehabilitation will be carried out.*

Although this level of detail is not typically provided as part of the development application, rather it comes with the application for the CAA post-consent, it has been provided upfront to support the proposed stream realignment works.

1.1 Biodiversity Management Plan Objectives

The aim of this BMP is to determine the reconstruction of a riparian area, schedule weed management and revegetation measures necessary to enhance habitat value and improve landscape connectivity of retained lands. This will be achieved by providing a stable watercourse and riparian corridor as well as enhancing existing vegetation.

The purpose of this plan is to:

- Reinstate a natural channel creating both ecological and hydraulic function.
- To create a Wildlife Corridor for native fauna in the area, with provisions such as connective canopy species such as the Endangered *Petaurus norfolcensis* (Squirrel Glider) are able to move through the Subject Site.
- To revegetation to a point that it can be naturally regenerated.
- To improve water quality within the Hunter Catchment.
- Provide habitat for both native terrestrial and aquatic species.

The BMP requires action to regenerate riparian lands while creating safe space within the proposed subdivision. The BMP incorporates best practices in bushland restoration, management of invasive species and revegetation to achieve the following objectives within the 5 years imparted:

- Regenerate physical and biological functions of the remnant bushland present within the VMP Lands to improve habitat values and connectivity for locally occurring biota;
- Reconstruct highly disturbed areas that cannot naturally regenerate, to stabilise and reinstate landforms and vegetation communities that are generally representative of those present prior to disturbance;
- Develop management actions detailed using the 'SMART' goals approach (Specific, Measurable, Achievable, Reasonable and Time bound);
- Ensure the site is maintained until vegetation in rehabilitated areas achieves a self-sustaining state;
- Enhance habitat and connectivity across the site through salvage of biomass from the development site and revegetation.
- Implement erosion and sediment control measures to minimise the transfer of soil and sediments into downslope receptors; and
- Implement a hygiene protocol to prevent the transfer of weeds and pathogens onto and off the site.

1.2 Supporting Reports

The BMP must be read and implemented in conjunction with the following reports:

- Anderson Environment & Planning (2024) *Streamlined Biodiversity Assessment Report for Residential Subdivision and Associated Infrastructure at 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar, NSW.*
- Anderson Environment & Planning (2024) *Aquatic Ecology Assessment Report for 898 New England Hwy, 25 Wyndella Rd and 39 Wyndella Rd, Lochinvar, NSW.*

2.0 Site Context and Existing Condition

2.1 Local Context

Lochinvar Developments Pty Ltd are proposing a 258 Lot residential subdivision with internal road, services, and asset protection zones (APZs). The residential development will be situated within Lots 2-6 and 9 DP747391, Lots 12 and 13 DP1219648 (approx. 21.99ha) currently zoned for General Residential (R1) land use. The proposed development is a large residential subdivision planned under the Lochinvar Urban Release Area with retained creek line proposed to be managed under a biodiversity management plan.

The BMP lands, totalling 1.37ha, are situated within an area designated as R1 - General Residential zoning, and were previously cleared and managed as agricultural land. The BMP will apply to land within the following five (5) lots:

- Lot 2 in DP 747391;
- Lot 3 in DP 747391;
- Lot 4 in DP 747391;
- Lot 5 in DP 747391;
- Lot 6 in DP 747391.

General ecological inspections and floristic surveys were undertaken by AEP in April 2024. Riparian assessments and fauna surveys were conducted between August 2022 and January 2023. The existing hydroline was assessed against the NRAR *Waterfront Land Tool* for the purposes of determining Vegetated Riparian Zones (VRZ).

A section of the creek is proposed to be realigned under the BMP and will require plantings and erosion and sediment controls to ensure the banks of the creek remain stable and natural flow and ecological function are maintained.

The BMP will utilise the principles of Brisbane City Council's 2003 Natural Channel Design to restore natural features within the proposed management zones and regenerate aquatic and riparian ecosystems. The channel will be restored with species from PCT 3975, and the riparian corridor PCT 3433, to create a functioning wildlife corridor focusing on *Petaurus norfolcensis* (Squirrel Glider), *Litoria aurea* (Green and Gold Bell Frog) and other native fauna. Proposed interventions include pocket plantings of canopy trees for Glider movement, low-lying fire-resistant species to minimize bushfire risk, and compliance with Safer by Design Guidelines to reduce potential antisocial behaviour.

To ensure consistency with water sustainable urban design principles the tailout scour protection area will not utilise chemical weed control this area is proposed to be managed by hand weed removal to ensure water quality is maintained (refer **Figure 3**).

The BMP lands are proposed to be managed under a 5-year Biodiversity Management Plan, including natural channel design, plantings, weed management, pest and disease management and installation of habitat.

All APZs are located outside of BMP lands and are to be managed under the provisions outlined in the Bushfire Report.

Figure 2 shows ground-truthed vegetation boundaries. **Figure 3** outlines the proposed management zones and areas impacted by the development.

2.2 Stages

The development is proposed in stages, to ensure the regeneration works are not impacted Stage 1 of the regeneration works are temporary to stabilise soils.

Stage 1 is the installation of a culvert on Wyndella Road. The removal of the existing road crossing will be undertaken and replaced with a culvert designed to ensure Fish Passage is maintained in perpetuity. The works are will be seeded with native groundcovers to stabilise soils.

Stage 2 is the commencement of the BMP, as outlined below.

2.3 Existing Vegetation Description

The Study Area covers approximately 26.49ha and the Subject Site totals approx. 22.25ha, comprising approx. 0.87ha of poor and highly degraded condition native vegetation, with the remainder of the Subject Site

consisting of non-endemic planted natives, exotic species and cleared lands.

The native vegetation within the BMP lands contains two (2) plant community types (PCTs), which are present in varying condition.

- 4044 - *Northern Creekflat Eucalypt-Paperbark Mesic Swamp Forest* – Highly degraded (0.51ha)
- 3433 - *Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest* – Degraded (0.12ha)

It should be noted that PCT 3433, a dry sclerophyll forest community (**Plate 2**), was planted approximately 20 years ago at the western extent of the riparian corridor. However, this vegetation type is not the most appropriate for a riparian zone as it does not naturally occur in these low-lying areas. PCT 4044 is expected to occur within this area and is likely to have been the naturally occurring plant community type historically.

Figure 1 and **2** shows the site location ground-truthed vegetation respectively.

2.3.1 PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest

PCT 3433 - Hunter Coast Foothills-Ironbark Grassy Forest currently present on site is dominated by a canopy of Spotted Gum (*Corymbia maculata*) and Grey Gum (*Eucalyptus punctata*). The vegetation is deemed not remnant due to being planted in what appears to be parallel lines no later than 20 years ago.

The species present are a mixture of Dry Sclerophyll Forest and Forested Wetland species such as *Casuarina glauca, Carex appressa* and *Juncus usitatus* as a result of plantings adjacent to the hydroline. Ground stratum species include *Centella asiatica, Rumex brownii, Lachnagrostis aemula* and *Parsonsia straminea*.

PCT 3433 – *Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest* is associated with the Endangered Ecological Community *Lower Hunter Spotted Gum – Ironbark Forest* (BC Act 2016). Given the absence of midstory, sparse native understory and fragmented condition of the site, the vegetation present is a highly disturbed variant of the EEC.

Plate 3 – PCT 3433 – Hunter Coast Foothills Spotted Gum – Ironbark Grassy Forest

2.3.2 PCT 4044 - Northern Creekflat Eucalypt-Paperbark Mesic Swamp Forest

This PCT is in the southern low-lying areas of the BMP lands covering approx. 0.51ha. The canopy is dominated *Casuarina glauca*, with a ground stratum consisting of *Juncus appressa, Juncus usitatus* and *Cynodon dactylon.*

Plate 4 – PCT 4044 – Northern Creekflat Eucalypt-Paperbark Mesic Swamp

2.3.3 Planted Native

Much of the BMP Lands consists of highly disturbed grassland (**Plate 5**). This area is largely cleared and dominated by planted *Cynodon dactylon* (Couch Grass) and introduced species such as *Paspalum dilatatum* (Paspalum), *Senecio madagascariensis* (Fireweed), and *Juncus acutus*.

While *Cynodon dactylon* is considered native by the NSW Herbarium, it is listed as non-native by the Commonwealth. Despite being widely cultivated as a lawn and pasture grass (DPE, 2022), it is historically associated with agricultural grazing practices, where it was likely sown. Consequently, the *Cynodon dactylon* present at the site is classified as 'planted native vegetation'.

Plate 5 – Exotic grassland in southern BMP lands

2.3.4 Exotic Riparian

The riparian zone of the BMP lands located in the south, is dominated by exotic species including *Juncus acutus, Hypochaeris radicata* and *Cyperus eragrostis*.

Plate 6 – Exotic riparian vegetation in unaltered hydroline alignment

2.4 Native Vegetation Condition

2.4.1 PCT 3433 - Hunter Coast Foothills Spotted Gum - Ironbark Grassy Forest

Areas of PCT 3433 are in moderate condition as a result of edge effects and disturbance from grazing cattle. The mid stratum is absent likely due to suppression of shrubs from grazing. The lower stratum, although highly disturbed, containing a large number of exotics, also comprises regenerating native understory species.

Plate 7 – PCT 3433 in moderate condition in west of BMP lands

2.4.2 PCT 4044 - Northern Creekflat Eucalypt-Paperbark Mesic Swamp Forest

PCT 4044 within the BMP lands is in a highly degraded condition. The native vegetation is limited to a small number of native species including *Casuarina glauca, Carex appressa* and *Juncus usitatus.* The majority of weed load in this area is comprised of understory species *Cyperus eragrostis* and *Juncus acutus.* Degraded ground cover in the south west is subject to extensive runoff from the development south of the NEH draining into this area and is starting to form a freshwater wetland, albeit in the early stages. Areas directly impacted by increased runoff will be reconstructed with aquatic species from PCT 3975 *Southern Lower Floodplain Freshwater Wetland* to reflect and support the change in conditions, assist in water treatment from road runoff and from adjoining residential subdivision, the species in this PCT are known for their ability to improve water quality. Additionally, reconstruction of PCT 3975 will be undertaken to ensure vegetation communities are commensurate with the Threatened Ecological Community (TEC) *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.* The wetland PCT will also provide potential habitat for amphibians such as Green and Golden Bell Frog.

Plate 8 – PCT 4044 in poor condition view facing east to west, proposed to be regenerated with PCT 3975 as freshwater wetland.

3.0 Regeneration Approach and Targets

Regeneration of the BMP lands will be undertaken over a period of 5 years. Management of the site will be undertaken to ensure compliance with the *Biosecurity Act 2015*.

Regeneration of the BMP Lands will aim to reach a state of "Natural Regeneration" requiring minimal to no intervention. To achieve this, an Integrated Regeneration Approach has been designed, with key elements and targets identified for each vegetation community within each Management Zone.

It is anticipated that after the 5 years duration of the BMP, the vegetation present will be in a state of natural regeneration and will be self-sustaining only requiring a low level of maintenance to address sporadic weed incursions.

3.1 Integrated Regeneration Approach for BMP Lands

Regeneration of the BMP lands will be undertaken by utilising where possible the principles of the *Society for Ecological Restoration Australasia* (2021) *National standards for the practice of ecological restoration in Australia Edition 2.2* and an ecological regeneration approach has been deemed suitable for the BMP lands. This approach utilises three integrated restoration techniques to achieve the goal of a Natural Regenerating ecosystem and include:

- Reconstruction Approach;
- Facilitated Regeneration Approach; and
- Natural Regeneration.

National Guidelines assigned to BMP Land areas are based on their history of disturbance and current state. These include the Natural Regeneration and Facilitated Regeneration approaches that will be utilised within the BMP lands with the aim of achieving the Natural Regeneration state by the end of the BMP Management period.

Note that the Reconstruction Approach will not be utilised due to the low weed load within the BMP Lands and resilience of the vegetation present. Nonetheless, adaptive management require the consideration for active restoration via supplementary planting due to the potential for unforeseen factors to arise such as new weed incursion, vandalism or introduction of pathogens that may impact one or more strata of vegetation.

3.1.1 Reconstruction Approach

This approach is used across sites where the vegetation condition is poor, generally due to a range of causes of degradation that have led to partial or total damage to biotic and abiotic factors. The Reconstruction Approach includes:

- Site preparation:
- Primary weeding;
- Installation of jute matting and coir logs in areas of high water-flow;
- Planting of tree, shrub and ground species in appropriate areas;
- Installation of guards around tree and shrub species;
- Watering;
- Secondary weeding;
- Mulching in areas without jute matting;
- Maintenance watering;
- Maintenance of tree guards; and
- Replacement of dead plants.

Zones 1,2,4,5 and 6 within the BMP lands have been appointed to be reconstructed.

3.1.2 Facilitated Regeneration Approach

This approach is generally used on sites where regeneration progress is at an intermediate level and active intervention is minimised.

As stated, the Facilitated Regeneration Approach requires active interventions, the tasks of which will be determined by the Bush Regeneration Contractor (BRC) and may involve the following tasks:

- Replacement of dead plants;
- Weeding;
- Watering;
- Mulching; and
- Maintenance of tree guards.
- Maintenance of jute matting

3.1.3 Natural Regeneration Approach

This approach is where damage is relatively low, and pre-existing biota should be able to recover after cessation of degrading practices.

The Natural Regeneration Approach requires limited to no interventions with weeding being the only task undertaken to encourage continual natural regeneration.

The majority of the BMP Lands will be managed via this approach due to weed loads being mostly low to negligible. Where weed densities are moderate, ongoing weed control targeting the vicinity of the tracks is expected to manage the edge effect and provide opportunities for native flora to recruit and colonize areas cleared of exotic species. Ongoing monitoring will determine whether weed control is effective and if adjusting management strategy to facilitated regeneration and/or reconstruction is necessary.

3.1.4 Natural Channel Design and Vegetated Riparian Zone

As part of the development footprint, the existing mapped hydroline will be realigned within the BMP lands. A section of the creek, currently vegetated with planted PCT 3433, will be retained. The rest of the riparian corridor will be regenerated with PCT 3433, In-stream aquatic vegetation will be from PCT 3975. This is shown in **Figure 3**.

The existing creek is highly degraded, eroded and modified by past and present agricultural uses. The Department of Planning and Environment (Water) requires a 10m VRZ from the top of bank on a 1st order stream.

The realigned creek has been designed to include:

- Defined bed and bank;
- Meanders;
- Pools;
- Riffles; and
- Aquatic vegetation.

Plates 9-12 below show examples of these design features.

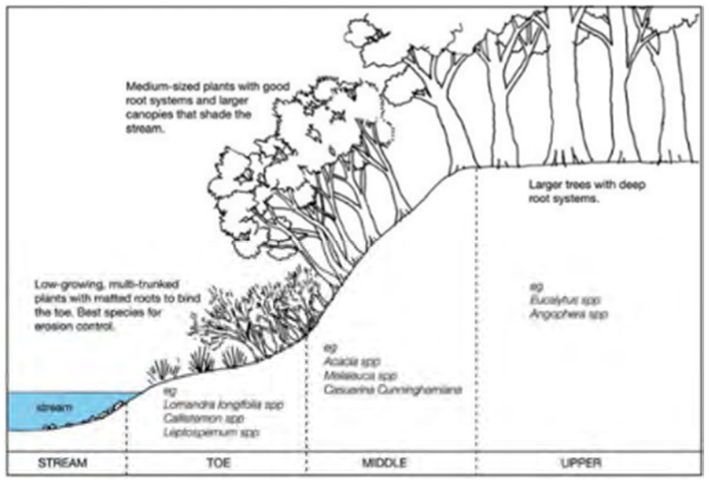

Plate 9 - Cross Section of Stream (NSW Water, 2022)

A review of the current literature showed that reinstated natural channels within the unnamed creek would ensure the above key hydrological features are present within the creek, and as a result improved water quality and habitat for both terrestrial and aquatic organisms will be provided. **Plates 7 – 9** show photos of natural channel design examples.

This BMP provides the concept plan for the channel design, detailed engineering plans will be prepared prior to Construction Certificate.

Plate 10 – Meanders, Riffles and shallow pools (STORMWATER, 2018).

Plate 11 – Low Flow Channel (Australian Wetland Consulting, 2018).

Plate 12 – Bundamba Creek Restoration works (Australian Wetland Consulting, 2018)

4.0 BMP Stages

4.1 Stage 1

Before the commencement of BMP works in Stage 2, temporary regeneration will occur before the stream alignment. This is due to the upgrade of Wyndella Road carriageway and the installation of a shared pathway. The focus of this stage is temporary bank stabilisation prior to Stage 2 works. The operation of the stream will also be in use short term, by implementing the BMP to a two-stage approach, the necessary road closures of Wyndella Road will be reduced to minimise disruption to local residents.

4.2 Stage 2

The permanent stream realignment will occur in association with the subdivision stage. Once all civil works are completed for the subdivision, the BMP works will commence.

5.0 Management Zones

The BMP lands within will be managed in six (6) Management Zones (MZs) to clearly identify objectives and targets. **Figure 4** shows the Management Zones.

- Management Zone 1 (MZ1): PCT 3975 Reconstruction - Low Flow Channel;
- Management Zone 2 (MZ2): PCT 3433 Reconstruction - Watercourse Bank;
- Management Zone 3 (MZ3): PCT 3433 – Facilitated Regeneration ;
- Management Zone 4 (MZ4): PCT 3433 Reconstruction – Riparian;
- Management Zone 5 (MZ5): PCT 3975 Reconstruction - Freshwater Wetland (Ground Cover); and

- Management Zone 6 (MZ6): PCT 3433 Reconstruction - Proposed Berm.

5.1 Management Zone 1 : PCT 3975 Reconstruction - Low Flow Channel

MZ1 (approx. 0.07ha) zone is located in the low flow channel to the top of the toe, consisting of a width of 1m – 2m. It will include the reinstating of aquatic vegetation and habitat such as snags and woody debris.

The Reconstruction Approach is being utilised in MZ1 due to the realignment of the creek line and density of weeds found on either end of the creek (East and West). De-watering, trenching, digging, construction and planting of native water plants will need to be implemented**.**

Weeding as defined in **Table 2**, effectively controlling priority species and areas through appropriate methods to eliminate highly competitive weeds from an area.

All works should be undertaken to ensure bed and bank stability, provisions of aquatic habitat for both flora and fauna.

As stated, the Reconstruction Approach requires active interventions, the tasks of which will be determined by the Bush Regeneration Contractor (BRC) and may involve the following tasks:

- Construction of natural channel;
- Planting of grasses;
- Installation of snags;
- Weeding;
- Watering; and
-
- Replacement of dead plants (1:1).

The BMP aims to move into Natural Regeneration Approach by the end of Year 5.

5.2 Management Zone 2 : PCT 3433 Reconstruction - Watercourse Bank

MZ2 (approx. 0.34ha) is located from the top of the toe to the top of the high bank approximately 2m either side of MZ1. MZ2 will be planted out with species commensurate with PCT 3433.

The Reconstruction Approach is being utilised in this section due to the realignment of the creek line and density of weeds found on either end of the creek (East and West). Therefore, planting of native species from PCT 3433 will assist with meeting the Targets outlines in Section 6.

To prepare for planting, spot spraying of the area should be undertaken and direct seeding of native grasses and ground covers may occur around the planting. This will be decided by the bush regeneration contractor.

Maintenance of the plantings will include watering and spot spraying of herbaceous weeds over the following months as well as replacement of dead plants if conditions are still favourable for planting. If weather is unsuitable, replacement and infill planting will be postponed till the following spring at autumn.

Weeding will be commenced, as defined in **Table 2** (effectively control priority species and areas through appropriate methods to eliminate highly competitive weeds from an area).

All works should be undertaken to ensure bed and bank stability, provisions of terrestrial habitat for both flora and fauna.

As stated, the Reconstruction Approach requires active interventions, the tasks of which will be determined by the Bush Regeneration Contractor (BRC) and may involve the following tasks:

- Planting of grasses and shrubs;
- Weeding;
- Watering;
- Mulching (if required); and
- Replacement of dead plants (1:1).

The BMP aims to move into Natural Regeneration Approach by the end of Year 5.

5.3 Management Zone 3 : PCT 3433 - Facilitated Regeneration

MZ3 (approximately 0.12ha) is located on the western boundary and currently consists of planted PCT 3433 and some regenerating casuarinas surrounding an existing watercourse. While canopy cover is present, there is no midstory, necessitating the initial planting of shrubs to establish a microclimate conducive to groundcover growth. Proposed interventions include pocket plantings of canopy trees and low-lying, fire-resistant species to facilitate Squirrel Glider movement, minimize bushfire risk, and comply with Safer by Design Guidelines to reduce potential antisocial behaviour.

The Facilitated Regeneration Approach is being employed in MZ3 due to high weed loads and the absence of mid and lower stratum vegetation. Planting native species from PCT 3433 will help achieve the targets outlined in **Section 5**. Primary weeding, as detailed in **Table 2**, will involve foliar herbicide application and the physical removal of woody weeds to effectively control priority species and eliminate highly competitive weeds.

As stated, the Facilitated Regeneration Approach requires active interventions, the tasks of which will be determined by the Bush Regeneration Contractor (BRC) and may involve the following tasks:

- Weeding;
- Planting;
- Watering;
- Mulching (if required); and
- Maintenance of tree guards;
- Maintenance of jute matting;
- Replacement of dead plants (1:1).

The BMP aims to move into Natural Regeneration Approach by the end of Year 5.

5.4 Management Zone 4 : PCT 3433 Reconstruction - Riparian

MZ4 (approx. 0.45ha) is from the edge of the floodplain to the landscaped road batters and parkland area. This zone will be planted to reflect a derived woodland of PCT 3433. This will ensure the Safer by Design Guidelines are met with more pocket plantings to ensure clear sightlines and no spaces where antisocial behaviour can occur.

The Reconstruction Approach is being utilised in MZ4 due to the high weed loads and lack of native vegetation within this zone. Therefore, canopy trees, shrubs and understory form PCT 3433 will assist with meeting the Targets outlines in **Section 6.**

Primary weeding as defined in **Table 2** to effectively control priority weed species and eliminate highly competitive weeds from an area. This may include high-volume herbicide application.

As stated, the Reconstruction Approach requires active interventions, the tasks of which will be determined by the Bush Regeneration Contractor (BRC) and may involve the following tasks:

- Installation of logs along edge as a buffer;
- Planting of grasses, shrubs and canopy species;
- Installation of habitat;
- Weeding;
- Watering;
- Mulching (if required); and
- Replacement of dead plants (1:1).

The BMP aims to move into Natural Regeneration Approach by the end of Year 5.

5.5 Management Zone 5: PCT 3975 Reconstruction - Freshwater Wetland

MZ5 (approximately 0.31ha) will be established to enhance connectivity and support the surrounding hydrological regime as part of a water sustainable urban design. This area will predominantly feature a mixture of freshwater wetland and semi-aquatic groundcover commensurate with PCT 3975. MZ5 plantings will be limited to ground cover only to reduce future bushfire risk to adjacent properties. These elements are designed to integrate with the terrestrial environment and meet the hydrological needs of the site. It is crucial to design this area to avoid shading the water features, as prolonged shading will reduce habitat suitability. The planting densities are based on evidence and historical data from various reports and case studies.

Shrubs and canopy in MZ4 will add a layered structure that assists MZ5 in reducing grassy weed cover and preventing weed incursion into the BMP lands from the road to the south.

The following management tasks are to be undertaken:

- Primary planting (Aquatic and terrestrial wetland ground cover vegetation commensurate with PCT 3975);
- Watering; and
- Ongoing maintenance (Watering, replacement of unsuccessful plantings).
- Primary and secondary weeding.

5.6 Management Zone 6: PCT 3433 Reconstruction - Proposed Berm

MZ6 (approximately 0.09ha) has been established to manage hydrological overflow and dispersion as part of a water sustainable urban design. This zone will regenerate PCT 3433 ground cover and shrub layer on a constructed berm and support various ecological functions.

The following management tasks are to be undertaken:

- Primary weeding;
- Planting of ground cover and mid-strum species only from PCT 3433;
- Weed control; and
- Maintenance weeding and replacement of any dead plantings.

6.0 Regeneration Targets

6.1 Ecosystem Targets

"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. (SER 2021)*"*

The overall target for the BMP Lands is to establish a naturally regenerating community that provides habitat for foraging, roosting and nesting for species associated with the PCTs and local region.

There are many ways to generate targets and establish measure tools to determine the health of an ecosystem such as:

- Benchmark conditions set under the Biodiversity Assessment Methods 2020;
- Percentage of species presence from community list per as a whole, or per stratum;
- Species composition;
- Physical condition;
- Absence or presence of threats;
- Structural diversity;
- Coverage of the flora species;
- Diversity of fauna guilds present; and
- Abundance of fauna recorded within the subject site.

AEP acknowledges that all the above are valid assessment tools to utilise and measure success, however there are several factors that limit all communities from reaching Benchmark Conditions:

- Availability to purchase seed or tube stock of many native species;
- Topographic features of each site vary;
- Aspect of BMP lands variation between sites;
- Accessibility / connectivity for mobile fauna to access and use the site;
- Soil types;
- Surrounding vegetation communities influence the seed stock and hence natural regeneration;
- Presence of absence of canopy, impacting the microclimates;
- Rainfall variation; and
- Growth timeframes.

When developing targets for BMP Lands the above must be taken into consideration without losing the main objective to *assist the recovery of an ecosystem.* Therefore, AEP has developed targets (refer to **Appendix A)** for each Regeneration Approach that can achieve a naturally regeneration functioning ecosystem, within the timeframes outlined in the BMP.

Utilising ecological references to identify the terrestrial or aquatic ecosystem and inform the targets of a regeneration project involves describing the specific compositional, structural, and functional attributes needing reinstatement. Only then can the desired outcome of "assisting the recovery of an ecosystem" be achieved. These attributes in combination can then be used to derive the targets for a BMP. A restored state is considered to have been achieved when an ecosystem is naturally regenerating.

6.1.1 BMP Land Targets

Integrated Regeneration Approach will be applied across the entire BMP Lands, with the following targets designed to be specific, measurable, achievable, reasonable, and time-bound (SMART), providing quantitative data within the BMP Lands.

Given the current condition of the BMP Lands the focus is on weed removal, which in turn will promote the growth of native vegetation from the seed bank in the soil and the seed brought in by mobile fauna.

Appendix A outlines the targets the BMP is aiming for each attribute within the BMP Lands.

When surveys were undertaken by AEP the vegetation within communities were was identified to be in two conditions requiring two of the three approaches to regeneration:

- **Management Zones 1, 2, 4, 5 and 6** were in poor condition requiring regeneration based on Reconstruction Approach. Targets are outlined in **Tables 1 - 2.**.
- **Management Zone 3** was identified in moderate condition requiring regeneration based on a Facilitated approach. Targets are outline in **Tables 1 - 2.**.

As stated above the condition of vegetation communities can vary significantly and as such baseline data will be collected to determine the targets for each of the Management Zones within the BMP Lands. The baseline report will be prepared at commencement of the BMP and submitted to Council outlining the specific targets for each zone, based on **Tables 1 - 2.**.

The Integrated Regeneration Approach will be used across the entire BMP Lands and the targets (**Tables 1 - 2**) have been designed to be measurable, providing both quantitative and qualitative data on species abundance and cover for the vegetation communities within the BMP Lands.

Weeds have a significant impact on structural integrity of vegetation communities. African Olive (*Olea europaea subsp. cuspidate*) was the only woody weed present, as both in juvenile and adult form. Various exotic grasses and herbs were present, primarily Black Nightshade (*Solanum nigrum*), Galenia (*Galenia pubescence*), Fire weed (*Senecio madagascariensis*), Pale Pidgeon *Grass (Setaria pumila),* Panic Veldt grass *(Ehrharta erecta),* Paspalum *(Paspalum dilatatum*) and Purple top (*Verbena bonariensis*).

Some of these species are identified as priority weeds (**Appendix A**) for the Hunter. These include priority weeds African Olive, Fire Weed and Galenia. Treatment of all other weeds will be a secondary measure.

To achieve Natural Regeneration throughout the entire BMP lands within five (5) years targets have been set within **Tables 1 - 2.**.

Table 1 – Regeneration Targets for Reconstruction Approach

Attribute	Baseline Data	Level 1	Level 2	Level 3	Level 4	Level 5
Approximate Timeframe from Commencement	**Commencement**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Species composition	At each monitoring point collect: • Native Species abundance • Native Species Cover • Weed / exotic Species abundance • Weed / exotic Species Cover	• 70% survival of each planted stratum. • 50% reduction in weeds from baseline data.	• 80% survival of each planted stratum. • 60% reduction in weeds from baseline data.	• 80% survival of each planted stratum. • 80% reduction in weeds from baseline data.	• 80% survival of each planted stratum. • 90% reduction in weeds from baseline data.	• 80% survival of each planted stratum. • 95% reduction in weeds from baseline data.
Structural diversity	Record the native growth forms present: • Tree; • Shrub; • Grass / grass like; • Forb; • Fern; and • Other.	One or fewer strata present and no spatial patterning or trophic complexity relative to from baseline data.	More strata present but low spatial patterning and trophic complexity, relative to benchmark from baseline data.	Most strata present and some spatial pattering and trophic complexity relative to benchmark from baseline data.	All strata present. Spatial pattering evident and substantial trophic complexity developing, relative benchmark from baseline data.	All strata present and spatial pattering and trophic complexity high. Further complexity and spatial pattering able to naturally regenerate.
Ecosystem Function	Leaf litter	A 2% - 5% increase from baseline data.	A 5% - 15% increase from baseline data.	A 15% - 25% increase from baseline data.	A 25% - 35% increase from baseline data.	A 35% - 50% increase from baseline data.
	Ground habitat installed	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)
	Stem classes present	No increase required as tube stock planted.	No increase required as tube stock planted.	No increase required as tube stock planted.	No increase required as tube stock planted.	2 -10% increase in stem class presence from baseline data
	Observed fauna: • Native species • Pest species	• No increase of native fauna required from baseline data. • 5%-10% reduction in pest species from baseline data	• No increase of native fauna required from baseline data. • 10% -20% reduction in pest species from baseline data	• 5% -15% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data	• 15% -25% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data	• 25% - 50% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data

Table 2 – Regeneration Targets for Facilitated Approach

Attribute	Baseline Data	Tired Targets (base on Baseline Data)	Level 2	Level 3	Level 4	Level 5	Level 5
Approximate Timeframe from Commencement	**Commencement**		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Species composition	At each monitoring point collect: • Native Species abundance • Native Species Cover • Weed / exotic Species abundance • Weed / exotic Species Cover	**Tier 1 – Diversity good at baseline.** No supplementary planting or other works required.	• Diversity / cover Maintained or improved from baseline data. • 60% reduction in weeds from baseline data.	• Diversity / cover Maintained or improved from baseline data. • 80% reduction in weeds from baseline data.	• Diversity / cover Maintained or improved from baseline data. • 90% reduction in weeds from baseline data.	• Diversity / cover Maintained or improved from baseline data. • 95% reduction in weeds from baseline data.	Maintain or improve on Year 4 targets
		Tier 2 – Diversity moderate to low at baseline. Works required such as supplementary planting, possible thinning, etc required.	• 80% survival of each planted stratum. Noting this will increase diversity in where required. • Maintain diversity recorded at baseline data. • 60% reduction in weeds from baseline data.	• 80% survival of each planted stratum. Noting this will increase diversity in where required. • Maintain diversity recorded at baseline data. • 80% reduction in weeds from baseline data.	• 80% survival of each planted stratum. Noting this will increase diversity in where required. • Maintain diversity recorded at baseline data. • 90% reduction in weeds from baseline data.	• 80% survival of each planted stratum. Noting this will increase diversity in where required. • Maintain diversity recorded at baseline data. • 95% reduction in weeds from baseline data.	
Structural diversity	Record the native growth forms present: • Tree; • Shrub; • Grass / grass like; • Forb; • Fern; and • Other.	N/A	More strata present but low spatial patterning and trophic complexity, relative to benchmark from baseline data.	Most strata present and some spatial pattering and trophic complexity relative to benchmark from baseline data.	All strata present. Spatial pattering evident and substantial trophic complexity developing, relative benchmark from baseline data.	All strata present and spatial pattering and trophic complexity high. Further complexity and spatial pattering able to naturally regenerate.	
Ecosystem Function	Leaf litter	N/A	A 5% - 15% increase from baseline data.	A 15% - 25% increase from baseline data.	A 25% - 35% increase from baseline data.	A 35% - 50% increase from baseline data.	
	Ground habitat installed		No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	No decline in ground habitat (replace if removed or damaged)	
	Stem classes present		No increase required as tube stock planted.	No increase required as tube stock planted.	No increase required as tube stock planted.	2 -10% increase in stem class presence from baseline data	

Attribute	Baseline Data	Tired Targets (base on Baseline Data)	Level 2	Level 3	Level 4	Level 5	Level 5
Approximate Timeframe from Commencement	Commencement		Year 1	Year 2	Year 3	Year 4	Year 5
	Observed fauna: • Native species • Pest species		• No increase of native fauna required from baseline data. • 10% -20% reduction in pest species from baseline data	• 5% -15% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data	• 15% -25% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data	• 25% - 50% increase in observed native fauna from baseline data. • 5% -10% reduction in pest species from baseline data	

7.0 Wildlife Management Strategy

7.1 Fauna Management

Macropods and possums were observed onsite and in the surrounding area. Consequently, protective guards should be installed around plantings to safeguard revegetation efforts in BMP lands from browsing. Should monitoring within management zones identify significant interference by pest species — such as excessive feeding — management strategies will be reassessed to mitigate these impacts.

Incidental fauna records are to be undertaken during monitoring surveys and reported.

Throughout all works onsite, any required fauna handling is to consider and/or implement the following:

- Native terrestrial and aquatic fauna will be transported by an appropriate method to a suitable nearby, vegetated area or permanent waterway as determined by the Project Ecologist.
- If fauna species encountered are listed as threatened species, all work must cease and the Project Ecologist must consult with a Council Ecology representative and Department of Primary Industries (Fisheries Unit) to review procedures.
- Frog handling will be undertaken in accordance with the Hygiene Protocol for the Control of Disease in Frogs (Murray et al. 2011).
- Fish species identified as exotic are to be ethically euthanised by a suitable method as determined by the Project Ecologist, and pest species eggs encountered are to be disposed at a suitably licenced landfill.
- The tailout scour protection area will not utilise chemical weed control to ensure water quality is maintained (refer **Figure 3**).

7.2 Habitat Corridor

The riparian vegetation and installation of ground habitat throughout the BMP Lands will provide a wildlife corridor within the Subject Site. The design of the corridor focused on both terrestrial and aquatic species ensuring mobile fauna can move through the BMP lands, including fish. The design of the corridor and planting regime must be undertaken to ensure a functioning corridor.

The focus was to ensure, movement and canopy connection. The Squirrel Gliders was not detected within the Subject Site, however, has been detected within the LGA, BioNet indicates sightings within 2 km. AEP used the movement, foraging and nesting requirements of this species to determine densities, and species to ensure they will be able to move through the BMP lands. This design supports the movement and foraging for many other native species.

Below outlines the species requirements.

7.2.1 Squirrel Glider

Squirrel Gliders (*Petaurus norfolcensis*) are threatened small gliding marsupials that have distinctive membranes of skin, stretching between their front and hind legs, that enable them to glide with ease through the air.

7.2.2 Breeding and foraging habitat

The Squirrel Glider prefers wet and dry sclerophyll forests and woodlands. The most common vegetation area where they can be found are typically characterized by one or more species of ironbark eucalypts (Australian Museum, 2024).

Squirrel Gliders tend to occur within three broad habitat types; Dry sclerophyll forests and woodlands dominated by winter flowering eucalypts such as Spotted Gum (*E. maculata*), various Box Gums and Ironbarks (such as *E. crebra*), Swamp Mahogany or Red Gum (*E. tereticornis*); Dry sclerophyll forests with an understorey of gum-producing acacias; Dry sclerophyll forests and woodlands with understorey of winter and autumn flowering banksias, as well as spring and summer flowering eucalypts (A.P.Smith and M.Murray, 2003).

The facilitated regeneration of MZ3 using PCT 3433 and reconstruction of MZ1,2,4,5 and 6 using species from PCT 3433 and PCT 3975 will allow for a suitable wildlife corridor and provide habitat for this species.

Where planting constraints allow the planting of canopy trees, a minimum twenty (20) *Eucalyptus robusta* will be planted and maintained by the BRC for the life of the BMP, to establish food and gliding resources.

7.2.3 Gliding Requirements

Glide calculations - extract from Goldingay & Taylor, 2009, the glide angle on average is 28.5 degrees with horizontal distance varying based on launch height. With the average gap crossing being 1.8m times the height. Therefore, gliding distance is launch height x 1.8. The above recommendation of planting 20 *Eucalyptus Robusta* approximately 15m apart should allow for future movement of the species within the BMP Lands.

7.3 Other habitat features

The BMP proposes the installation of Overwintering Habitat Structures, the aim of these structures is to create areas of refuge outside of the inundated areas and to provide some form of overwintering habitat for fauna that require them, including insects, lizards, snakes and amphibians. The simplest construction of these types of refuges is the placement of rocks into a pile while a slightly more complex structure can involve digging a small hole approx. 0.5m in depth and up to 1m width, filling the hole with a jumble of bricks or rocks up to approx. 0.5m above ground level and then placing plant material, soil/clay and other natural material loosely over the top of the bricks or rocks. The aim being to create small spaces that are reasonably thermally stable that can be used to hibernate or seek refuge if threatened while commuting or foraging.

Rocks used in this process should be between approx. 150mm to 200mm in diameter and environmentally stable, meaning they will not affect the pH of the water.

At least one (1) of these structures should be placed in Zone 6 area as indicatively indicated in **Figure 3**.

7.4 Aquatic Fauna

7.4.1 Conservation and Habitat Restoration

Habitat for various aquatic fauna species includes semi-permanent/ephemeral wet areas and within 1km of swamps, waterbodies or wet areas. Potential habitat is present for Green and Golden Bell Frog (*Litoria aurea)* within the broader lot. However, two nights of nocturnal searches within the recommended survey period did not detect this species within the proposed impacted dams (*AEP, EAR 2023*). The creek realignment will include the creation of four (4) in-channel reservoirs within the low flow line. In addition, one (1) dispersion area and overwintering habitat structure will be installed in the south west of the BMP lands. Freshwater wetland in MZ5 will utilise vegetation species from PCT 3975 for regeneration plantings which is known to be associated with *L. aurea.* All these areas offer suitable habitat for numerous aquatic species potentially present within the locality as documented in historic Bionet records.

7.4.2 Breeding and Foraging Habitat

A large range of aquatic fauna species have been recorded in the locality within a number of habitat types including coastal swamps, marshes, dune swales, lagoons, lakes and other estuary wetlands, as well as around floodplain wetlands and slow flowing or non-perennial streams. Many of these species prefer foraging in areas that contain flowering plants, grasses and foliage. The vegetation may be near breeding sites or considerable distance away. Tussock forming plants provide ideal foraging habitat and shelter. Regenerated vegetation will aim to provide habitat for a range of aquatic fauna.

7.4.3 Hydrological Dispersion and Overwintering Habitat Structures Construction

Examples of aquatic habitat are provided within **Appendix D** and are provided to give examples, not to be strictly adhered to, with on-site conditions likely to determine exact shape and placement of potential permanent and/or ephemeral habitat.

7.4.4 Permanent and Refuge Aquatic Habitat

A permanently inundated freshwater wetland area will be established adjacent to the road to manage stormwater runoff, as depicted in **Figure 3**. This area, integral to water sustainable urban design and biodiversity management, will measure approximately 15 to 20 meters in diameter. It will feature a sloped or stepped design with a compacted clay base of 0.3 meters, overlaid with topsoil to support aquatic vegetation planting.

To enhance habitat and ecosystem balance refuge habitat is recommended to be installed in the form of large rocks and, where available, hollow logs strategically placed along the water's edge to provide sunning spots and refuges for wildlife. Note that rock placement will be selective rather than encompassing the entire perimeter.

7.5 Pest Species

Rabbits have been observed onsite. Therefore, protection guards should be placed around plantings so that revegetation efforts within BMP lands is not compromised by grazing. If monitoring within management zones indicates pest species pose notable impediments to achieving the aims of the BMP (i.e., through excessive browsing, burrowing, spreading seed etc.), then management actions will be reviewed to address these issues.

It is strongly recommended to engage with Local Land Services (LLS) and adjacent landholders to identify the most suitable approach to control rabbits in the locality. The most effective approach combines a number of specific management actions including

- Baiting with Pindone;
- Warren destruction;
- Warren fumigation;
- Trapping; and
- Biological control.

Note that baiting with 1080 should not occur less than 500m from habitations as per LLS guidelines and as such should not be used onsite. Pindone is the only poison that can be used in urban area. Also note that Shooting is not recommended due to proximity to existing and proposed urban development.

No significant evidence of other feral animals was observed on site.

8.0 Regeneration Management

8.1 Site Preparation

The schedule of works and timing has been outlined in **Table 3**. Prior to the commencement of regeneration, the BMP Lands must be prepared. The following works have been recommended to assist in site preparation:

- Establishment of pathogens and diseases controls. Diseases which could affect the site include Myrtle Rust (*Puccinia psidii*), affecting Myrtaceous plants, including Melaleuca species; and Amphibian Chytrid fungus disease, Chytridiomycosis, caused by Chytrid fungus (*Batrachochytrium dendrobatidis*). Appropriate hygiene controls are to be employed to minimise the chances of any such introduction occurring. This may include a hygiene station equipped with sterilizing agents and cleaning equipment to clean boots, tools and machinery. Response plans are needed to be designed and implemented to mitigate impacts in the event of disease or pathogen outbreaks;
- All extant rubbish/waste is to be removed from BMP lands including farm fencing and structures. The need to remove such material should be assessed on a case-by-case basis as in some instances the material is inert, for example, concrete, rocks and timber posts. This material may inadvertently provide geomorphic stability;
- Clearly mark native vegetation for retention and approved removal;
- Install temporary fence around the BMP Lands, and clearly mark as a “No Go Area” prior to commencement of civil works;
- Fencing should have clearly visible signage erected at key entry points to BMP (**Appendix E**).
- Implement erosion and sediment control measures in accordance with specifications set out in the latest edition of the Landcom publication “Soils and Constructions – Volume 1” (The Blue Book);
- Construction of the natural channel;
- Establish monitoring and photo points;
- Vegetation clearing;
- Determine baseline data;
- Primary weed removal;
- Installation of ground habitat;
- Planting of Vegetation (see **Appendix C** for a detailed species list). All plant stock must be provenance specific seed/ material collected from locally endemic species, grown by suitably experienced and qualified nurseries, and hardened-off before planting. This will ensure the structure and composition of these communities will meet the targets set; and
- Mulching and watering.

8.2 Vegetation Clearing

For the clearing phase, retained vegetation will be delineated by safety bunting flags, fencing and signage indicating environmental protection zone, which will still allow fauna to egress the development area as needed. Following the completion of clearing works, permanent delineation features such as logs should be installed to protect the retained vegetation during operational phase of the development;

- Vegetation clearing should be timed to avoid cold weather periods where overnight temperatures are forecast to be less than 12°C. Cold weather is likely to make it difficult for resident hollow dependent fauna to successfully relocate. This is particularly relevant for low body-weight species;
- A staged approach to clearing is to be undertaken to provide fauna the opportunity to disperse outside the area of impact. Staging to include Phase 1 Clearing: Underscrubbing, Phase 2 Clearing: Removal of non-habitat trees, and Phase 3 Clearing: Removal of habitat and connecting trees;
- All clearing works to be undertaken under the supervision of the Project Ecologist;
- Clearing should occur in a direction from previously disturbed lands towards retained lands;
- Implement clearing protocols, including pre-clearance surveys to identify habitat and vegetation to be retained;
- All clearing works to be attended by a suitable equipped and experienced ecologist to deal appropriately with any displaced fauna species;
- Any fauna rescued during vegetation clearing is to be assessed for injuries, and subsequently released to a suitable nearby location; this may require holding fauna until dusk for release in accordance with relevant animal ethics licencing and standards;
- If any fauna is injured during vegetation clearing, they are to be taken promptly to a nearby veterinarian or suitable wildlife carer contact;
- In addition, prior to clearing of any vegetation, an ecologist is to inspect the area for any signs of resident fauna requiring attention, and in particular nesting birds. Where such is identified, appropriate strategies are to be developed and instigated to minimise impacts.
- Pre-clearance surveys to include diurnal surveys, stagwatching and nocturnal surveys;
- Civil Construction staff to be inducted into pre-clearing and clearing protocols, and to identify environmental features for protection;
- Suitable logs from felled trees are to be emplaced along the cleared/retained boundary to create a physical barrier between Subject Site and the retained lands;
- All cleared vegetation is to be mulched on site and spread to help stabilise any exposed soil and minimise offsite movement of biomass. Fallen timber and hollow logs identified to be retained to be relocated into the retained lands.

8.3 Weed Management

Weed control works within each Management Zone are to be undertaken by a qualified bushland regeneration team using industry standards (summary provided in **Table 3**).

Any reproductive material of weeds, including weeds that can spread vegetatively or seeds, must be taken off site to be disposed of at an appropriate local waste collection service. No weed material with the potential of spreading may be stockpiled within the Subject Site, or the BMP Lands.

The *Biosecurity Act 2015* outlines several ‘duties’; the general biosecurity duty, and additional duties under mandatory measures, regional measures, prohibited matter or biosecurity zone. Specific actions for these measures may be required. Weed control is required to occur in the following sequence:

1. **Primary Weeding** – Initial period of weeding within Management Zones.
2. **Consolidation** – After initial weeding, weed control zones will need monthly monitoring to remove regenerating weeds and those stimulated by disturbance, which compete with planted and regenerating native plants. Regular visits are crucial to prevent

weed recolonization, dominance, and inhibition of native species regeneration.

3. **Maintenance Weeding** – After six months, monthly maintenance will continue due to issues with woody weeds and other annual weeds in the area.

This interval will be evaluated based on-site condition during each monitoring period. Weed control works across the site are to be undertaken over the maintenance period of five (5) years, however given the adaptive management approach, this time-frame is flexible, and may need to be extended based on changing site conditions and results indicating management zones have reached targets set out in this BMP.

Establishment of monitoring point and compliance checking of other aspects within this rehabilitation plan will be the responsibility of the Project Ecologist working with the Civil Contractor.

The client will be responsible for the engagement of a suitably qualified Bush Regeneration Contractor to undertake weed control and planting works outlined in this rehabilitation plan (Table 3). The Project Ecologist will be responsible for the establishment of monitoring points within the BMP along with collection of baseline data that will be monitored against this over the five-year period of this rehabilitation plan with the overall targets. The Project Ecologist will be responsible for monitoring and reporting on weed management, and Regeneration Approach success.

Table 3 – Weed Control Activities

Activity	Minimum Requirement
Pre-works	Undertake baseline surveys to identify priority weeds present on site to be the focus of weed management activities. Priority weeds based on listings under the *Biosecurity Act 2015*, and notably problematic weeds on site have been identified, and listed in **Section 6.0**.
Primary Works	Effectively control priority species and areas through appropriate methods to eliminate highly competitive weeds from an area. Include high disturbance activities that could negatively impact later regeneration such as high-volume herbicide application, and physical removal of large trees which would pose safety hazards to the public or others if left to perish *in-situ*.
Secondary Works	Treat any regrowth from primary weed control and expand on control measures by targeting Priority species and expanding the primary control boundaries where desirable. Thin retained weeds to increase light penetration where appropriate. Generally, expand on and solidify primary work.
Maintenance Works	Maintain exclusion of weeds controlled during Primary and Secondary works. Prevent reinfestation of weeds progressively, and others as time permits.
Woody Trees & Shrubs	Where appropriate, remove trees via mechanical means (i.e., chainsaw or handsaw) and apply chemical to the cut stump. Material may be retained on-Site or disposed of appropriately off-Site. Retained material should be situated to provide additional ground habitat and slope stability but should not be left in such a way that would hamper natural regeneration or existing native plants. Care should be taken with species which have the capacity to regrow vegetatively such as *Erythrina x sykesii* (Coral Tree). Alternatively, trees and shrubs may be treated via frill or drill application of herbicide and left to perish *in-situ* as habitat.
Woody Thickets	Treat via cut or scrape and paint or high-concentration low-volume foliar herbicide control (i.e., splatter application). Material may be left *in-situ* (particularly after spraying) or broken up and rafted off the ground to perish (taking care to remove from expected high flow areas of the dam). Do not manually remove root stock in a manner that will encourage soil instability or erosion. Once dead, standing material may be broken down and left on the ground as mulch. Mechanical removal (i.e., brush cutter equipped with mulching blade or similar) may be used where practical and regrowth treated with foliar application of herbicide.
Vines and Creepers	Skirt from trees and vegetation to prevent smothering and leave material to perish *in-situ*. Cut or scrape and paint stems or runners. Foliar herbicide control where appropriate. Do not unduly expose soil via manual removal of plants where they may be providing soil stabilisation. Isolated manual removal as appropriate.
Ground Cover	Retain exotic species where they are providing ground stabilisation or habitat until such time as they hinder native species establishment or are no longer necessary. Relevant examples include retaining *Tradescantia fluminensis* (Trad) along drainage lines where removal would expose bare soil to erosion. Weed control is to focus on the patch removal of such weeds from around native regeneration or planting, with progressive removal of larger patches over time.
Retention of forage/habitat	Retain trees and shrubs that have evidence of occupation i.e., bird nest/possum dreys, until such time as other suitable habitat is available or the nest is abandoned. Retain manageable clumps of vegetation that can be easily removed at a later date for intermediate food and habitat supply within the semi-cleared and disturbed landscape, which will emerge between weed control and establishment of native plants.
	These retained features can be removed as they become redundant at the discretion of the Bush Regeneration Contractor (BRC).

9.0 Project Management

Establishment of monitoring points and compliance checking of other aspects within this BMP will be the responsibility of the Project Ecologist working with the Civil Contractor.

The client will be responsible for the engagement of a suitably qualified Bush Regeneration Contractor to undertake weed control and planting works outlined in this BMP.

Bush Regenerator(s) or company(s) shall have the following qualifications:

- Australian Association of Bush Regenerators (AABR) Accreditation. The Bush Regenerators shall hold a current AQF3 qualification.
- Site Supervisor must have demonstrated minimum of 2 years' experience in the bush regeneration or related field and must have experience at a supervisory level in providing training, supervision and technical advice to staff, clients, volunteers and members of the public.
- The Site Supervisor must hold a current AQF 3 qualification or higher and must have completed the Bush Regeneration Level IV Certificate or have a diploma or degree in a field related to natural resource management.

The Project Ecologist will be responsible for the establishment of monitoring points within the BMP lands along with collection of baseline data that will be monitored against this over the three-year period of this BMP with the overall targets. The Project Ecologist will be responsible for monitoring and reporting on weed management, and Regeneration Approach success.

9.1 Monitoring

Monitoring will occur at commencement and biannual basis at monitoring points

9.1.1 Baseline Data

Baseline data is collected at commencement of the BMP refer.

Indicative monitoring points have been identified within the BMP Lands (refer **Figure 3)**. The final location of the monitoring points is to be determined when commencing works, as environmental conditions change over time and the indicative locations may not be reflective of the communities at the time of commencement.

Baseline data will cover:

- Species diversity (both native and exotic);
- Species Abundance (both native and exotic);
- Overall health of the BMP Lands;
- Photos in north, east, south and west aspects; and
- Record incidental fauna.
- Presence/absence of Survey for exotic Mosquito Fish (*Gambusia affinis)* within pond and pools using the dip netting technique

The Monitoring Points established for the baseline surveys will then be monitored on a biannual basis, as per **8.1 Monitoring**.

9.1.2 Biannual Monitoring

The following tasks are scheduled every six (6) months from the start, continuing for up to three years or until the targets are achieved, whichever comes later:

- Weed species, coverage and location;
- Native species, coverage and location;
- Effectiveness of weed control methods;
- Photo records at monitoring points at each aspect (north, east, south, west);
- General health of each Management Zone
- Survey for Gambusia within Ponds using the dip netting technique
- Incidental fauna use of site; and
- Evaluation of management effectiveness.

9.2 Reporting

A baseline report is prepared at the beginning of the BMP and submitted to Council. Subsequently, annual status reports are to be prepared and submitted to the consent authority throughout the duration of the BMP. A final report will be prepared at the conclusion of the BMP, detailing the fulfillment of BMP conditions.

Biannual monitoring will inform the evaluation of management effectiveness, until the Regeneration Benchmark Targets are met.

As part of adaptive management, the reports will include evaluations and recommendations relating to all areas covered in the monitoring schedule and address any other problems or deficiencies found during monitoring. If required, the report should also outline any changes that are required to planned works to ensure better ecological outcomes.

Regeneration of the BMP Lands will occur over a period of five (5) years or until the Year five (5) overall targets are achieved. Once the targets are met, the BMP lands will transition to a state of natural regeneration. Management of the site thereafter will adhere to the requirements of the *Biosecurity Act 2015* and *Biosecurity Regulations 2017*.

9.2.1 Future Management Actions

With all regeneration plans, objectives and targets are set based on good conditions, however, this may not always be the case. The following table has been prepared for an immediate and concise action plan is generated to ensure targets can be achieved.

Table 4 – Intervention: Handling Unexpected Outcomes

Element Change	Step 1	Step 2	Step 3	Step 4	Step 5
Fire	BRC to notify Project Ecologist and arrange a joint site inspection.	Assess impact to BMP Lands.	Prepare regeneration plan	Submission of notification and modified Plan to Council.	Implement approved Plan
Flood					
Drought					
Other weather event					
Pest Species damage					
Introduction of pathogen					
Vandalism					
Theft					

Table 5 – Proposed Works Schedule

Activity	Specific Action	Year 1				Year 2				Year 3				Year 4				Year 5			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
VMP Lands Preparation	Installation / removal of temporary fencing and signage	Installed at the beginning of Year 1 and removed once construction is finished																			
	Implementation of pathogen and disease controls	To be implemented throughout the duration of the VMP																			
	Installation / removal of sediment and erosion control	Installed at the beginning of Year 1 and monitored throughout the duration of the VMP																			
	Realignment of watercourse and construction of ponds and hibernacula																				
	Relocation of logs to BMP Lands																				
Weed control	Primary weeding all MZs (Monthly)																				
	Consolidation (Secondary and Tertiary) weeding (Monthly)																				
	Maintenance Weeding (to be adjusting according to findings from monitoring)																				
Revegetation	Buffer Planting along VMP Lands boundary (MZ4)																				
	Initial canopy planting (MZ4)																				
	Consolidation and replacement planting (All zones)																				
	Direct Seeding of groundcovers (if required). (MZ1,2,4,5 and 6)																				
	Shrub (MZ2,3,4,6) and grasses, macrophytes (MZ1,5) planting																				
	Replacement of dead plants if required																				
Project Management	Set up Monitoring Plots and collect baseline data																				
	Survey for Gambusia within Ponds (dip netting)																				
	Vegetation Cover, Dispersion Area and Hibernacula monitoring (Spring and autumn)																				
	Reporting (to be submitted to MCC within a month of second bi-annual monitoring event)																				**Final**

10.0 References

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Figure 1 - Site Map

Date: July 2024

Location: 898 New England Hwy, 25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd
C/- ADW Johnson Pty Ltd

AEP ref: 2699.04
BOAMS: 00048759

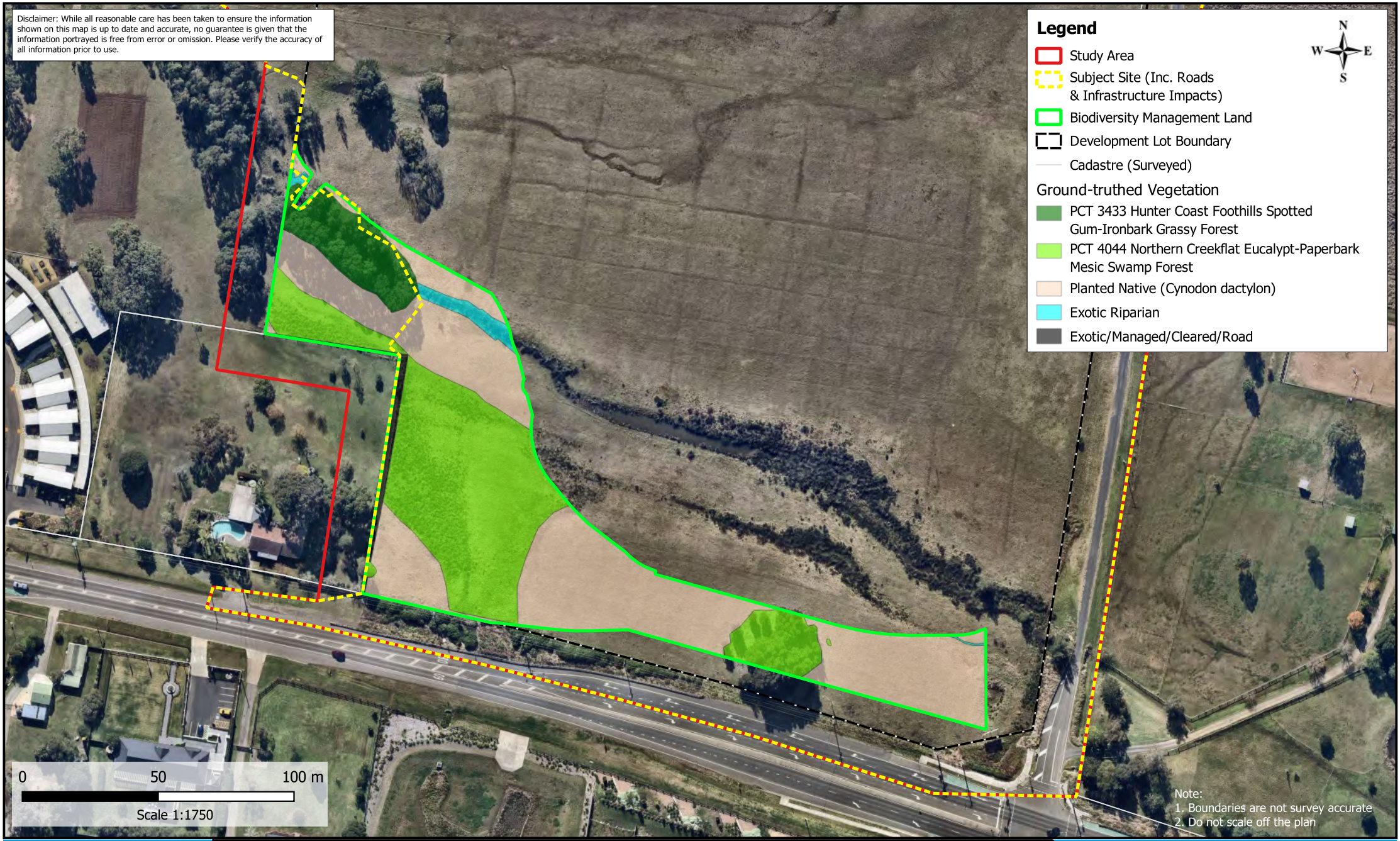

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Figure 2 - Ground-truthed Vegetation — Date: July 2024

Location: 898 New England Hwy, 25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd — AEP ref: 2699.04
C/- ADW Johnson Pty Ltd — BOAMS: 00048759

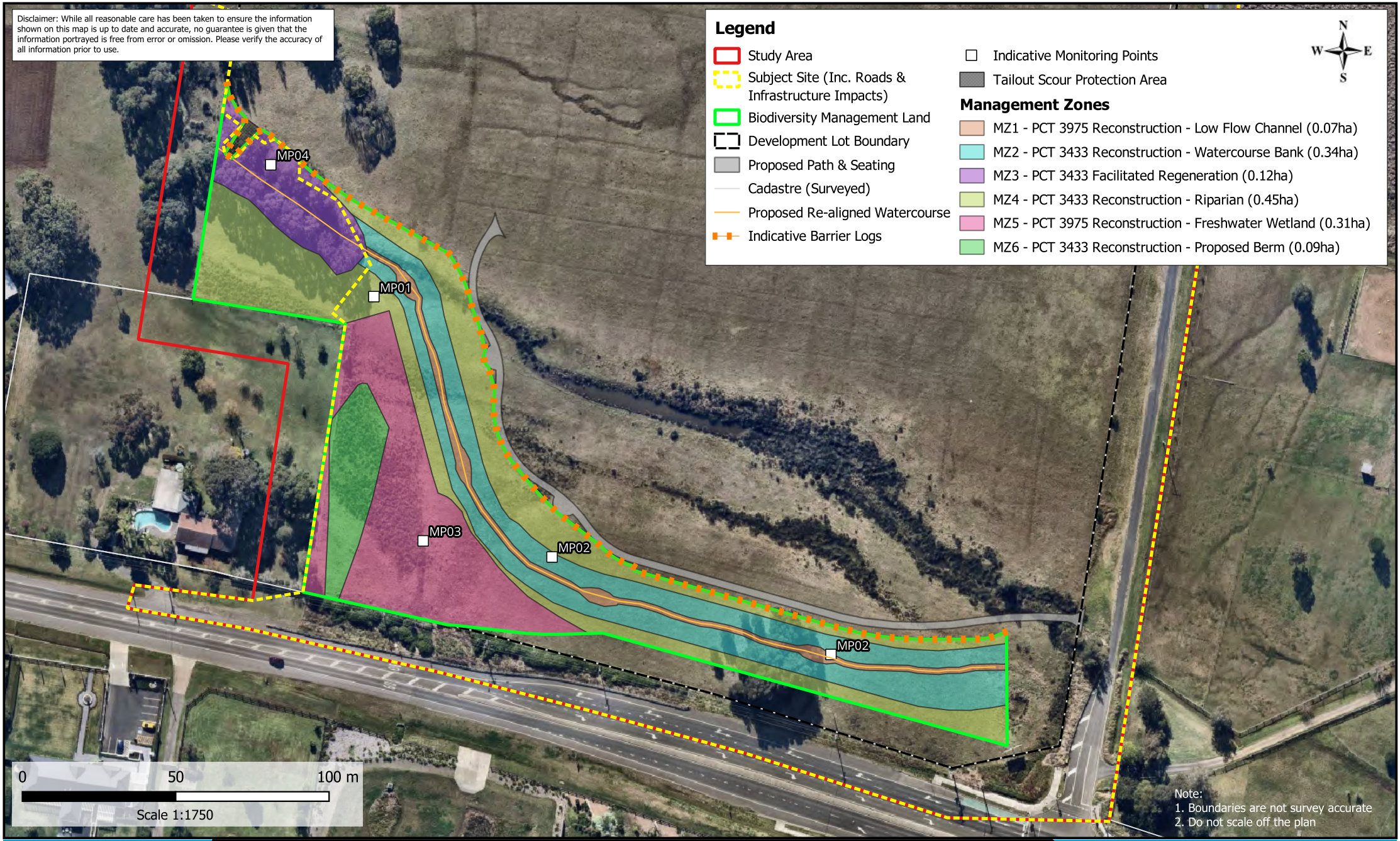

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Figure 3 - Management Zones & Monitoring Points Date: July 2024

Location: 898 New England Hwy, 25 & 39 Wyndella Rd, Lochinvar NSW

Client: Lochinvar Developments Pty Ltd AEP ref: 2699.04
C/- ADW Johnson Pty Ltd BOAMS: 00048759

Appendix A – Flora and Priority Weeds within BMP lands

Family Name	Scientific Name	Common Name	Priority weed under Biosecurity Act 2015 Hunter Regional Strategic Weeds Management Plan
Aizoaceae	***Galenia pubescens****	**Galenia**	**Regional Priority - Containment**
Apiaceae	*Foeniculum vulgare**	Fennel	General Biosecurity Duty
Apiaceae	*Centella asiatica*	Swamp Pennywort	
Apiaceae	*Cyclospermum leptophyllum**	Slender Celery	General Biosecurity Duty
Apocynaceae	*Parsonsia straminea*	Common Silkpod	
Apocynaceae	*Araujia sericifera**	Mothvine	General Biosecurity Duty
Apocynaceae	*Gomphocarpus fruiticosus**	Narrow Leaf Cotton Bush	General Biosecurity Duty
Asteraceae	*Bidens pilosa**	Cobbler's Pegs	General Biosecurity Duty
Asteraceae	*Conyza bonariensis**	Flax-leaf Fleabane	General Biosecurity Duty
Asteraceae	*Oncosiphon piluliferum**		General Biosecurity Duty
Asteraceae	*Onopordum acanthium subsp. Acanthium**	Scotch Thistle	General Biosecurity Duty
Asteraceae	*Silybum marianum**	Variegated Thistle	General Biosecurity Duty
Asteraceae	*Hypochaeris radicata**	Flatweed	General Biosecurity Duty
Asteraceae	*Senecio madagascariensis**	Fireweed	General Biosecurity Duty
Casuarinaceae	*Casuarina glauca*	Swamp Oak	
Convolvulaceae	*Dichondra repens*	Kidney Weed	
Cyperaceae	*Baumea juncea*		
Cyperaceae	*Cyperus sesquiflorus**		General Biosecurity Duty
Cyperaceae	*Cyperus spp.*		
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-rush	
Cyperaceae	*Carex appressa*	Tall Sedge	
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge	General Biosecurity Duty
Fabaceae	*Trifolium repens**	White Clover	General Biosecurity Duty
Gentianaceae	*Centaurium erythraea**	Common Centaury	General Biosecurity Duty
Juncaceae	***Juncus acutus****		**Regional Priority - Asset Protection**
Juncaceae	*Juncus cognatus**		General Biosecurity Duty
Juncaceae	*Juncus usitatus*	Common Rush	
Lobeliaceae	*Lobelia purpurascens*	Whiteroot	
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne	General Biosecurity Duty
Myrtaceae	*Eucalyptus punctata*	Grey Gum	
Myrtaceae	*Eucalyptus spp.*		
Myrtaceae	*Corymbia maculata*	Spotted Gum	

Family Name	Scientific Name	Common Name	Priority weed under Biosecurity Act 2015 Hunter Regional Strategic Weeds Management Plan
Myrtaceae	*Eucalyptus microcorys*	Tallowwood	
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany	
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	
Myrtaceae	*Melaleuca bracteata*	Black Tea-tree	
Myrtaceae	*Melaleuca ericifolia*	Swamp Paperbark	
Oleaceae	***Olea europaea subsp. cuspidata****	**African Olive**	**Regional Priority - Containment**
Onagraceae	*Ludwigia peploides subsp. montevidensis*	Water Primrose	
Phormiaceae	*Dianella caerulea*	Blue Flax-lily	
Pittosporaceae	*Pittosporum revolutum*	Yellow Pittosporum	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	
Plantaginaceae	*Plantago lanceolata**	Ribwort	
Poaceae	*Cynodon spp.**		General Biosecurity Duty
Poaceae	*Setaria pumila**	Pale Pigeon Grass	General Biosecurity Duty
Poaceae	*Paspalum dilatatum**	Paspalum	General Biosecurity Duty
Poaceae	*Stenotaphrum secundatum**	Buffalo Grass	General Biosecurity Duty
Poaceae	*Andropogon virginicus**	Whisky Grass	General Biosecurity Duty
Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass	
Poaceae	*Bothriochloa macra*	Red Grass	
Poaceae	*Briza maxima**	Quaking Grass	
Poaceae	*Briza minor**	Shivery Grass	
Poaceae	*Briza subaristata**		
Poaceae	*Chloris gayana**	Rhodes Grass	
Poaceae	*Eragrostis brownii*	Brown’s Lovegrass	
Poaceae	*Rytidosperma pallidum*	Silvertop Wallaby Grass	
Poaceae	*Megathyrsus maximus**	Guinea Grass	General Biosecurity Duty
Poaceae	*Bromus spp.**	A Brome	General Biosecurity Duty
Poaceae	*Poa spp.**		General Biosecurity Duty
Poaceae	*Ehrharta erecta**	Panic Veldtgrass	General Biosecurity Duty
Poaceae	*Sporobolus elongatus*	Slender Rat’s Tail Grass	
Poaceae	*Lachnagrostis aemula*	Blown Grass	
Poaceae	*Themeda triandra*	Kangaroo Grass	
Poaceae	*Lolium rigidum**	Wimmera Ryegrass	General Biosecurity Duty

Family Name	Scientific Name	Common Name	Priority weed under Biosecurity Act 2015 Hunter Regional Strategic Weeds Management Plan
Polygonaceae	*Rumex brownii*	Swamp Dock	
Polygonaceae	*Persicaria spp.**	Knotweed	General Biosecurity Duty
Primulaceae	*Lysimachia arvensis var. caerulea**	Blue Pimpernel	General Biosecurity Duty
Proteaceae	*Hakea bakeriana*		
Pteridaceae	*Cheilanthes sieberi*	Rock Fern	
Ranunculaceae	*Ranunculus inundatus*	River Buttercup	
Restionaceae	*Empodisma minus*	Spreading Rope-rush	
Solanaceae	*Solanum nigrum**	Black Nightshade, Black-berry Nightshade	General Biosecurity Duty
Solanaceae	*Solanum seaforthianum**	Climbing Nightshade	General Biosecurity Duty
Verbenaceae	*Verbena bonariensis**	Purpletop	General Biosecurity Duty

Appendix B – Regeneration Species List

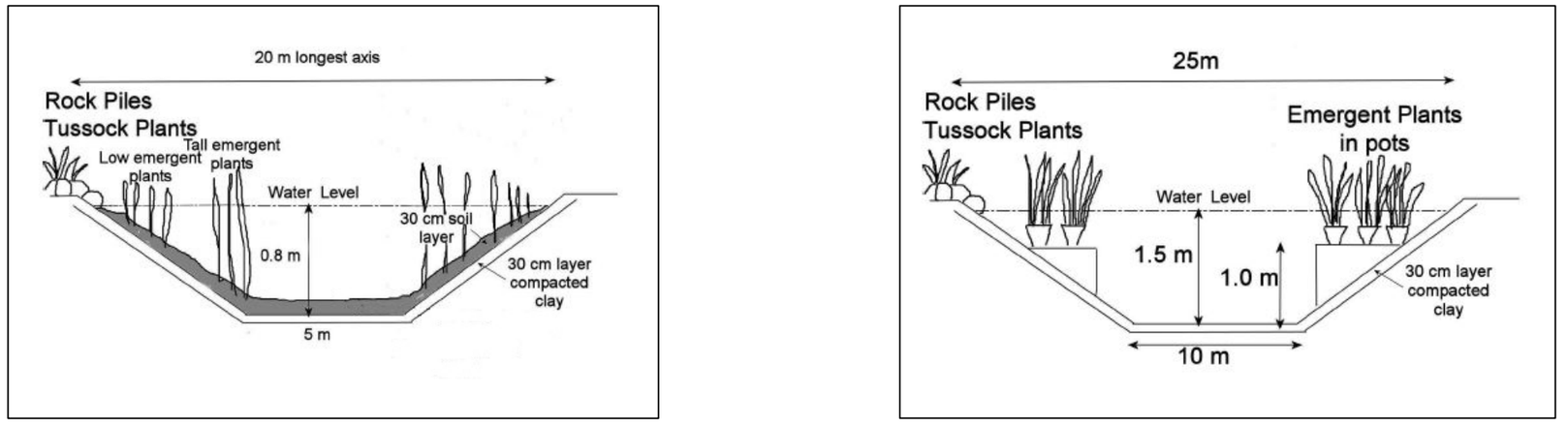
Species List – Approximate densities and species for regeneration.

It should be noted that not all the listed species below are easily obtainable, substitutions to be made on the advice of bush regeneration contractor or Project Ecologist.

Canopy	Density	Shrubs	Density	Ground Cover	Density
Management Zone 1 and 5 – PCT 3975					
Not Applicable in this Management Zone	N/A	Not Applicable in this Management Zone	N/A	*Paspalum distichum*	6 to 8 /1m^2
				Typha orientalis	
				Eleocharis sphacelata	
				Juncus polyanthemus	
				Bolboschoenus caldwellii	
				Juncus usitatus	
				Carex appressa	
				Phragmites australis	
				Eleocharis acuta	
				Juncus gregiflorus	
				Persicaria decipiens	
				Cycnogeton microtuberosum	
				Ludwigia peploides subsp. Montevidensis	
				Alisma plantago-aquatica	
				Cycnogeton procerum	
Management Zone 2, 3, 4 and 6 - PCT 3433					
Eucalyptus punctata	1/20 m^2	*Bursaria spinosa*	1/10m^2	*Paspalidium distans*	5/m^2 or Direct Seeding
Eucalyptus umbra		*Persoonia linearis*		*Aristida vagans*	
Eucalyptus globoidea		*Leptospermum polygalifolium*		*Microlaena stipoides*	
Corymbia maculata		*Melaleuca nodosa*		*Themeda triandra*	
Eucalyptus fibrosa		*Acacia ulicifolia*		*Cymbopogon refractus*	
		Leucopogon juniperinus		*Lomandra confertifolia*	
		Breynia oblongifolia		*Entolasia stricta*	
		Dillwynia retorta		*Lepidosperma laterale*	
		Callistemon linearis		*Dichelachne micrantha*	
		Melaleuca styphelioides		*Echinopogon caespitosus*	
		Polyscias sambucifolia		*Fimbristylis dichotoma*	
		Pultenaea villosa		*Juncus usitatus*	
		Melaleuca decora		*Lomandra longifolia*	
				Panicum simile	
				Commelina cyanea	

Canopy	Density	Shrubs	Density	Ground Cover	Density
				Dianella revoluta	
				Pomax umbellata	
				Dianella caerulea	
				Poa labillardierei var. labillardierei	
				Entolasia marginata	

Appendix C – Aquatic Habitat and Hibernacula Examples



Example Pond designs - Breeding ponds to the left, Refuge ponds on the right (Ecological, Arncliffe Habitat Creation Plan).

Example Pond designs - Breeding ponds to the left, Refuge ponds on the right (Ecological, Arncliffe Habitat Creation Plan).

Example of a hibernacula made from bricks and wood and grass material (AggNet – Brickworth, UK)

Appendix D – BMP Lands Signage

NO UNAUTHORISED ENTRY

This is a Vegetation Rehabilitation Area

- **NO DUMPING or WASTE DISPOSAL**
- **NO ANIMALS, VEHICLES or MACHINERY**

For information – contact Site Manager

AEP VMP SIGNAGE permanent sign, minimum size 600mm x 400mm erected and maintained at key access points to VMP lands for the life of the project

Appendix E – CVs

Staff	Title/Qualification	Tasks
Natalie Black	Senior Environmental Manager BSc (Hons), Master Planning, Cert IV (TA) BAAS: 19076	Report review
Emma O'Dwyer	Ecologist BEnvSc. Hons EnvSc	Field surveys and report
Bryce Dedal	Ecologist BEnvSc. Cert IV CLM	Report
Alissa Rogers	Ecologist BParkMgt. Cert IV CLM	Report and mapping
Angela Metcalfe	Ecologist / Spatial Analyst BEnvSc. Hons (Earth Science) GradCert GeospSc (completion in 2025)	Report and mapping amendments following client feedback and changes in development plans

Appendix E – Site Photos

Above and Below: Gambusia

Above: Instream impacts of cattle.

Below: Instream Casuarina. Vegetation to be retained.

Appendix F – Glossary of Terms

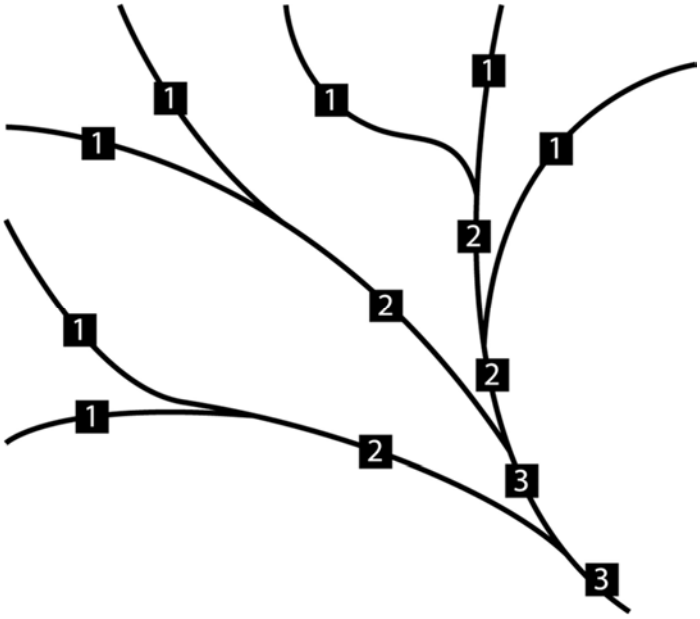
Activity Approval	A controlled activity approval or an aquifer interference approval.
Alien species	a species originating in a foreign country, not native to NSW waters, but is now living in the wild in Australia. The species may have been introduced deliberately or accidentally to Australia.
Alluvial	Deposited by running water.
Alluvium	A general term for detrital deposits made by stream processes on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during times of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.
Anabranch	A diverging branch of a river that re-enters the main stream.
Aquaculture	cultivating fish or marine vegetation for the purposes of harvesting for sale or other commercial purpose (e.g. 'fish out') but does not include a pet shop or aquarium.
Aquatic reserves	an area declared by the Minister for Primary Industries as an aquatic reserve, via notice in the Gazette, to conserve the biodiversity of fish and marine vegetation or to facilitate educational activities and scientific research. The declaration must be consistent with the requirements outlined in the *Fisheries Management Act 1994* and associated regulations.
Aquatic Vegetation	A plant characteristically growing wholly or partly submerged in water.
Aquifer	A geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water.
Aquifer Interference Activity	means an activity involving any of the following— (a) the penetration of an aquifer, (b) the interference with water in an aquifer, (c) the obstruction of the flow of water in an aquifer, (d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, (e) the disposal of water taken from an aquifer as referred to in paragraph (d).
Bank	The side slopes of a channel between which the streamflow is normally confined.
Bar	Deposited sediment accumulation from altered in-stream flow due to variation in channel geomorphology.
Bed	The bottom of a channel.
Channel	An area that contains continuously or periodically flowing water that is confined by banks and a streambed.
Coastal Lake	A large open body of saline or brackish water which has a relatively narrow permanent or intermittent connection to the sea.
Construct a Work	includes install, maintain, repair, alter or extend the work.
Controlled Activity	As defined in the Dictionary of the *Water Management Act, 2000:* (a) the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or (b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or (c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or

	(d) the carrying out of any other activity that affects the quantity or flow of water in a water source.
Deposition	The laying down of sediment carried by wind, flowing water, the sea or ice.
Diadromous	fish migrating from fresh to salt water or vice versa in order to spawn.
Drainage Work	means a work (such as a pump, pipe or channel) for the purpose of draining water from land, including a reticulated system of such works, and includes all associated pipes, sluices, sluicegates, valves, metering equipment and other equipment, but does not include— (a) any sewage work (within the meaning of Part 2 of Chapter 6), or (b) any work declared by the regulations not to be a drainage work.
Dredging	includes: (a) any work that involves excavating water land, or (b) any work that involves the removal of material from water land that is prescribed by the FM Regulations as being dredging work.
Endemic species	a native species occurring only within one locality, such as a river system, defined zoogeographic region, state or territory.
Environment	includes all aspects of the surroundings of human beings, whether affecting them as individuals or in their social groupings.
Erosion	Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.
Estuary	As defined in the Dictionary of the Water Management Act, 2000 (a) any part of a river whose level is periodically or intermittently affected by coastal tides, or (b) any lake or other partially enclosed body of water that is periodically or intermittently open to the sea, or (c) anything declared by the regulations to be an estuary, but does not include anything declared by the regulations not to be an estuary.
Exotic species	species introduced from other countries or states, which is not native to NSW.
Extinction	a species is presumed extinct, in the opinion of the NSW Fisheries Scientific Committee, if it has not been recorded in its known or expected habitat in NSW, despite targeted surveys over a time frame appropriate to its life cycle and form.
Fish	(in respect to the FM Act) includes fin-fish and other aquatic animal life at any stage of their life history (whether alive or dead) including oysters and other aquatic molluscs, crustaceans, echinoderms, beachworms and other invertebrates that spend all or part of their life cycle in aquatic habitats. This definition does not include amphibians, reptiles, birds and mammals – these aquatic animals are protected under separate legislation administered by OEH.
Fisheries Scientific Committee	an independent Committee responsible for determining whether any species, populations or ecological communities or threatening processes should be listed on schedules 4, 4A, 5 and 6 of the FM Act.
Flood Channel	Low sinuosity subsidiary channel. Entrance height approximates bankfull stage. Commonly observed at valley margins. Floodchannel depth tends to increase down-pocket with the basal section of the floodchannel elevated above the low flow channel
Flood Work	A work (such as a barrage, causeway, cutting or embankment)— (a) that is situated—

	(i) in or in the vicinity of a river, estuary or lake, or (ii) within a floodplain, and (b) that is of such a size or configuration that, regardless of the purpose for which it is constructed or used, it is likely to have an effect on— (i) the flow of water to or from a river, estuary or lake, or (ii) the distribution or flow of floodwater in times of flood, and includes all associated pipes, valves, metering equipment and other equipment, but does not include any work declared by the regulations not to be a flood work.
Floodplain	an area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.
Floodplain Pocket	Narrow, discrete floodplain typically on the bank of valley confined channel.
Floodplain Vegetation	Vegetation that is seasonally or irregularly flooded by changes in river level, hence can tolerate inundation for periods of time. It is noted that the tolerance to inundation reduces with the distance from the waterfront land
Flora Stratum	Vertical layering of vegetation in the riparian zone and the classification of its layers and height of growth including trees, heath/shrubs or a ground layer consisting of grasses or sedges.
Gravel Bed	An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these.
Groundwater	Water contained under the ground's surface, located in the spaces between soil particles and in the cracks of sand, gravel, and rock; a natural resource and source of water for drinking, irrigation, recreation, and industry.
Gully	is not a 'stream channel' (or watercourse); is a persistent erosional feature, with active head or walls on average > 0.5 m deep, and has multiple modes of expansion, but always including headward retreat into an otherwise un-dissected landscape; erodes unconsolidated materials and saprolite, but not bedrock; must have an active head scarp or head wall at the upslope limit of the gully (which may or may not be a clear nick point): sometimes a series of head scarps may occur; a 'scalded' or desiccated area (i.e. an area stripped of its topsoil with degraded vegetative cover) may often fringe the upslope area of the head scarp and head walls; has an erosional gully wall scarp, or clear erosional cut. some exceptions, such as the expanding, shrink-swell, cracking clays (i.e. Vertosols† and friable Black Dermosols, or 'blacksoil', and 'reactive clays') that may have convex walls and a head 'ramp' need considering for evidence of other active erosion present in these cases, e.g. piping, tunnels or slumping; has the head (head scarp, head wall), or heads, marking the upstream boundary of concentrated water flow and sediment transport between definable banks; has a cross-sectional shape (U-shaped, V-shaped, trapezoidal, slot, or tiered‡) that is permanently recognizable without flow; has a straight bed long-profile, rather than a curved one (of stream channels); has a dominant proportion of a 'hard margin' (a comparatively sharp break of slope from the unbroken land surface to the incisional feature, that represents a gully head scarp and wall scarp of active erosion, commonly referred to as a rim, edge or scarp), active or otherwise, or equivalent; has active erosional walls of at least moderately steep gradient (~ 30o; ~ 60 %), and gully walls are dominantly bare soil materials;

	are autonomous – having the active sediment source predominantly within the gully (a clear autocthonous, or 'internal', erosional zone); may have land upslope of the head, or beyond, that may be a drainage depression (swale), or marshland in keeping with the incisional caveats above; k. is typically driven by proximal ephemeral flows (i.e. associated with rainfall directly in the gully and in the gully catchment).
Habitat	(in respect to the FM Act) any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component.
Harm	(in respect of Part 7 of the FM Act): in relation to marine vegetation, means gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it. Policy and guidelines for fish habitat conservation and management (2013 update). Harm in relation to threatened species (Part 7A of the FM Act) means: a) in the case of fish—take, injure or otherwise harm the fish, or b) in the case of marine vegetation—gather, cut, pull up, destroy, poison, dig up, remove, injure or otherwise harm the marine vegetation, or any part of it, but in any such case does not include harm by changing the habitat of the fish or marine vegetation.
Headwater	Source of a river of stream.
High Bank	The upper most extent of the bank.
Inside Bend	Inside bank of a meander subject to deposition from slow flow.
Instream Habitat	Any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component.
Key threatening process	(in respect of Part 7A of the FM Act) is one which adversely affects threatened species, populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened.
Lake	(a) a wetland, a lagoon, a saltmarsh and any collection of still water, whether perennial or intermittent and whether natural or artificial, and (b) any water declared by the regulations to be a lake, whether or not it also forms part of a river or estuary, but does not include any water declared by the regulations not to be a lake.
Land	includes any water source, and also includes the land on or in which any water source is situated.
Levee	Raised elongate asymmetrical ridge that borders the channel. Composed almost entirely of suspended load sediments (dominantly silt, often sandy).
Marine park	an area declared by the NSW Governor, by proclamation, to be a marine park in accordance with the requirements of the Marine Parks Act 1997 and associated regulations. The area can include any area of waters of the sea or subject to tidal influence, or any area of water, or land, adjacent to such waters, or any area of land within such waters, or any area of land from time to time covered by such waters. The area declared aims to conserve marine biological diversity and marine habitats by maintaining ecological processes in the marine park, provide for ecologically sustainable use of fish (including commercial and recreational fishing) and marine vegetation in the marine park, and provide opportunities for public appreciation, understanding and enjoyment of the marine park.
Marine protected areas	includes marine parks, aquatic reserves and marine components of national parks and nature reserves.

Marine vegetation	(in the case of the FM Act) means any species of plant that at any time in its life must inhabit water (other than fresh water). This includes saltmarsh, mangroves, seagrass and marine macroalgae (seaweeds).
Meander	The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.
Outside Bend	Outside bank of a meander subject to erosion from high flow.
Overland Flow	4A Meaning of "overland flow water" (1) In this Act, overland flow water means water (including floodwater, rainfall run-off and urban stormwater) that is flowing over or lying on the ground as a result of— (a) rain or any other kinds of precipitation, or (b) rising to the surface from underground, or (c) any other process or action of a kind prescribed by the regulations. (2) Water is flowing over the ground for the purposes of subsection (1) even if it flows over the ground by means of artificial structures such as roads, canals or road gutters. (3) However, subsection (1) does not include— (a) water that is collected from a roof (including water collected from a roof using a rainwater tank), or (b) water that is flowing over or lying on the bed of a river, lake or estuary, or (c) water flowing over or lying on the ground in such circumstances as may be prescribed by the regulations.
Oxbow	An abandoned meander in a river or stream, caused by cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.
Pools	A reach of a stream that is characterized by deep, low-velocity water and a smooth surface.
Protected species	are species of fish that are protected under **s19** of the FM Act whereby it is illegal to take or have in your possession a protected fish without a permit from NSW DPI. There are also specific fish species identified as 'protected from commercial fishing' under **s20** of the FM Act. Protected fish species are listed under **clause 5** of the FM Regulations.
Reclamation	any work that involves the placement of any material (sand, soil, gravel, rocks, etc.) to fill in water land or the draining of water from water land for the purpose of its reclamation.
Recruitment	the breeding success of native fish and resultant juveniles reaching sexual maturity.
Riffles	Topographic highs along an undulating reach-scale longitudinal profile.
Rip Rap	Run of quarry rock placed over a bedding layer of cobbles used to stabilise and rehabilitate disturbed areas including topsoil, revegetation and regeneration. Must be able to withstand the velocities of runoff or discharge from site.
Riparian Corridor	A riparian corridor (RC) forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse (aquatic environment). Riparian corridors perform a range of important environmental functions
Riparian Vegetation	The plants growing on the water's edge, the banks of rivers and creeks and along the edges of wetlands
River	As defined in the Dictionary of the *Water Management Act, 2000:*

	(a) any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and (b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows, and (c) anything declared by the regulations to be a river, whether or not it also forms part of a lake or estuary, but does not include anything declared by the regulations not to be a river.
Snag	Term used to describe large woody debris from trees and shrubs, including whole fallen trees, broken branches and exposed roots that have fallen or washed into a waterway and are now wholly or partially submerged by water.
The Strahler System	As defined in *Schedule 2* - Water Management (General) Regulation 2018: The method of determining the stream order of a watercourse shown on a topographic map is the Strahler system. The Strahler system is as follows— (a) Any watercourse that has no other watercourses flowing into it is classed as a first order stream. (b) If 2 streams join, the resulting stream is— (i) the same order as the highest order of the 2 streams, or (ii) if the 2 streams are of the same order, the order greater than that of the 2 streams. For example, in the diagram below— (a) If 2 first order streams join, the stream becomes a second order stream (2). (b) If a second order stream is joined by a first order stream, it remains a second order stream. (c) If 2 second order streams join they form a third order stream (3). (d) If a third order stream is joined by a first or second order stream, it remains a third order stream. (e) If 2 third order streams join they form a fourth order stream. 
Vegetated Riparian Zone	The required width of the VRZ measured from the top of the high bank on each side of the watercourse.

Vegetation Management Plan	Details how the restoration or rehabilitation of the riparian corridor will be carried out. The main objective of a VMP is to provide a stable watercourse and riparian corridor which will emulate local native vegetation communities.
Water Land	(with respect to the FM Act) means land that is intermittently or permanently submerged by water (either naturally or artificially) and includes wetlands.
Water Source	means the whole or any part of— (a) one or more rivers, lakes or estuaries, or (b) one or more places where water occurs on or below the surface of the ground (including overland flow water flowing over or lying there for the time being), and includes the coastal waters of the State.
Waterfront Land	Land within 40m of a river, stream, creek, wetlands, estuary. As defined in the Dictionary of the *Water Management Act 2000*: (a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or (a1) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or (a2) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or (b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters, where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that falls into 2 or more of the categories referred to in paragraphs (a), (a1) and (a2) may be waterfront land by virtue of any of the paragraphs relevant to that land.
Waterfront Land Maps	CAA exemptions can only apply within certain waterfront land shown in maps that include shaded areas such as: Botany Bay and Georges River area, Brisbane Water area, Hunter River area, Lake Macquarie area, Lake Mulwala area, Port Hacking area, Port Jackson (Sydney Harbour) area, Port Stephens area, Tuggerah Lakes area, and, Wallis Lakes area These can be found within the WFLT.
WaterNSW	WaterNSW is a State-Owned Corporation established under the *Water NSW Act 2014* and operates under an Operating Licence.
Western Land Map	NRAR Map – Western land map within the WFLT that includes shaded local government areas in inland NSW areas.
Wetlands	Includes marshes, mangroves, swamps, or other areas that form a shallow body of water when inundated intermittently or permanently with fresh, brackish or salt water, and where the inundation determines the type and productivity of the soils and the plant and animal communities.

Woody Debris	Consists of large masses of trees or shrubs that have fallen or been washed into rivers and streams, and onto floodplains. Once instream, they become waterlogged and rest in the streambed providing both habitat and refuges for aquatic fauna
Wrack	seaweed or seagrass floating or cast-up on a beach or foreshore.

Appendix G – CVs

BRENDON YOUNG

Project Manager

Profile Summary

Brendon works with AEP in the role of Project Manager and Ecologist/Aquatic Ecologist. He graduated with a Bachelor of Applied Science (Fisheries w/Honours), a Masters in Environmental Management and Graduate Certificate in Fish Conservation and Management. Brendon has previously worked in large retail operations in staff and budget/data management, reporting and quality assurance which adds to the experience that he currently contributes to the AEP team.

Academic Qualifications

Charles Sturt University

- Master of Environmental Management (Water Resources) 2022
- Graduate Certificate of Fish Conservation and Management

University of Tasmania

- Bachelor of Applied Science (Fisheries) with Honours

Training, Licences and Professional Memberships

- NSW Class C Driver's Licence
- WHS NSW Construction Induction White Card
- First Aid (Provide First Aid HLTAID011)

Professional Experience

Project Manager/Aquatic Ecologist Anderson Environment & Planning Newcastle NSW	Jan 2024 – Present
Project Lead/Ecologist Anderson Environment & Planning Newcastle NSW	Oct 2023 – Jan 2024
Ecologist Anderson Environment & Planning Newcastle NSW	Sept 2022 – Oct 2023
Department Manager Woolworths Pty Ltd	2013 - 2022
Produce Quality Control Officer Woolworths Pty Ltd	Mar 2019 - Oct 2019

Relevant Project Experience

Ecological Surveys

- Watercourse Assessment with the NRAR Waterfront Land Tool in Huner Valley, Central Coast, Midcoast and Dubbo regions.
- Key Fish Habitat surveys at Karuah River Port Stephens, Hunter River Lochinvar and Chisholm, Manning River Tibbuc and Lachlan River Stubbo.
- Dip netting for *Mogurnda adspersa* in Lochinvar, Tibbuc, Chisholm and Stubbo.

- Seagrass and Mangrove surveys in Port Stephens.
- Targeted, systematic transects for threatened flora species.
- Deployment of Camera Traps, Songmeter and Anabats across central Coast and Hunter Valley regions for targeted survey.
- Spot Assessment Technique surveys: Halloran, Windella, Ourimbah, Chisholm.
- Weed mapping: Taree, Ourimbah, Hunter Valley.

University

- Training with aquatic sampling techniques such as seine nets, gill nets and fyke nets.
- Training in the use of mist netting, bat harp traps, Elliot traps, pitfall traps and camera traps.
- Identification of fish, reptiles, insects, and plants to species level through honours research and other projects while studying.

Ecological Assessment

- Riparian and watercourse assessment with the Waterfront Land Tool in the Hunter Valley, Central Coast, Sydney and Hastings regions.
- Preparation of Vegetation Management Plans in the Hunter Valley, Central Coast and Midcoast regions.
- Bushfire Threat Assessment in accordance with PBP 2019 at various sites across the Hunter Valley and Central Coast regions.
- Assist with Arborists assessments in Central Coast, Sydney, Mudgee and Hunter Valley Regions.

Ecological Monitoring

- Primary contributing author for Garden Suburbs Biodiversity Stewardship Site Assessment Report and associated Management Plan.

Publications

- Courtney, A.J., Schemel B.L., Wallace, R., Campbell, M.J., Mayer, D.G. and Young, B. (2005) *Reducing the impact of Queensland's trawl fisheries on protected sea snakes*. FRDC Project No. 2005/053. Queensland Government.

NATALIE BLACK

Senior Ecologist

Profile Summary

Natalie works with AEP in the role of Senior Environmental Manager. She has extensive knowledge in environmental management, environmental planning, fisheries, aquatic and riparian environments, and report writing and assessment. With a detail understanding of planning, catchment management, coastal management and rehabilitation. Natalie has had a successful career with both state and local government in conservation, planning and field investigation roles. Natalie has also gained extensive communication skills and project management through her previous career in lecturing in a range of course with a focus on environmental management and environmental legislation. Her background and experience in the ecological and planning fields is utilised in a diverse array of application in her current role.

Natalie Black is a conservation detection dog handler and is currently working with his purpose breed working English Springer Spaniel “Gus” who is currently trained to detect Koala scat, Forest Owl pellets and Cane Toads.

Academic Qualifications

- B.Sc (Hons) Sustainable Resource Management and Marine Science – University of Newcastle, 2001
- Master Planning – University of Technology Sydney, 2007
- Certificate IV Training and Assessment – TAFE, 2012
- BAM Assessor; accreditation number: BAAS19076

Training, Licences and Professional Memberships

- NSW Class C Driver’s Licence
- Provide First Aid HLTAID011
- Evidence Gathering and Legal Process, Australian Institute of Environmental Health
- Conflict Resolution Course (LGSA)
- Report Writing Course (LGSA).
- Powerful Presentation (LGSA)
- NSW Rural Fire Services Bush Fire Assessment
- Relocation of Threatened Species, Botanical Gardens Sydney
- Sustainable Home Assessment Reduction Revolution
- Flora and Fauna Survey Assessments Niche Environment and Heritage

Professional Experience

Senior Environmental Manager / Works Coordinator 2019 – Present

Anderson Environment & Planning

Newcastle NSW

Principal Environmental Planner 2010 - 2019

Black Earth

Newcastle NSW

Senior Lecture 2010 - 2019

Hunter TAFE

Range of Hunter Campuses

Natural Resource Manager and Development Assessment Officer	2003 - 2010
Lismore City Council	
Lismore NSW	
Fish Passage Expert	2002 - 2003
NSW Department of Primary Industries	
Ballina NSW	
Conservation Officer	2000 - 2002
NSW Department of Primary Industries	
Crows Nest, NSW	
Volunteer NSW Fisheries	1998 - 2000
Varied Roles	
Port Stephens, NSW	

Relevant Project Experience

Ecological Survey examples

- Target surveys for *Thelymitra adorata* Halloran; Wyee, Wadalba;
- Target surveys for *Melaleuca biconvexa* Mardi, , Halloran; Wyee, Wadalba
- Target surveys for *Tetratheca juncea* Hillsborough, Mardi, Thornton, Warners Bay;
- Target surveys for *Rhodamnia rubescens* Hillsborough, Mardi, Thornton, Stuarts Point, South West Rocks,
- Target Survesy for Cumberpalin Snail and Dural Snail, Rouse Hill
- Target Search for seagrass and threatened marine fauna, Stuarts Point, South West Rocks, Lake Macquarie, Peat Island,
- Powerful Owl nest locating and monitoring: Salamander Bay
- Spot Analysis Techniques surveys: Lismore, Wallsend, Salamander Bay, North Arm Cove, Warnervale, Hamlyn Terrace, Wyee, Charlestown, Chisholm, Gillieston Heights, Mount Vincent, Hillsborough;
- Surveys for Squirrel Glider (*Petaurus norfolcensis*) Wadalba, Rouse Hill, Claremount Meadows, Wyee, Hillsobourgh, South West Rocks, Stuart Point;
- Frog Surveys: Lismore, Wallsend, Salamander Bay, North Arm Cove, Warnervale, Hamlyn Terrace, Wyee, Charlestown, Chisholm, Hillsborough Rouse Hill, Kariong, Wadalba,

Ecological Assessment examples

- Accredited Assessor for approved Biodiversity Development Assessment Reports:
  - Teraglin Village, Chain Valley Bay;
  - Railway Road, Warnervale;
  - McFarlane's Road, Chisholm;

- Fairlands Road, Medowie;
- Raymond Terrace Road Chishlm,
- Annangrove Road, Rouse Hill
- Richmond Road, Marsden Park,
- Claremount Meadows,
- Newcastle Golf Course, Fern Bay,
- Newell Highway, Gilgandra
- Narromine Road, Dubbo

- Ecological Assessment Report for Proposed Modification to Approved Western Rail Coal Unloader At Pipers Flat;
- Infrastructure Ecology Reports;
  - Wyee Water Main;
  - Mardi Water Main;
  - Wyee Rising Main;
  - Mardi Rising Main;
- Summerhill Waste Facility Recycling Plant

Ecological Offsets and Monitoring

- Biodiversity Stewardship Agreements including:
  - Hillsborough
  - Blueys Beach,
  - Allandale,
  - South-West Rocks.
- Biodiversity Management Plans / Vegetation Management Plan / Wildlife Management Strategies
  - VMP for Proposed Modification to Approved Western Rail Coal Unloader At Pipers Flat;
  - VMP / WMS / Dewatering Plan for Wyee for 23ha Offset lands
  - VMP Rouse Hill Commercial Development.
  - BMP – Claremount Meadows Commercial Development.

Planning – Approved Review of Environmental Factors

- South West Rocks Installation of Seawall,
- Lake Macquarie upgrade of carpark, boat ramp and jetty,
- Demolition of two (2) jetties Peat Island,
- Stuart Point upgrades to caravan park including boat ramp.
- Wyee Rising Main
- Anambah Recycling Facility

Bushfire Threat Assessments

- Kempsey Correctional Facility for upgrade
- Stuarts Point Caravan Park for upgrades
- Claremount Meadows for a Commercial development included Daycare, and service station
- Batlow for a Service Station
- Lovedale for a change of use to Brewery