Appendix F Riparian Corridor Management Plan

CTENVIRONMENTAL
ECOSYSTEM MANAGEMENT AND MONITORING

Mamre Road Precinct Rezoning: Waterway Assessment

Kemps Creek and Mount Vernon

South Creek Catchment

Prepared for: Sydney Water

April 2020

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Executive Summary

The purpose of this study was to determine the presence of mapped and potential unmapped waterways across the Mamre Road Precinct and to map the top of bank of waterways to determine appropriate Vegetated Riparian Zones (VRZ) as required by *NSW Water Management Act 2000.*

Field assessment involved a visual inspection of mapped waterways and inspection of gullies that have potential to be watercourses.

In the three weeks leading up to the field assessment, 438 mm of rain was recorded which resulted in easy identification of overland flow paths due to the amount of run-off generated.

Results of this assessment confirmed that all waterways assessed fit the definition of a river as defined by the *NSW Water Management Act 2000* and although some lacked bed and bank geomorphology, all had defined flow paths which formed broad and shallow drainage depressions, a typology which is typical of the Cumberland Plain.

An exception to this was the upper most section of Unnamed Trib South Creek 1 which was considered a topographical depression rather than a watercourse.

An unmapped 1st order watercourse was validated in the upper section of Unnamed Trib South Creek 1 and an unmapped wetland adjacent to Unnamed Trib Ropes Creek was validated by field assessment.

Watercourses assessed by this study had varied ecological value. Unnamed Trib Kemps Creek 1 and 2 had minimal ecological value due to a lack of native riparian vegetation and significant alteration of flow paths. Unnamed Trib South Creek 1 had some quality habitat patches in the form of wetland vegetation and remnant vegetation. The upper section of Unnamed Trib South Creek 2 had wetland and woodland habitats and Unnamed Trib Ropes Creek although highly modified had matrix of habitats which included wetlands and remnant woodland.

Recommendations from this assessment include;

1. Consider an alternative zoning for Unnamed Trib Kemps Creek 1 and 2.
2. Consider appropriately sized Vegetated Riparian Zones as per those required by the *NSW Water Management Act 2000*.
3. Consider an alternative zoning for Unnamed Trib Ropes Creek.
4. Consider extending the E2 Environmental Conservation on Ropes Creek to include the full extent of the 30 m Vegetated Riparian Zone.

Results of this study will inform the development of a Riparian Corridor Strategy for the Precinct.

Introduction

The Department of Planning, Industry and Environment (DPIE) have outlined amendments to the State Environmental Planning Policy (Western Sydney Employment Area) 2009 (WSEA SEPP) to rezone the Mamre Road Precinct (the Precinct) for primarily industrial purposes. DPIE has sought feedback on the proposed plan for the Mamre Road Precinct in the Western Sydney Employment Area (WSEA).

Sydney Water have been engaged to inform the water servicing, and flood management for the Precinct. In turn CTENVIRONMENTAL was engaged to undertake an assessment of waterways across the Precinct.

The Precinct is located approximately 40 km west of the Sydney CBD and 12 km southeast of the Penrith CBD. It is located entirely within the Penrith City Council Local Government Area (LGA). It is bordered by the Sydney Water Warragamba Pipeline to the North, South Creek and Kemps Creek to the West, Ropes Creek to the East and Mount Vernon to the South. The precinct has an approximate gross site area of 1002 Ha.

The focus of this assessment was four unnamed tributaries that flow to Ropes Creek (1), South Creek (2) and Kemps Creek (2) and a section of Ropes Creek (Figure 2).

Study Objectives

The purpose of this study was to determine the presence of mapped and potential unmapped waterways across the Precinct that are to be retained post rezoning and to map top of bank of waterways where present to enable determination of the appropriate Vegetated Riparian Zone (VRZ) for these waterways as required by *NSW Water Management Act 2000.*

Results of this study will inform the development of a Riparian Corridor Strategy for the precinct.

NSW Water Management Act 2000

The primary objective of the *Water Management Act 2000* (WM Act) is to manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs.

Since 2018, the Water Management Act has been administered by Natural Resources Access Regulator (NRAR) and establishes an approval framework for activities within waterfront land which is defined as land 40 m from the highest bank of a river, lake, wetland or estuary.

The definition of a ‘river’ as per the Water Management Act is as follows;

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.

In relation to point (c) of the definition of 'river' in the Dictionary to the Act, the following are declared to be a river as per the *Water Management (General) Regulation 2018* (WM Regulation):

a) any watercourse, whether perennial or intermittent, comprising an artificial channel that has changed the course of the watercourse,

b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows.

The *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR 2018) provides guidance to establish Vegetated Riparian Zones (VRZ) along watercourses which are based on the Strahler stream ordering system.

The VRZ is measured from the top of the creek bank and also includes the creek channel (Figure 1). The minimum required VRZ width for a first order stream is 10 m either side of the creek (measured from top of bank) plus the width of the creek channel. The maximum required VRZ is 40 m either side of the creek (measured from top of bank) plus the channel width and this is applied to 4th order and greater streams, wetlands, estuaries and tidal influenced waters (Table 1).

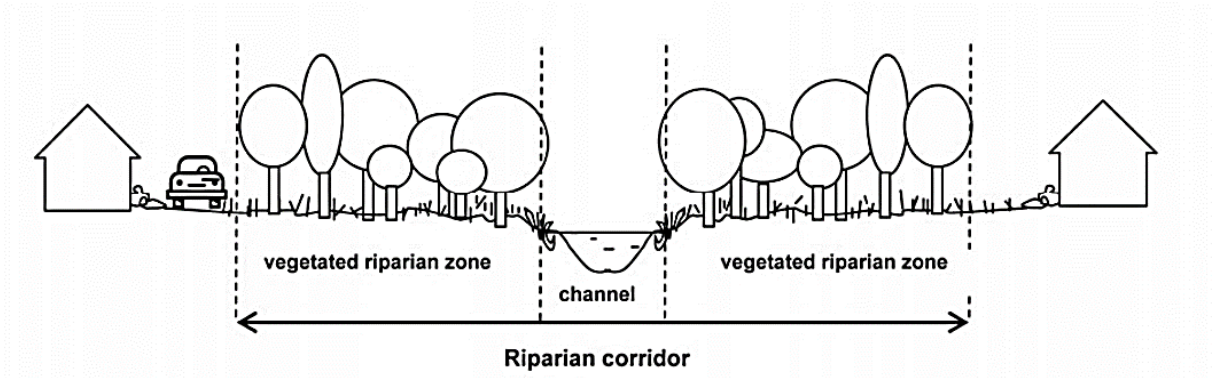

Figure 1: Vegetated Riparian Zone and watercourse channel comprising the riparian corridor (NRAR 2018).

Table 1: Required riparian corridor widths according to Strahler stream order (NRAR 2018).

Strahler steam order	**VRZ WIDTH (m)** **(each side of watercourse)**	**Total Riparian corridor width (m)**
1st order	10 m	20 m + channel width
2nd order	20 m	40 m + channel width
3rd order	30 m	60 m + channel width
4th order and greater, wetlands, estuaries and tidal influenced watercourse	40 m	80 m + channel width

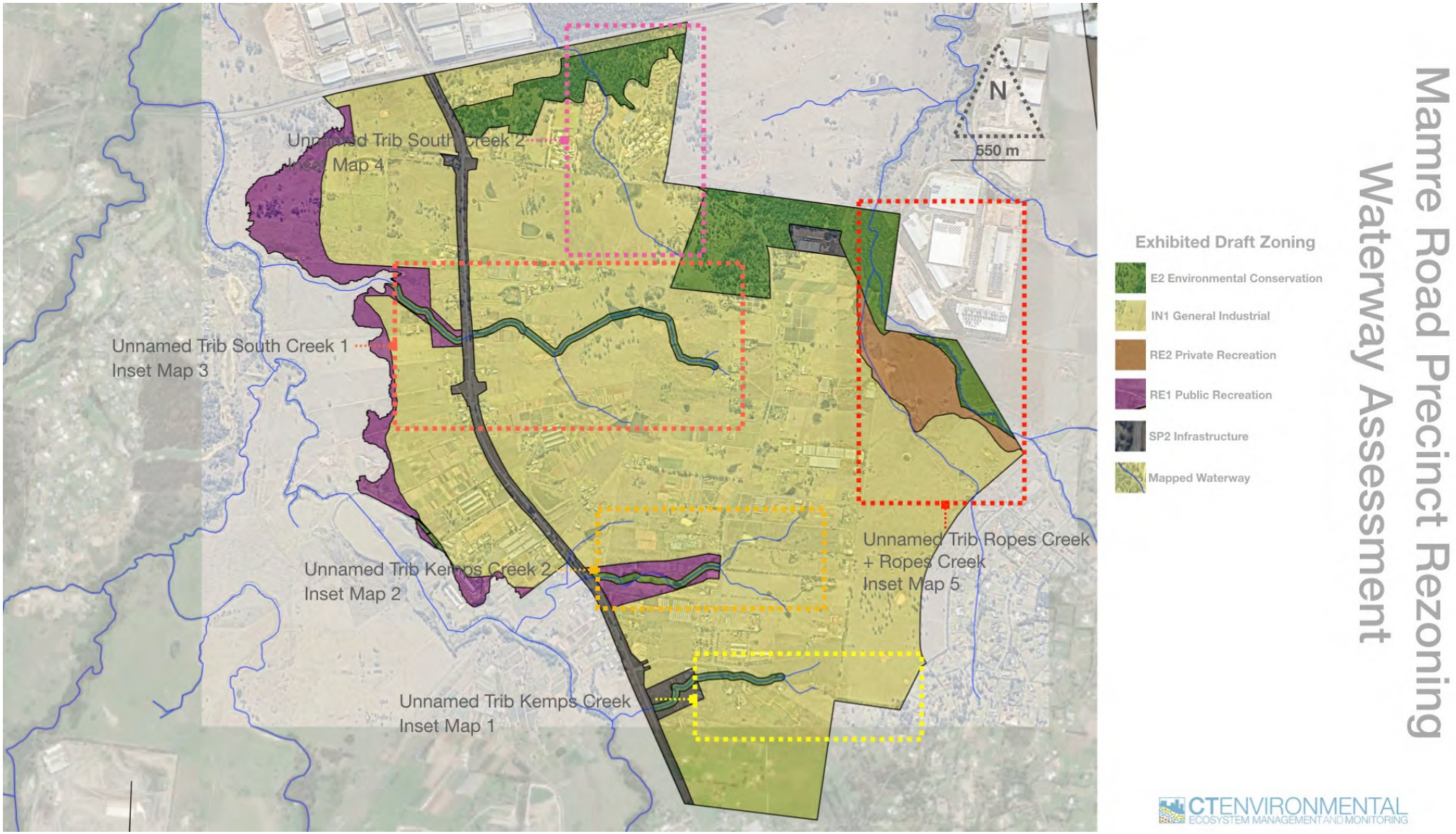

Figure 2: Waterways subject to assessment by this study are bordered by colour and labelled with the according inset map number.

Method

To undertake this study a combination of desktop review and field assessment was applied.

Desktop review

Prior to undertaking field assessment, a desktop review of spatial data, relevant policy and legislation and previous studies were reviewed. This included;

- NSW 1:25,000 topographic mapping of the Precinct area (SIX maps)
- Strahler stream order GIS data
- Proposed rezoning footprint of the Precinct
- NSW Water Management Act 2000 (WM Act)
- Guidelines for Controlled Activities on waterfront land—Riparian corridors (NRAR 2018)
- Aspect Industrial Estate State Significant Development Application - Riparian Assessment (Eco logical Australia 2019)
- 113 - 127 Aldington Road, Kemps Creek - Riparian Constraints Assessment (Eco Logical Australia 2019)

Field assessment

Field assessment of waterways across the Precinct was undertaken over a three-day period from February 25 -27, 2019. Assessment involved a visual inspection of mapped waterways across the site and inspection of gullies that have potential to be watercourses.

In the three weeks leading up to the field assessment 438 mm of rain was recorded at the Erskine Park reservoir weather station (BOM 2020). This rainfall resulted in easy identification of overland flow paths due to the amount of run-off generated.

To determine the presence of waterways within the Precinct, 1:25,000 topographic map for the area was loaded into the GIS field app iGIS and displayed on a field iPad. The CTENVIRONMENTAL undertook visual inspection of all mapped waterways across the Precinct by walking the length of each. Where access was not permitted visual inspection was undertaken using a MAVIC Pro 2 drone with 4k camera.

In the case where creek bed and bank were present, top of bank mapping was undertaken using a Trimble DGPS by walking along the route of the high point on the creek bank and recording the route on the GPS.

Results

Unnamed Trib Kemps Creek 1

Results of the inspection of Unnamed Trib Kemps Creek 1 validated the waterway is of 2nd order. Two first order watercourses were evident in the headwaters which run to the north and south of the house in the upper catchment (Figure 3). A clear flow path was evident below their confluence which validated the presence of a 2nd order watercourse. The flow path did not have defined bed and banks which is likely due to the buffering of flow velocity and erosion provided by three upstream farm dams (Figure 5).

However approximately 200 m below the confluence the waterway was heavily modified and formed into a drainage channel which was realigned to direct flows along a channel which runs parallel to Abbot Road and continues to Mamre Road (Figure 4).

Further inspection validated that the mapped lower section of this waterway was not present (Figure 5) and it was concluded that due to the lack of vegetation along the upper section of the headwaters and significant modification to a drainage channel of the lower section, the watercourse had minimal ecological value.

Figure 3: Upper headwater 1st order waterways on Unnamed Trib Kemps Creek 1.

Figure 4: Lower highly modified section of Unnamed Trib of Kemps Creek 1.

Figure 5: Unnamed Trib Kemps Creek 1. Field validated channel flow path and validated watercourses.

Unnamed Trib Kemps Creek 2

Field inspection of Unnamed Trib Kemps Creek 2 validated the waterway is of 2nd order. Two 1st order watercourses were evident in the headwaters which rise to the east of Aldington Road (Figure 6, Figure 7), both of which are significantly modified due to the construction of a series of farm dams along their flow paths(Figure 6, Figure 7). Native riparian vegetation was absent from both watercourses.

Figure 6: Northern 1st order watercourse above confluence point, east of Adlington Road, Unnamed Trib Kemps Creek 2.

Figure 7: Southern 1st order watercourse above confluence point, east of Adlington Road, Unnamed Trib Kemps Creek 2.

The lower section of this waterway which was proposed for E2 and RE1 zoning in the Exhibited Draft Mamre Road Precinct Zoning (DPIE 2020) in the draft was field validated as 2nd order however this section is significantly modified and at the time of inspection was a series of farm dams linked by a drainage channel and diverted from the original flow path (Figure 10). The channel had a heavy infestation of the invasive weed, *Juncus acutus* (Figure 8).

The original flow path of this waterway, likely to have been a broad, swampy depression which meandered through the centre of the area shown in Figure 8, has been significantly modified to become a market garden and pig paddock and has been deeply furrowed to allow crop irrigation (Figure 9).

Field inspection of this watercourse validated that the mapped lower section was significantly modified to be a series of farm dams linked by a diversion channel. It was concluded that due to the lack of vegetation along the upper section of the headwater watercourses and significant modification to a drainage channel of the lower section, the watercourse had minimal ecological value.

Figure 8: View looking towards the east over the proposed E2 and RE1 zoning. Diversion channel can be seen running parallel to the track on the left.

Figure 9:Deeply furrowed section of the adjacent to the drainage diversion channel in the proposed E2 and RE1 zoning area.

Figure 10: Unnamed Trib Kemps Creek 2. Field validated channel flow path and validated watercourses.

Unnamed Trib South Creek 1

Field inspection of Unnamed Trib South Creek 1 validated the upper section of the waterway as 1st order which turns to 2nd order approximately 100 m downstream of the gully headwall (Figure 18)

The most eastern extent of the mapped 1st order stream was field validated as not fulfilling the definition of a river as per the *NSW Water Management Act 2000* and therefore was considered as a topographic feature in the landscape (i.e. a depression) rather than a watercourse (Figure 11).

The mapped watercourse section below this point and the most upper mapped 2nd order section had a defined bed and bank which was DGPS mapped (Figure 12). As a result, a 10 m Vegetated Riparian Zone measured from top of bank is required on the 1st order section which will increase to a 20 m Vegetated Riparian Zone for the 2nd order section (as per NSW Water Management Act 2000) (Figure 18)

Figure 11: Upper most section of mapped 1st order waterway which is considered by this assessment as not present.

Figure 12: Mapped upper 2nd order section with bed and bank evident.

Downstream of the creek section with defined bed and bank the flow path transformed to a broad and shallow depression. No bed and bank was evident for most of this section and it is likely the series of large farm dams within the drainage path has buffered the depression from high velocity flows and erosion (Figure 13).

Figure 13: Typical broad and shallow flow depression in 2nd order section of watercourse.

Field inspection validated the presence of an unmapped watercourse which forms an east – west flowing 1st order tributary (Figure 18).

At the time of inspection, a clear flow path was identified although no bed and bank was evident. This watercourse contained a small dam that was full of *Typha orientalis* and linked to a remnant patch of native bushland higher up in the valley headwall (Figure 14).

Figure 14: Field validate unmapped tributary with farm dam in foreground and native vegetation patch in the upper section.

Within the mid-section of this watercourse two large dams are present which have likely buffered this flatter section from high velocity flow and erosion. As a result, no bed and bank was evident however a broad and shallow drainage depression that contains overland flows when rainfall is sufficient to trigger dam overflow was apparent (Figure 15).

These large dams were found to contain a range of aquatic and riparian habitats which included fringing wetland vegetation, shallow marsh and standing dead trees. The dam pictured in Figure 15 has a dense stand of *Casuarina glauca* at the upstream end (top right corner) which provides habitat value.

Field validation of the unnamed 1st order tributary that flows to Unnamed Trib South Creek 1 from the south confirmed this watercourse is significantly modified and at the time of inspection was found to be a series of large farm dams that has likely lost all stream function and provides minimal habitat (Figure 16).

Figure 15: Mid-section of watercourse with large farm dam. Overland flow path is evident on downstream side of dam.

Figure 16: Mapped unnamed 1st order tributary modified to a series of farm dams. Photo looking downstream toward Unnamed Trib South Creek 1.

A defined bed and bank was evident in the section of watercourse which begins approximately 250 m upstream of Mamre Road and continues through to the western extent of the exhibited E2 zone. As a result, a 20 m Vegetated Riparian Zone is required as per the *NSW Water Management Act 2000* measured from top of bank on both sides of the channel (Figure 18).

Much of this section of waterway has undergone modification and appeared to be channelised and realigned with bed incision and bank erosion increasing as the waterway approached South Creek (Figure 17). There is

a lack of native vegetation along the watercourse corridor in the proximity to South Creek and adjacent floodplain however given there is some habitat value in the upstream portion, including a series of farm dams, this waterway has potential to provide a valuable ecological corridor between South Creek and Ropes Creek.

Figure 17: Lower section of Unnamed Trib South Creek 1. Channel modification and erosion is evident.

Figure 18: Unnamed Trib South Creek 1. Field validated channel flow path, validated watercourses, mapped top of bank and required Vegetated Riparian Zones.

Unnamed Trib South Creek 2

Field inspection of Unnamed Trib South Creek 2 validated the presence of a 1st order watercourse (Figure 24). The upper most section (south of Aldington Road) of this watercourse has been modified to a series of farm dams with overland flow paths providing links across a broad and shallow drainage depression (Figure 19). Fringing and emergent wetland vegetation and large native trees were present around all dams which provide habitat value for native fauna (Figure 20).

Figure 19: Upper section of Unnamed Trib South Creek 2 showing series of farm dams.

Figure 20: Emergent wetland vegetation and large native trees in upper section of Unnamed Trib South Creek 2.

Field inspection of the lower section of Unnamed Trib South Creek Trib 2 validated the presence of a defined bed and bank. As a result, a 10 m Vegetated Riparian Zone is required to be maintained on both banks (Figure *24)* as per *NSW Water Management Act 2000.*

In this section the creek channel has been modified and realigned and a series of dams and diversions were observed at the northern most extent of the Precinct where the Sydney Water pipeline forms the boundary. The section of the channel within the grounds of the school had a heavy infestation of the invasive species *Juncus acutus* (Figure 21) and once the watercourse entered the patch of remnant bushland downstream this became a heavy cover of *Typha orientalis* (Figure 22).

Figure 21: Infestation of *Juncus acutus* in Unnamed Trib South Creek 2.

Figure 22: Thick cover of *Typha orientalis* in Unnamed Trib of South Creek 2.

The exit point of the watercourse was difficult to define due to the modified flow path of the lower section which included dams and diversion channels. On inspection it was apparent the watercourse exited the Precinct as a wide depression (Figure 23).

Figure 23: Flow path of Unnamed Trib South Creek 2 at the northern boundary of the Precinct.

Unnamed Trib South Creek 2 has high ecological value in the lower portion within the remnant bushland which is proposed to be rezoned as E2. The upper section of this waterway has ecological value as it provides wetland and woodland habitat and has potential to provide an ecological corridor between Ropes Creek and South Creek.

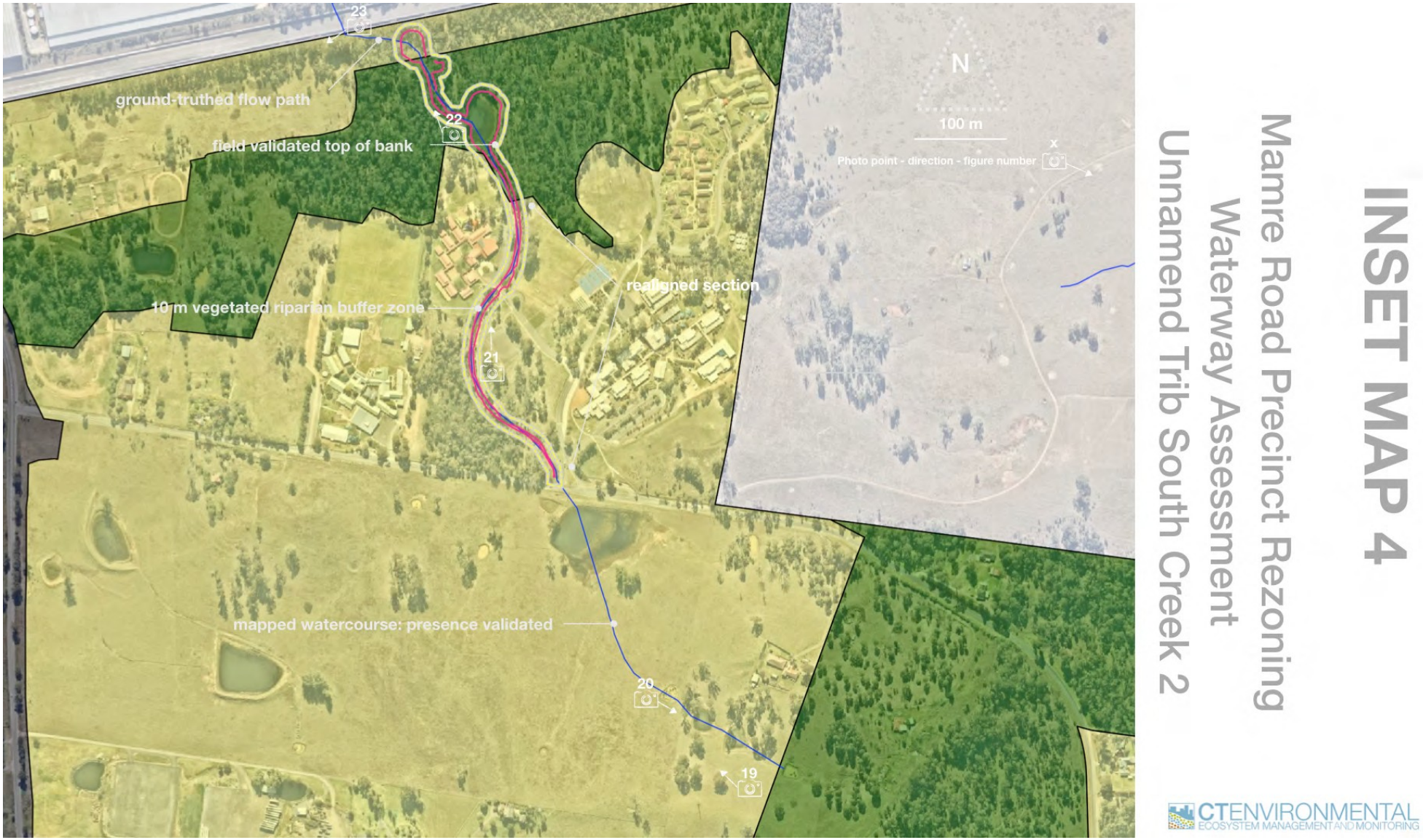

Figure 24: Unnamed Trib South Creek 2. Field validated watercourse, mapped top of bank and required Vegetated Riparian Zones.

Ropes Creek and Unnamed Trib Ropes Creek

Ropes Creek was field validated as a 3rd order stream and Unnamed Ropes Creek Trib was field validated as 1st order. Both waterways had a defined bed and bank and therefore top of bank was mapped (Figure 30). As a result a 30 m Vegetated Riparian Zone is required on Ropes Creek and 10 m Vegetated Riparian Zone is required on each bank of Unnamed Trib Ropes Creek (Figure 30) as per *NSW Water Management Act 2000*.

Field assessment recorded the presence of an unmapped wetland with an area of approximately 0.5 ha between Ropes Creek and Unnamed Trib Ropes Creek (Figure 25). This wetland had a thick cover of native wetland vegetation and lies in a shallow depression adjacent to a large online farm dam on Unnamed Trib Ropes Creek. The extent of the wetland was mapped and as a result a 40 m Vegetated Riparian Zone is required as per *NSW Water Management Act 2000* (Figure 30).

Figure 25: Unmapped wetland looking north towards Ropes Creek corridor.

The majority of the flow path of Unnamed Trib Ropes Creek has been modified to a series of farm dams (Figure 30). Where a channel exists between dams, heavy infestation of the invasive weed *Juncus acutus* was evident (Figure 26). However, at the time of assessment there was a diverse matrix of native fringing and emergent wetland plants within these farm dams and patches of *Casuarina glauca* scattered across the site (Figure 27).

In the lower section of the watercourse, upstream of the Ropes Creek confluence the flow path widened in places and root supported knick points were evident in a dense stand of Casuarina glauca which protects the channel from accelerated erosion (Figure 28).

Although modified, Unnamed Trib Ropes Creek provides a complex matrix of habitat which includes wetlands, emergent vegetation, riparian forest and creek channel. It is proposed this area is rezoned to a

combination of Industrial, Private Recreation and Environmental Conservation. Given the habitat value of the online dams and wetland on and adjacent to this watercourse consideration should be given to zoning that offers protection of this waterway.

Figure 26: Unnamed Trib Ropes Creek with infestation of *Juncus acutus* and patch of *Casuarina glauca*.

Figure 27: Unnamed Trib Ropes Creek online farm dam with emergent and fringing wetland vegetation.

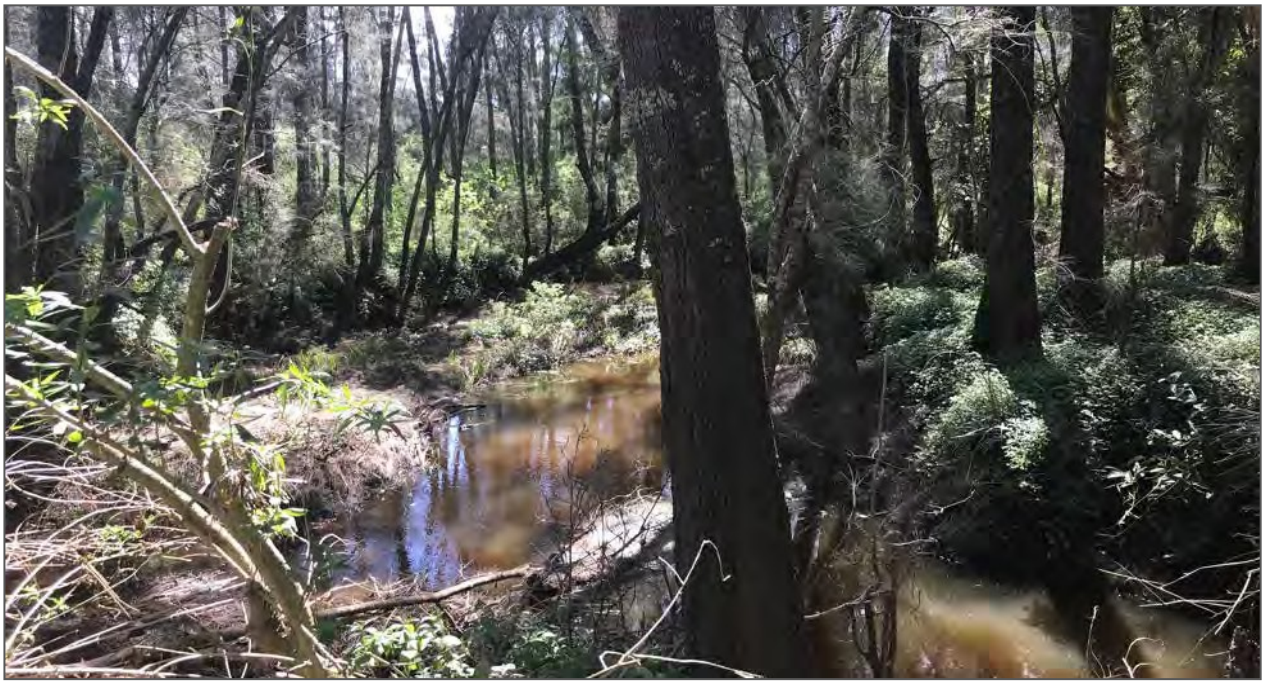

Figure 28: Widened channel upstream of Ropes Creek confluence.

Assessment of Ropes Creek validated the presence of a defined bed and bank which has undergone accelerated erosion due to land use change and the associated changes to stream hydrology. The banks of Ropes Creek are vegetated by dense stands of Casuarina glauca (Figure 29) however for a large portion of the creek this is restricted to a narrow strip which is less than the extent of the 30 m Vegetated Riparian Zone (Figure 30) as per *NSW Water Management Act 2000*.

The Ropes Creek corridor has ecological value as it contains endangered ecological communities and species and provides habitat and a movement corridor for native fauna species. The proposed rezoning has included the Ropes Creek corridor as Environmental Conservation. However, the extent of the proposed zoning does not include the full width of the 30 m Vegetated Riparian Zone and therefore consideration should be given to expand the Environmental Conservation zone to accommodate the full Vegetated Riparian Zone.

Figure 29:Ropes Creek corridor looking north west (downstream). Unnamed Trib Ropes Creek can be seen as a series of online dams to the left of the photo.

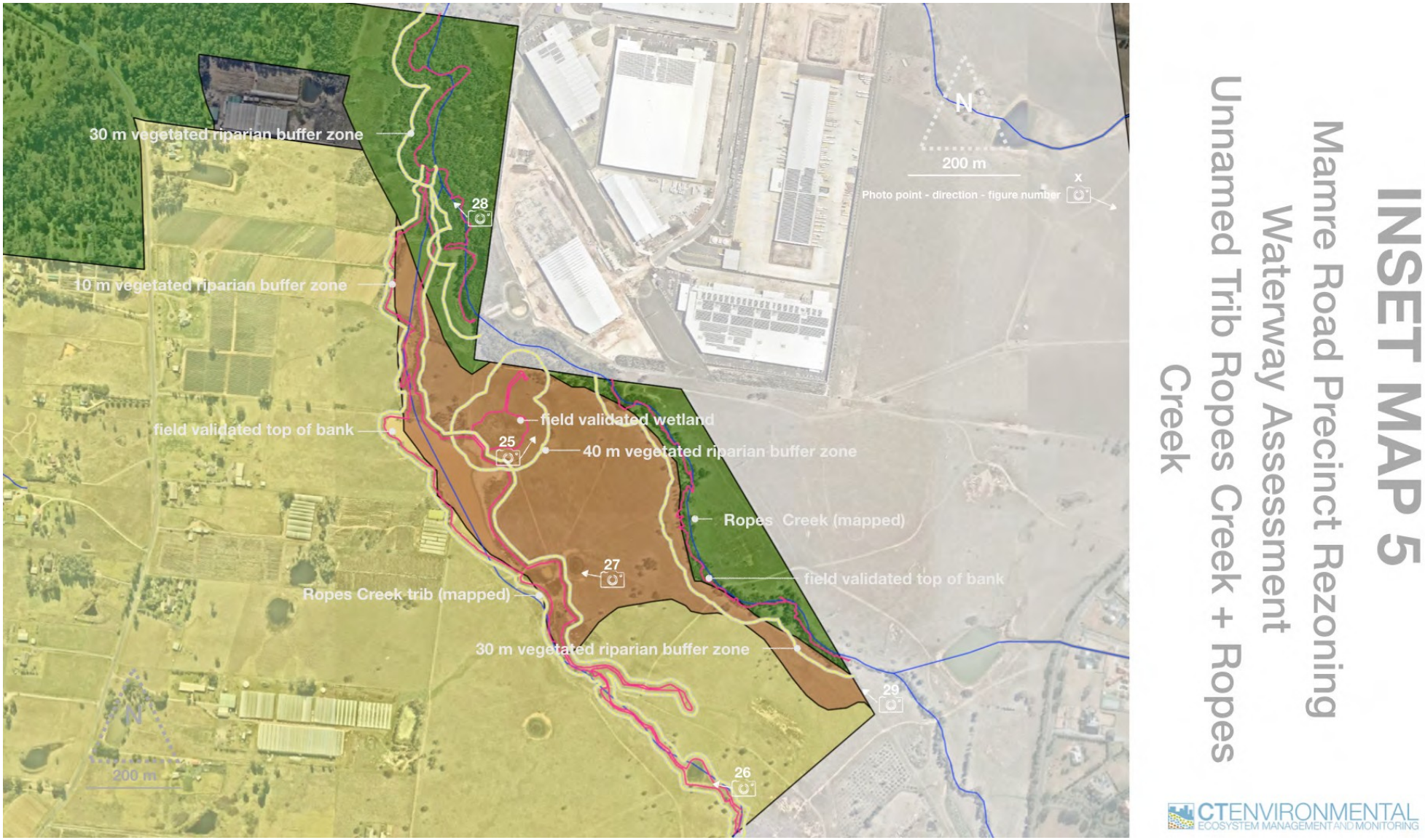

Figure 30: Ropes Creek and Unnamed Ropes Creek Trib. Field validated watercourse, mapped top of bank and required Vegetated Riparian Zones.

Conclusion and Recommendations

Results of this assessment have confirmed that all waterways assessed fit the definition of a river as defined by the *NSW Water Management Act 2000* which states;

The definition of a 'river' is as follows;

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.

Although some watercourses lacked a defined bed and bank geomorphology, all had defined flow paths which were broad and shallow drainage depressions, a typology which is typical of the Cumberland Plain.

An exception to this was the upper most section of Unnamed Trib South Creek 1 which on inspection was considered more a topographical depression than a watercourse.

In addition to those watercourses that were mapped on the 1:25,000 topographic maps, an unmapped 1st order watercourse was validated in the upper section of Unnamed Trib South Creek 1. An unmapped wetland adjacent to Unnamed Trib Ropes Creek was also validated by field assessment.

Watercourses assessed by this study had varied ecological value. Unnamed Trib Kemps Creek 1 and 2 were found to have minimal ecological value due to a lack of native riparian vegetation and significant alteration of flow paths.

Unnamed Trib South Creek 1 was found to have some quality habitat patches in the form of wetland vegetation and remnant vegetation and has potential to become an ecological corridor linking Ropes Creek and South Creek.

The upper section of Unnamed Trib South Creek 2 was found to have wetland and woodland habitats and has the potential to form an ecological corridor which links the downstream high-quality remnant bushland patch to Ropes Creek which has high ecological value.

Unnamed Trib Ropes Creek although highly modified was found to have a matrix of habitats which includes wetlands, emergent and fringing wetland vegetation and remnant woodland. This watercourse has potential to enhance the ecological value of the Ropes Creek corridor if managed accordingly.

Results of this study have informed the following recommendations which include;

1. Consider an alternative zoning for Unnamed Trib Kemps Creek 1 and 2. These watercourses have minimal ecological value due to the significant modification of the upper catchments and flow paths

however an alternative zoning may offer protection to these creeks under a future development scenario and facilitate potential creek restoration/realignment to be undertaken in accordance with Natural Resource Access Regulator (NRAR) Guidelines.

2. Consider appropriately sized Vegetated Riparian Zones as per those required by the *NSW Water Management Act 2000*. This includes 10 m buffers on each bank of 1st order streams, 20 m buffers on each bank of 2nd order streams, 30 m buffers on each bank of 3rd order streams and 40 m buffer around the perimeter of wetlands. Where defined bed and bank is absent, the extent of overland flow paths could be considered as a substitute for top of bank.

3. Consider an alternative zoning for Unnamed Trib Ropes Creek. The current proposal is for this waterway to become zoned as Industrial and Private Recreation. Given the diverse range of habitat found on this watercourse consideration of an alternative zoning may enhance the ecological value of the Precinct and maintain an efficient drainage corridor which could include retaining the farm dams and re-engineering them as online stormwater treatment to improve both water quality and hydrology. The adjacent wetland should also be incorporated into this alternate zoning.

4. Consider extending the E2 Environmental Conservation on Ropes Creek to include the full extent of the 30 m Vegetated Riparian Zone. The current proposed rezoning has a portion of the 30 m Vegetated Riparian Zone located within the Private Recreation zone and therefore this area may become under private ownership which may result in difficulties managing the riparian corridor. Consideration to extend the E2 zone to incorporate this area will provide benefit to biodiversity and future management of the area.

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