



ecoplanning

ecology | planning | offsets

Groundwater Dependent Ecosystems, Key Fish Habitat and Riparian Assessment



**585-649 Mamre Road, Orchard Hills,
Western Sydney Employment Area**

Prepared for ALTIS Property Partners Pty Ltd

23 March 2016

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

PROJECT NUMBER	2015-021	
PROJECT NAME	Groundwater Dependent Ecosystems, Key Fish Habitat and Riparian Assessment – 585-649 Mamre Road, Orchard Hills	
PROJECT ADDRESS	Mamre Road, Orchard Hills	
PREPARED FOR	ALTIS Property Partners Pty Ltd	
AUTHOR/S	Carl Tippler	
REVIEW	Lucas McKinnon	
VERSION	Version	Date to client
	1.0 – Draft	25 February 2016
	1.0 – Final	23 March 2016

This report should be cited as: *Ecoplanning (2016). Groundwater Dependent Ecosystems. Key Fish Habitat and Riparian Assessment – 585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area (v 1.0 Final). Prepared for Altis Property Partners Pty Ltd.*

ECOPLANNING PTY LTD
29 MUNNI ST NEWTOWN NSW 2042
M: 0421 603 549
www.ecoplanning.com.au

Disclaimer: This report has been prepared by Ecoplanning Pty Ltd for Altis Property Partners Pty Ltd and may only be used for the purpose agreed between these parties, as described in this report. The opinions, conclusions and recommendations set out in this report are limited to those set out in the scope of works and agreed between these parties. Ecoplanning P/L accepts no responsibility or obligation for any third party that may use this information or for conclusions drawn from this report not provided in the scope of works or following changes occurring subsequent to the date that the report was prepared.

Contents

1. Introduction	1
1.1 Project background and legislative context.....	1
1.2 Study area and subject site	1
2. Desktop assessment.....	7
2.1 Literature and database review	7
2.2 Topography and soils	8
2.3 Rainfall	8
2.4 Groundwater Dependent Ecosystems (GDE)	9
2.5 Riparian assessment.....	13
2.5.1 Key Fish Habitat (KFH)	13
2.5.2 Riparian corridors.....	13
3. Field assessment	16
3.1 Methods	16
3.1.1 Vegetation.....	16
3.1.2 Key Fish Habitat.....	16
3.1.3 Riparian Vegetation and Creek Channel Condition Assessment	16
3.2 Results	18
3.2.1 Vegetation.....	18
3.2.2 Key Fish Habitat.....	23
3.2.3 Riparian Vegetation and Creek Channel Condition	24
4. Conclusion	28
4.1 Groundwater Dependent Ecosystems	28
4.2 Riparian assessment.....	28
4.2.1 Key Fish Habitat.....	28
4.2.2 Riparian corridors.....	29
5. Recommendation	30
References.....	31
Appendix A: Riparian site assessment results	33
Appendix B: Concept Civil Works Plan for stormwater.....	36

Figures

Figure 1.1: Subject site locality.	3
Figure 1.2: Subject site and study area.	4
Figure 1.3: Subject site, study area and land zoning (Penrith LEP 2010).	5
Figure 1.4: Subject site and surrounding land use.	6
Figure 2.1: Mean monthly rainfall for Orchard Hills, 1970 – 2015. Data sourced from BOM (2016).....	8
Figure 2.2: Soil landscapes at the subject site and study area (Bannerman and Hazelton 1990).....	10
Figure 2.3: Underlying geology at the subject site and study area (Clark and Jones 1991). ...	11
Figure 2.4: Groundwater Dependent Ecosystems (from Atlas of Groundwater Dependent Ecosystems - BOM).	12
Figure 2.5: Determining Strahler stream order (from DPI 2012a).....	13
Figure 2.6: Strahler stream order, Key Fish Habitat and associated riparian buffers on and adjacent to the subject site and study area.....	15
Figure 3.1: Field survey effort.	17
Figure 3.2: Field validated vegetation and fauna habitat.....	20
Figure 3.3: A large farm dam onsite, colonised by native and exotic aquatic and semi-aquatic flora.	20
Figure 3.4: Wet pasture colonised by native and exotic sedge and rush species.....	20
Figure 3.5: Remnant trees of underscrubbed Shale Plains Woodland within the subject site..	21
Figure 3.6: Underscrubbed Alluvial Woodland in the north-east of the site, with some regrowth vegetation to the left.	23
Figure 3.7: Rapid Riparian Appraisal (RRA) assessment sites with 50 m assessment buffer, corresponding assessment condition and water quality monitoring sites, South Creek, Mamre West Precinct.	25

Tables

Table 1.1: Lots included in study area.	2
Table 1.2: Current zoning of the study area.	2
Table 2.1: Riparian corridors recommended by <i>Guidelines for Riparian Corridors on Waterfront Land</i> (DPI 2012a).	14
Table 2.2: Area of study area affected by riparian corridors.	14
Table 3.1: Daily weather observation at Albion Park.	16
Table 4.1: Key Fish Habitat Classification for South Creek, Mamre West Precinct.	23
Table 4.2: Water quality results for South Creek, Mamre West Precinct.	24
Table 4.3: Results of Riparian and Creek Channel Assessment using RRA method (Findlay et al 2011).	27
Table 5.1: Waterway class, type and recommended riparian buffer.	29

Glossary and abbreviations

ACRONYM	DESCRIPTION
BWSEA	Broader Western Sydney Employment Area
CEEC	Critically Endangered Ecological Community
DP	Deposited Plan
EC	Electrical Conductivity
EEC	Endangered Ecological Community
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
GDE	Groundwater Dependent Ecosystem
KFH	Key Fish Habitat
LEP	Local Environment Plan
LGA	Local Government Area
NSW	New South Wales
PCT	Plant Community Type
RRA	Rapid Riparian Assessment
SEPP	State Environmental Planning Policy
TEC	Threatened Ecological Community
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
WSEA	Western Sydney Employment Area
*	Denotes species not indigenous to the Penrith LGA

1. Introduction

1.1 Project background and legislative context

This Groundwater Dependent Ecosystems (GDE), Key Fish Habitat (KFH) and Riparian and Creek Channel Assessment has been undertaken to accompany a Development Application (DA) relating to the proposed industrial development located at Lot 2171 // DP 1153854, Mamre Rd, Orchard Hills (the *subject site*). This report accompanies the 'Ecological and Riparian Assessment' prepared for the Mamre West Precinct, Orchard Hills (Ecoplanning 2015).

The subject site covers an area of approximately 48.3 ha, which is proposed to be developed into a warehouse and logistics industrial precinct similar to that in the adjacent Erskine Business Park, east of Mamre Road. The site is considered a State Significant Development (SSD), and as such Secretary's Environmental Assessment Requirements (SEARs) have been issued by the Department of Planning and Environment (DPE) (SSD 7173).

The submission from NSW DPI in the SEARs requests consideration of the potential impacts on any GDEs at the site and in the vicinity of the site, including:

- the effect of the proposal on the recharge to groundwater systems;
- the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections; and
- the effect on the function of GDEs (habitat, groundwater levels, connectivity).
- Provide safeguard measures for any GDEs.

The SEARs state with respect to Watercourses, Wetlands and Riparian Land that the assessment include details on all watercourses potentially affected by the proposal, including:

- A detailed description of all potential impacts on the watercourses/riparian land.
- A detailed description of all potential impacts on the wetlands, including potential impacts to the wetlands hydrologic regime; groundwater recharge; habitat and any species that depend on the wetlands.
- A description of the design features and measures to be incorporated to mitigate potential impacts.
- Geomorphic and hydrological assessment of water courses including details of stream order (Strahler System).

1.2 Study area and subject site

The **study area** is located at Mamre Road, Orchard Hills within the Penrith Local Government Area (LGA) (**Figure 1.1**). The study area is bounded by Mamre Road in the east, a Sydney Water pipeline in the south, South Creek in the west and the northern boundary of Lot 1 // DP 1117416 and Lot 2172 // DP 1153854. The study area currently

consists of the two lots aforementioned and Lot 2171 // DP 1153854 and totals 117.8 ha (**Figure 1.2**).

The **subject site** sits completely within the study area and is the area subject to the rezoning application. The subject site is comprised of only Lot 2171 // DP 1153854 and totals 48.3 ha (**Table 1.1**).

Table 1.1: Lots included in study area.

Lot / DP	Area (ha)	Area (%)
1 / 1117416	0.9	0.80
2171 / 1153854 (subject site)	48.3	41.0
2172 / 1153854	68.6	58.2
Total	117.8	100

Currently, the study area is predominantly zoned RU2 (Rural Landscape) under the Penrith Local Environment Plan (LEP) 2010 (**Table 1.2** and **Figure 1.3**) and lands adjacent to South Creek are zoned E2 (Environment Conservation). The State Environmental Planning Policy (Western Sydney Employment Area) Amendment 2014 was formally made on 16 January 2015 and accordingly the land is now subject to the State Environmental Planning Policy (Western Sydney Employment Area) 2009 (the WSEA SEPP) and is included within Precinct 11 – Broader Western Sydney Employment Area (BWSEA).

Table 1.2: Current zoning of the study area.

Zone code	Zone description	Area (ha)	Area (%)
RU2	Rural Landscape	110.2	93.5
E2	Environment Conservation	7.6	6.5
Total		117.8	100

The study area is surrounded by a variety of different land use types (**Figure 1.4**). Directly to the east lies the WSEA, with associated industrial land. To the north-east are the urban suburbs of Erskine Park and St Clair. Rural or rural residential land adjoins to the north, west, south and south-east. Inclusion of the study area and surrounding lands in the BWSEA will result in a significant amount of the adjacent land being used for industrial purposes.

The riparian vegetation community along the South Creek corridor contains scattered patches of Alluvial Woodland and remnant canopy trees. Both banks are dominated by invasive weed species and numerous patches have been subject to recent and ongoing livestock grazing. Isolated patches of underscrubbed Shale Plains Woodland and Alluvial Woodland (as described by NPWS 2002; Tozer 2003) are scattered across the subject site with grass and exotic species dominating the ground cover (Ecoplanning 2015).

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

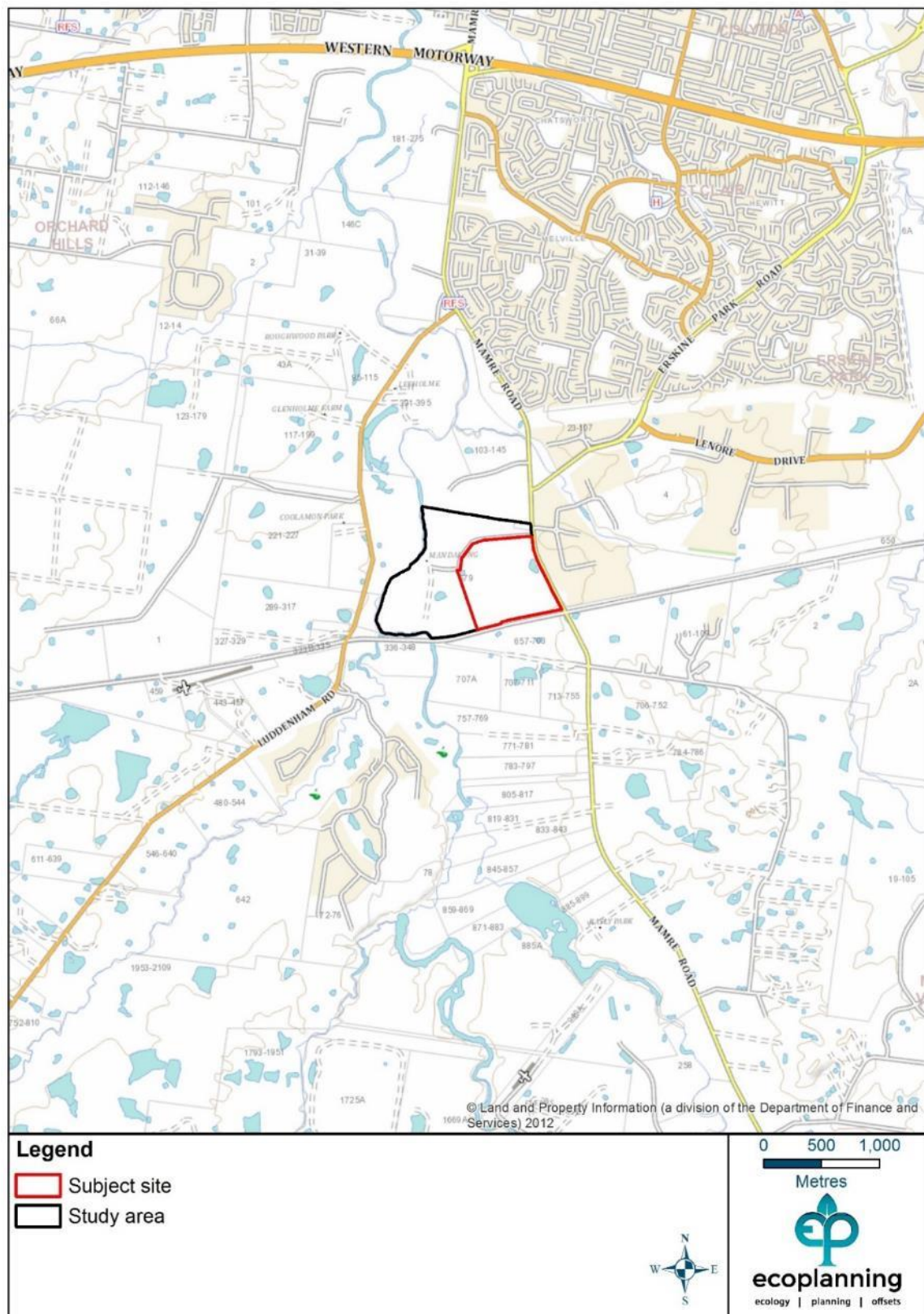


Figure 1.1: Subject site locality.



Figure 1.2: Subject site and study area.

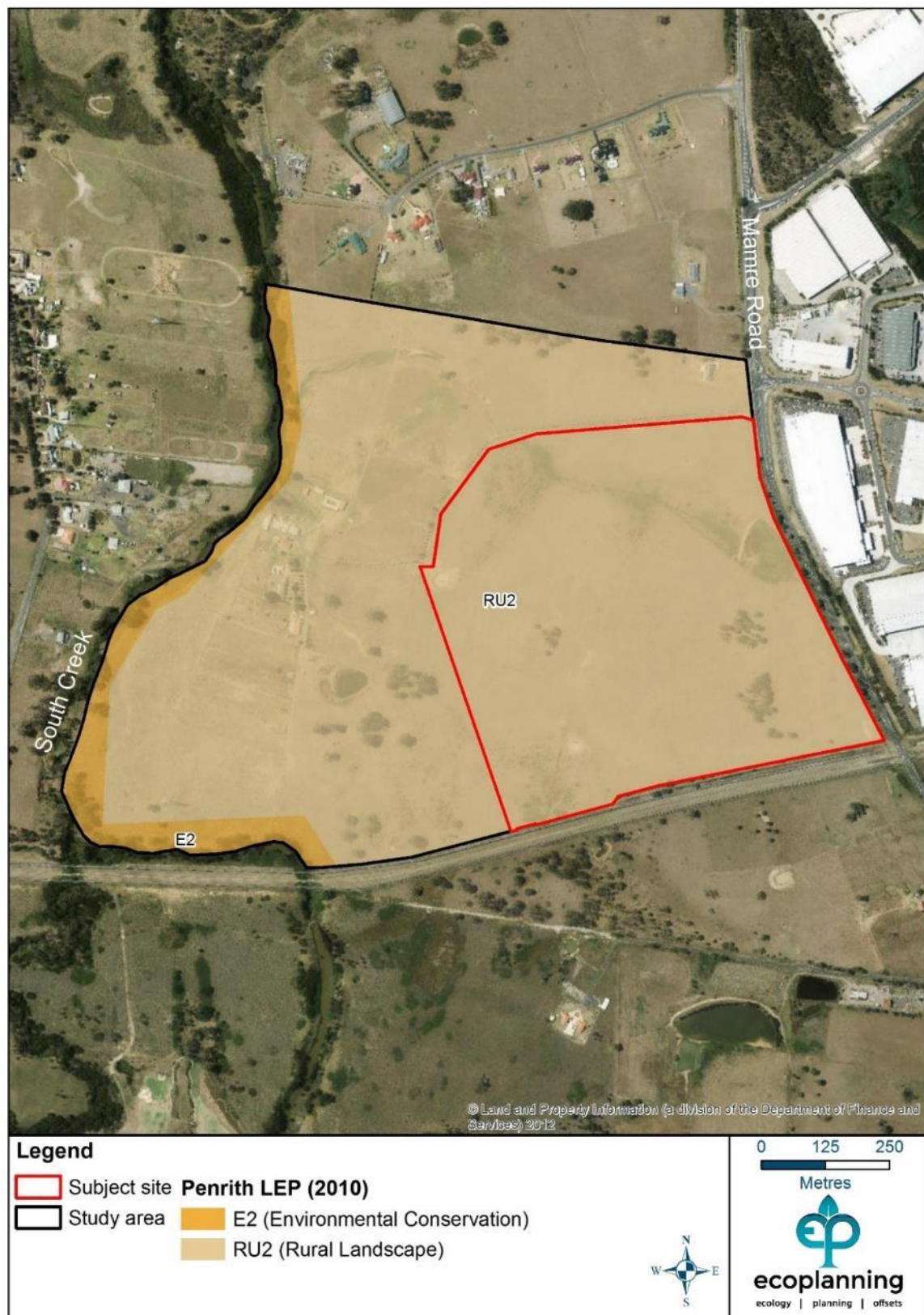


Figure 1.3: Subject site, study area and land zoning (Penrith LEP 2010).

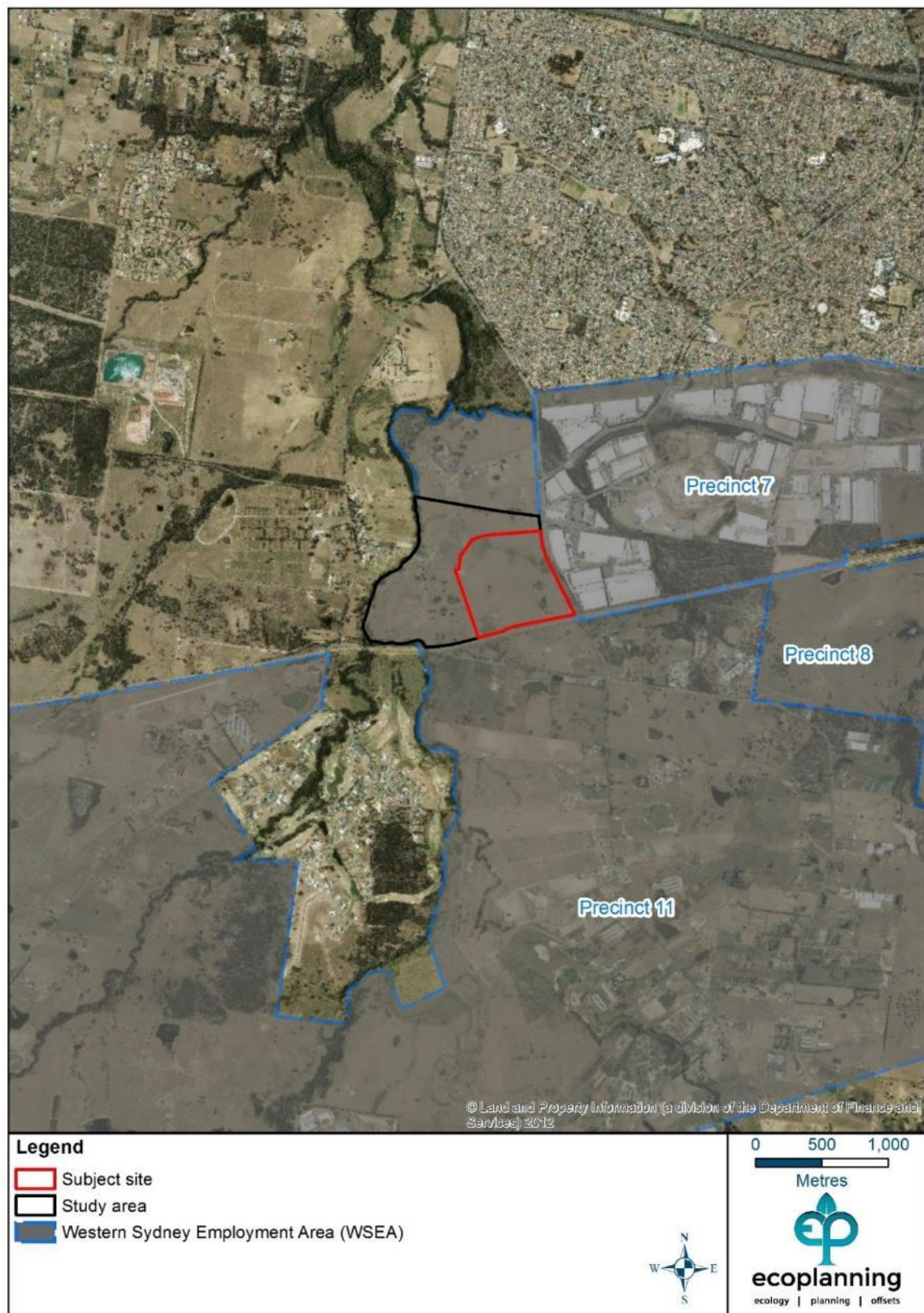


Figure 1.4: Subject site and surrounding land use.

2. Desktop assessment

2.1 Literature and database review

A site specific literature and database review was undertaken prior to undertaking field survey and the preparation of this report. This included desktop analysis of aerial photography and regional scale mapping resources from the following sources:

- NSW Planning Viewer (NSW Dept. of Planning and Environment 2015)
- Native vegetation of the Cumberland Plain (NPWS 2002 and Tozer 2003)
- Native Vegetation of South East NSW (Tozer et al 2006)
- Soil landscapes of the Wollongong-Port Hacking 1:100 000 mapsheet (Bannerman and Hazelton 1990)
- SIX Maps (LPI 2015)
- Google Earth Pro (Google 2015)
- NSW Key Fish Habitat Mapping (NSW Department of Primary Industries 2007)
- Broader Western Sydney Employment Area – Ecology Study. Prepared for NSW Department of Planning and Infrastructure (Eco Logical Australia 2013)
- Groundwater Dependent Ecosystem Atlas (Australian Government Bureau of Meteorology 2012)
- Ecological and Riparian Assessment – Mandalong Precinct, Erskine Park, Western Sydney Employment Area. Prepared for ALTIS Property Partners Pty Ltd. (Ecoplanning 2015).
- Bureau of Meteorology (2016) Climate and rainfall data: www.bom.gov.au

Policies and guidelines relating to the proposed development:

- Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (NSW Department of Primary Industries 2013).
- Office of Water Controlled Activities on Waterfront Land – Guidelines for Riparian Corridors on Waterfront Land (NSW Department of Primary Industries NSW 2012a)
- Office of Water Guidelines for Vegetation Management Plans on Waterfront Land (NSW Department of Primary Industries 2012b)
- Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge. 2003).
- Development and Application of a Rapid Assessment Tool for Urban Stream Networks. (Findlay et al 2011)
- Risk assessment guidelines for groundwater dependent ecosystems, Volumes 1 and 3 – The conceptual framework, NSW Department of Primary Industries, Office of Water, Sydney (Serov et al 2012)
- Development Control Plan – Mamre West Land Investigation Area (Urbis 2016)

2.2 Topography and soils

The highest point of the study area occurs in the south-east corner, and is approximately 35-40 m above sea level (masl). From the highest point the subject site gently slopes down to the west and north, towards both South and Cosgrove Creeks. The lowest point is approximately 30 masl, resulting in a study area with low relief and slope.

The study area is dominated by alluvial soils associated with South and Cosgrove Creeks, with most of the site mapped as the South Creek soil landscape, which commonly occurs along floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain (Bannerman and Hazelton 1990). The subject site is mapped as the Blacktown soil landscape, which includes gently undulating rises on Wianamatta Group shales and broad rounded crests and ridges with gently inclined slopes (Bannerman and Hazelton 1990) (**Figure 2.2**).

Regional scale geological mapping by Clark and Jones (1991) shows the site is dominated by an underlying geology of Quaternary fine-grained sand, silt and clay (Qal) of fluvial origin. The eastern side of the site, as with the soil landscape mapping, has an underlying geology drawn from the Wianamatta Group (Rwb) dominated by shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff (**Figure 2.3**).

2.3 Rainfall

Historic rainfall records (1970 -2015) for the Orchard Hills area (BOM 2016) show consistent falls are recorded throughout the year and therefore would provide a reliable water source to these vegetation patches even throughout what could be considered “dry spells” (**Figure 2.1**).

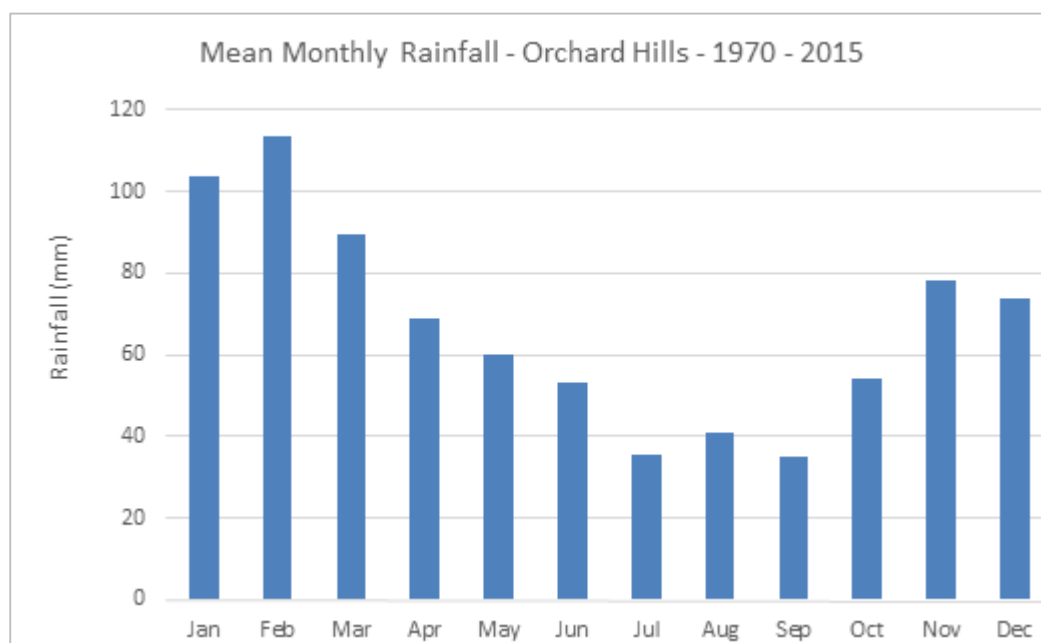


Figure 2.1: Mean monthly rainfall for Orchard Hills, 1970 – 2015. Data sourced from BOM (2016).

2.4 Groundwater Dependent Ecosystems (GDE)

Groundwater Dependent Ecosystems (GDEs) are defined in a number of ways:

- Richardson et al (2011) define GDEs as: *ecosystems that require access to groundwater to meet some or all of their water requirements to maintain the communities of plants and animals, ecological processes they support and ecosystem services they provide*
- The NSW Water Management Act 2000 defines GDE's as: *'ecosystems which have their species composition and ecosystem processes wholly or partially determined by groundwater'* (Serov et al 2012)
- National Water Commission (NWC) defines GDE's as: *ecosystems that are dependent on groundwater for their existence and health* (Serov et al 2012).

Following the Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov et al 2012) this report will consider GDE's as any ecosystem that uses groundwater at any time for any duration in order to maintain its composition and condition.

Examples of GDEs include wetlands, terrestrial vegetation communities, groundwater fed stream ecosystems, cave systems, springs and hanging swamps. Key threats to GDE's include over extraction of groundwater and contamination of aquifers by chemicals and heavy metals (Serov et al 2012).

A desktop review of groundwater mapping for the Hawksbury-Nepean Catchment contained in the Risk Assessment Guidelines for Groundwater Dependent Ecosystems, Volume 3 (Serov et al 2012) did not identify groundwater sources to be present within or adjacent to the study area. As a result, high probability GDEs including groundwater dependent vegetation and wetlands were not identified within the study area or subject site.

A desktop review of GDE mapping generated by the Groundwater Dependent Ecosystem Atlas (BOM 2012), which provides the most comprehensive inventory of the location and characteristics of groundwater dependent ecosystems for Australia, shows GDE's are not present within the subject site.

However, GDE's are mapped as occurring within the South Creek and Cosgrove Creek corridors that form the western border of the study area. The GDE Atlas (BOM 2012) shows South Creek as being reliant on the surface expression of groundwater (**Figure 2.4**). In addition, the riparian community of Cosgrove Creek is identified as having high potential for groundwater interaction (**Figure 2.4**), with the developed area directly to the east of the subject site identified as having a moderate potential for groundwater interaction (**Figure 2.4**).

A review of aerial photography using Google Earth Pro (Google 2015) showed South Creek retained permanent water throughout the period 2002 – 2015, however surface water dams across the subject site were almost dry at multiple times throughout that time period. The same review showed pasture grasses and macrophyte beds exhibited periodic die back, however canopy trees across the subject site maintained green foliage.

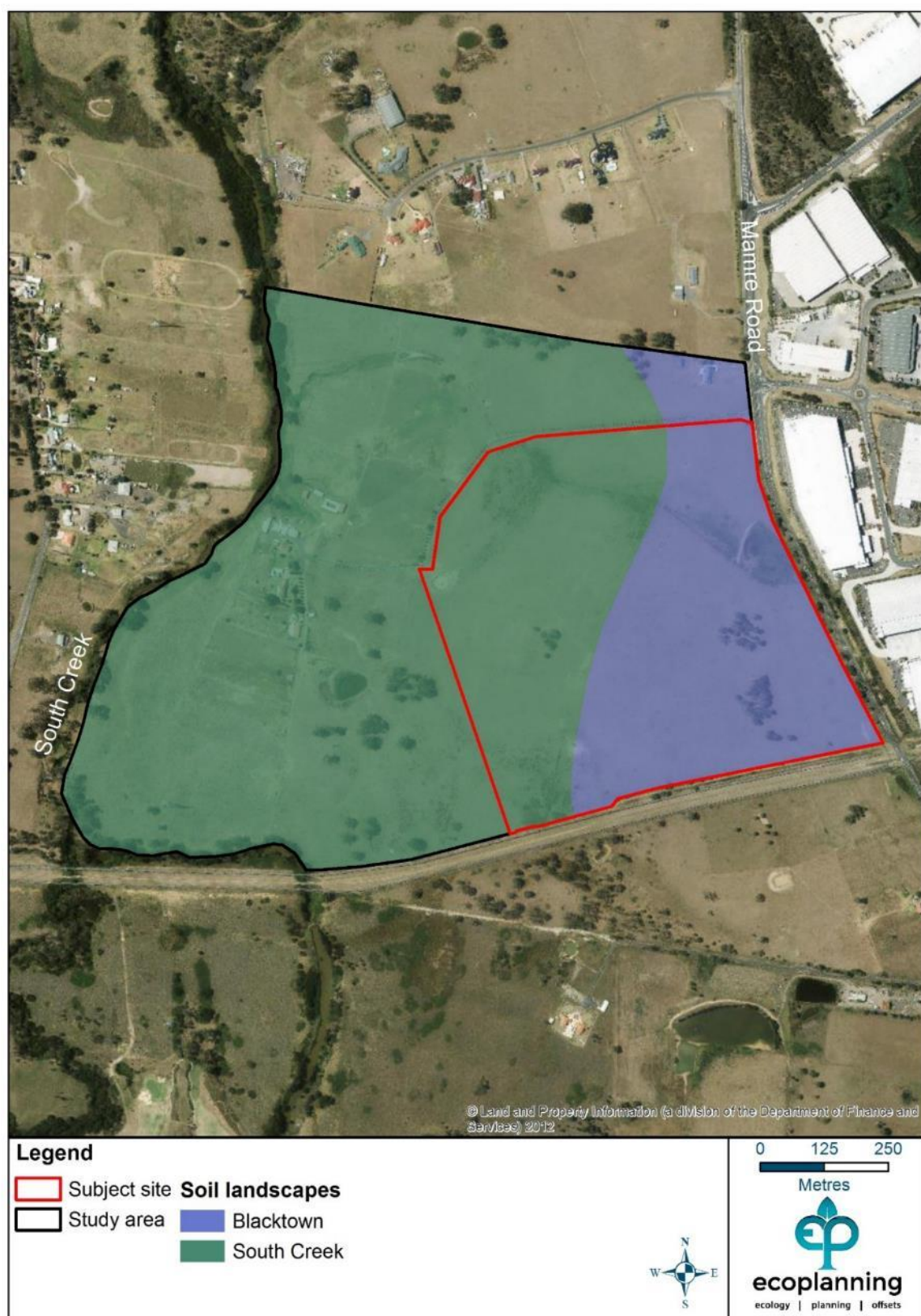


Figure 2.2: Soil landscapes at the subject site and study area (Bannerman and Hazelton 1990).

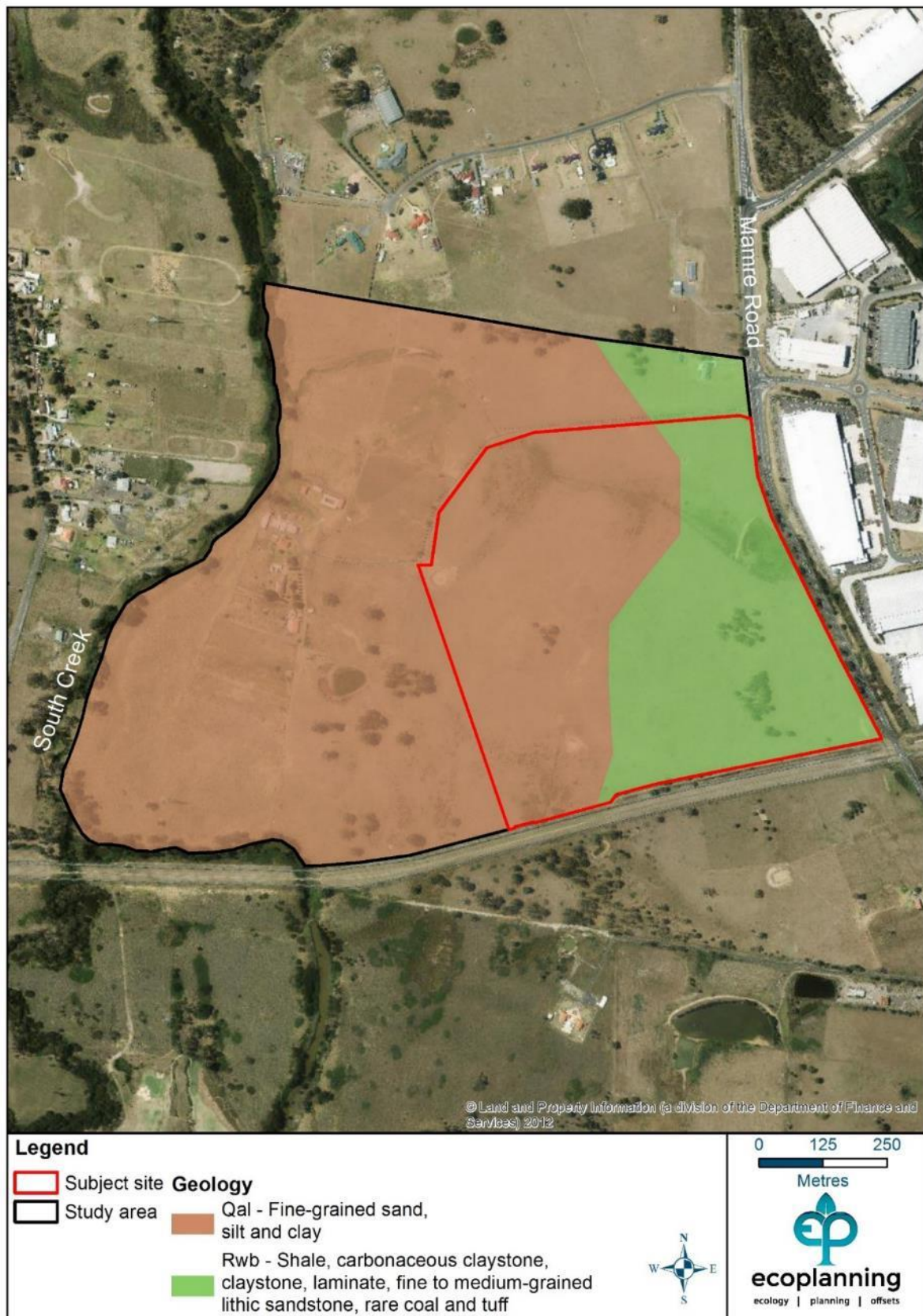


Figure 2.3: Underlying geology at the subject site and study area (Clark and Jones 1991).



Figure 2.4: Groundwater Dependent Ecosystems (from Atlas of Groundwater Dependent Ecosystems - BOM).

2.5 Riparian assessment

The study area contains, or is adjacent to, a number of mapped drainage lines and a desktop assessment of each of these drainage lines was undertaken. Drainage features identified on the 1:25,000 topographic map were reviewed and Strahler stream order determined as outlined in **Figure 2.5**.

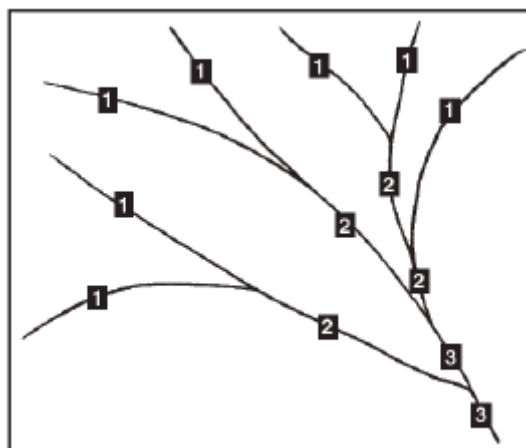


Figure 2.5: Determining Strahler stream order (from DPI 2012a).

Results show South Creek, which lies on the western and southern side of the study area and drains in a northerly direction, is classified as Fifth Order. Cosgroves Creek, which confluences with South Creek on the southern boundary of the study area is of Fourth Order. In addition, two First Order unnamed drainage depressions (also tributaries of South Creek) are located in the central area of the study area (**Figure 2.6**).

Mapped drainage lines are not present across the subject site. However, three surface water fed dams are located within the subject site (see **Section 3**).

2.5.1 Key Fish Habitat (KFH)

Review of the NSW Key Fish Habitat (KFH) Map for Sydney LGA's (NSW DPI 2007) shows the reach of South Creek located along the western boundary of the study area is classified as KFH. In addition, Cosgroves Creek which confluences with South Creek on the southern boundary of the study area is also classified as KFH (**Figure 2.6**). Key Fish Habitat is not present within the subject site.

Review of the NSW Threatened and Protected Species Record Viewer (NSW Department of Primary Industries 2015) shows no threatened fish records for the study area.

2.5.2 Riparian corridors

Consistent with the *Guidelines for Riparian Corridors on Waterfront Land* (DPI 2012a) the riparian corridors, or 'buffers', required for each creek were determined based on Strahler Stream Order. This system requires increasing riparian vegetation buffers on creek banks as Strahler Stream Order increases. Riparian corridor buffer widths as recommended by DPI (2012a) are summarised in **Table 2.1**.

Table 2.1: Riparian corridors recommended by *Guidelines for Riparian Corridors on Waterfront Land* (DPI 2012a).

Strahler Stream Order	Corridor Width on Each Bank	Total Riparian Corridor Width
1 st order	10 metres	20 metres + channel width
2 nd order	20 metres	40 metres + channel width
3 rd order	30 metres	60 metres + channel width
4 th order and greater	40 metres	80 metres + channel width

A 40 m riparian corridor on each bank (total 80 m riparian corridor width), as required by *Guidelines for Riparian Corridors on Waterfront Land* (DPI 2012a), has been applied to both South Creek and Cosgroves Creek due to classification as Fifth and Fourth Order streams respectively (**Figure 2.6**).

In addition, the two unnamed First Order tributaries on the western side of the study area are assigned 10 m buffers on each bank (total 20 m riparian corridor).

Total area of riparian corridor across the study area is 8.0 ha, or 6.8 % of the total area of the study area (**Table 2.2**). This is dominated by the riparian corridor for South Creek, which occupies 6.2 ha, or 5.3 % of the study area.

Table 2.2: Area of study area affected by riparian corridors.

Strahler stream order	Buffer width	Total riparian corridor width	Area on study area (ha)*	Proportion of study area (%)
1 st order	10 m	20 m	1.8	1.5
2 nd order	20 m	40 m	0	0.0
4 th order and greater	40 m	80 m	6.2	5.3
Total			8.0	6.8

* Rounding errors apply

It is important to note that the riparian buffers in this study have been derived from the centre of the drainage line, and none are within the subject site. DPI (2012a) requires that the buffer be applied from the waterway Top of Bank (ToB). A ToB assessment has not been completed for this study and will be completed as a component of more detailed studies at the construction or subdivision development application stage in the broader study area. Some changes to the alignment of waterways and the extent of the buffers within the subject site would be expected following these detailed studies.

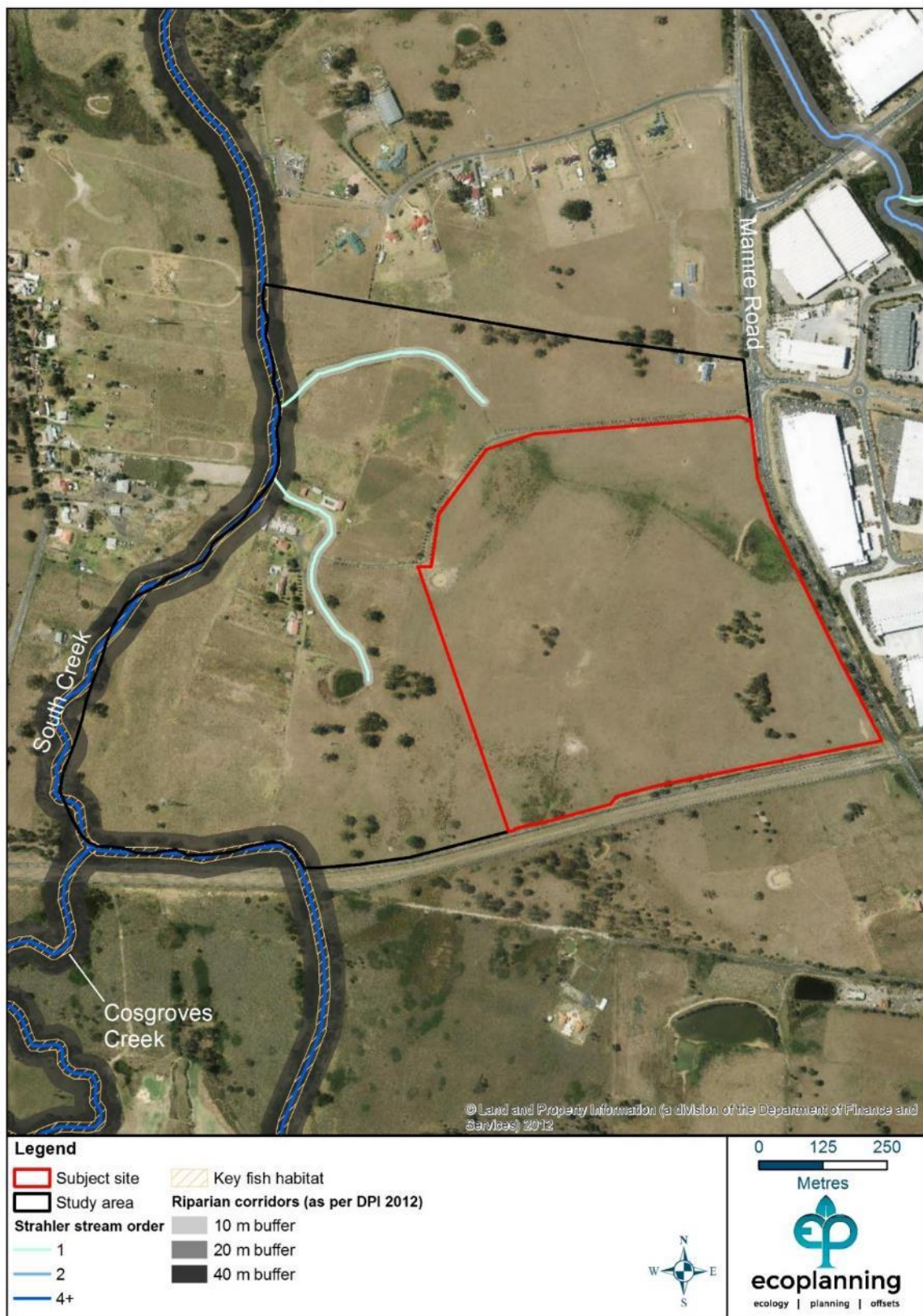


Figure 2.6: Strahler stream order, Key Fish Habitat and associated riparian buffers on and adjacent to the subject site and study area.

3. Field assessment

3.1 Methods

Field survey was undertaken on 10 August 2015 by Lucas McKinnon (Principal Ecologist, Ecoplanning) and Carl Tippler (Principal Ecologist, CT Environmental). Field survey effort is provided in Figure 3.1.

Terrestrial vegetation, KFH and riparian vegetation and creek channel condition were assessed during field survey. Weather conditions at the time of survey were considered calm and mild and no rainfall was recorded in the 24 hours prior to survey (**Table 3.1**).

Table 3.1: Daily weather observation at Albion Park.

DATE	TEMP (°C)		RAINFALL (mm)	MAX WIND	
	Min	Max	Previous 24 hours	Direction	Speed (km/h)
10/08/15	3.1	21.5	0	NW	30

Source: www.bom.gov.au

3.1.1 Vegetation

Vegetation desktop and field survey methodology and classification is covered comprehensively in Ecoplanning (2015). Briefly, the methods employed utilised desktop vegetation mapping, aerial photo interpretation and general field based survey (CSIRO 2009) and BioMetric plot based survey (OEH 2014).

3.1.2 Key Fish Habitat

To assess Key Fish Habitat, the framework outlined by Policy and Guidelines for Fish Habitat Conservation and Management (Fish Habitat Policy) (NSW DPI 2013) was applied.

3.1.3 Riparian Vegetation and Creek Channel Condition Assessment

The condition of the riparian vegetation community and creek channel were assessed by applying the Rapid Riparian Assessment (RRA) developed by Findlay et al (2011).

This method has been used widely throughout the greater Sydney region and combines the assessment of both instream and riparian habitat condition. Creek attributes assessed by this method are incorporated to assess KFH. Four assessment sites were selected along South Creek at points where distinct changes in vegetation or land use were evident.

No assessment was undertaken along Cosgrove Creek due to lack of access. Assessments were also not completed along the First Order drainage channels as these are not considered as KFH. Riparian vegetation and creek channel condition was assessed under low flow conditions. Field survey locations are provided in **Figure 3.1**.

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

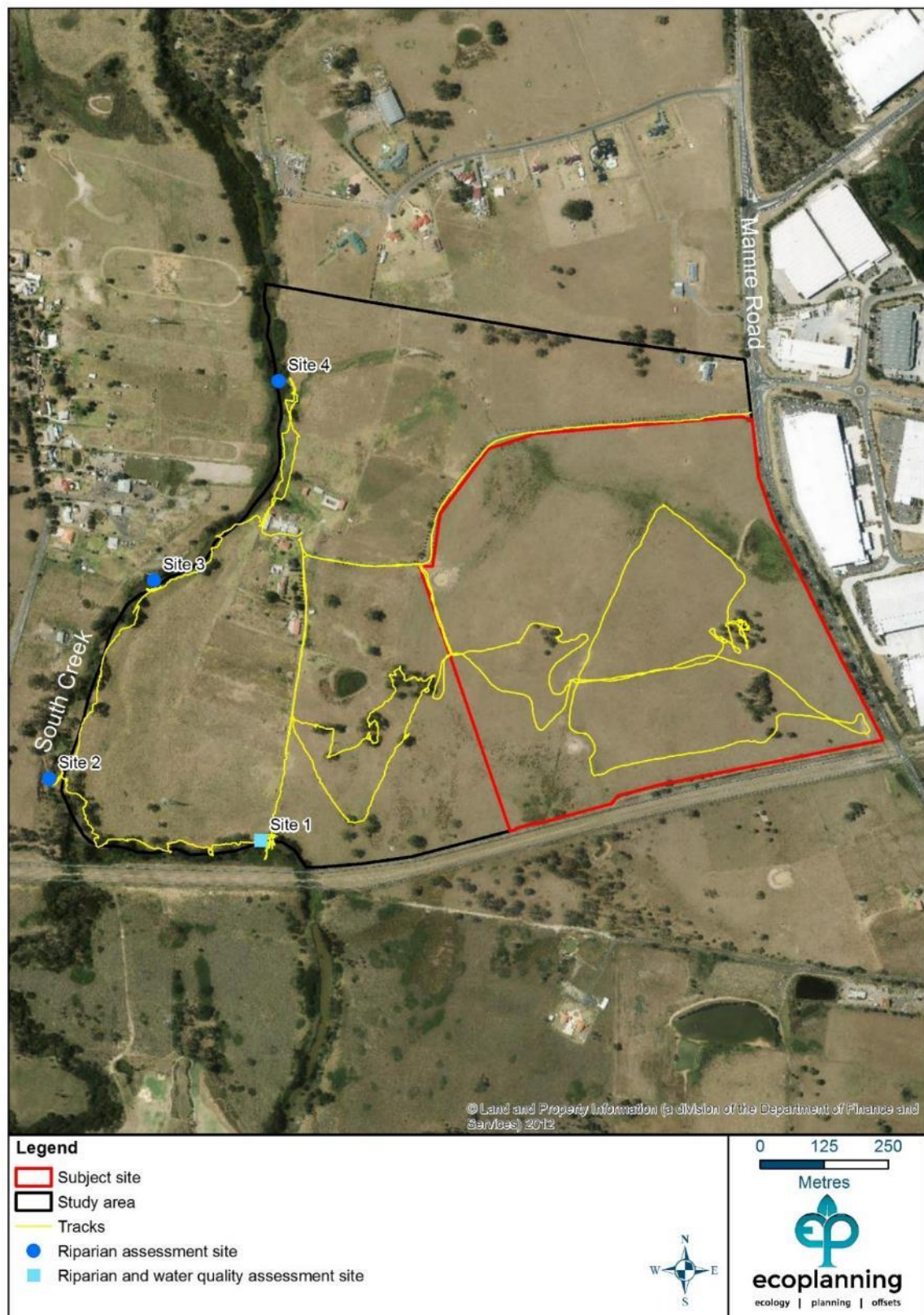


Figure 3.1: Field survey effort.

3.2 Results

3.2.1 Vegetation

Five distinct vegetation assemblages with a potential dependence on groundwater were recorded along riparian corridors, in close proximity to water sources or semiaquatic/aquatic environments (**Figure 3.2**). Only two are considered to be remnant native vegetation types and include:

- Dams
- Wet pasture
- Planted/exotic/introduced
- Shale Plains Woodland (remnant native)
- Alluvial Woodland (remnant native)

Brief descriptions for each vegetation type identified are provided below. For detailed vegetation community descriptions see Ecoplanning (2015) (Note: '*' refer to species not indigenous to the Penrith LGA).

Dams

Four dams of varying size are mapped across the study area, three of which lie within the subject site. All dams across the subject site have been constructed to water stock and review of aerial photos (Google 2015) shows fluctuating water levels and near dry conditions at times (**Figure 3.3**).

The larger dams have been colonised with native rushes and forbs such as, *Juncus* spp., *Eleocharis* spp. and *Ludwigia peploides* (Water Primrose). However, a number of noxious weeds recorded across the site, such as *Alternanthera philoxeroides** (Alligator Weed), *Eichhornia crassipes** (Water Hyacinth) and *Salvinia molesta** (Salvinia).

Dam water is sourced from rain and associated overland flows and stormwater runoff from surrounding industrial estates and roadways.

Wet Pasture

Wet pasture is present in the shallow modified draining depression that runs east-west across the site and in the south-western corner of the subject site (**Figure 3.4**). This depression is colonised by native rushes/sedges such as *Juncus* spp., *C. appressa*, and exotic the *C. eragrostis**. Native and exotic pasture grasses dominate higher points surrounding the depression and include *A. fissifolius**, *C. gayana**, *C. dactylon**, *E. erecta**, *E. curvula**, *H. vulgare**, *Microlaena stipoides*, *P. dilatatum**, *P. clandestinum** and *P. aquatica*.*

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

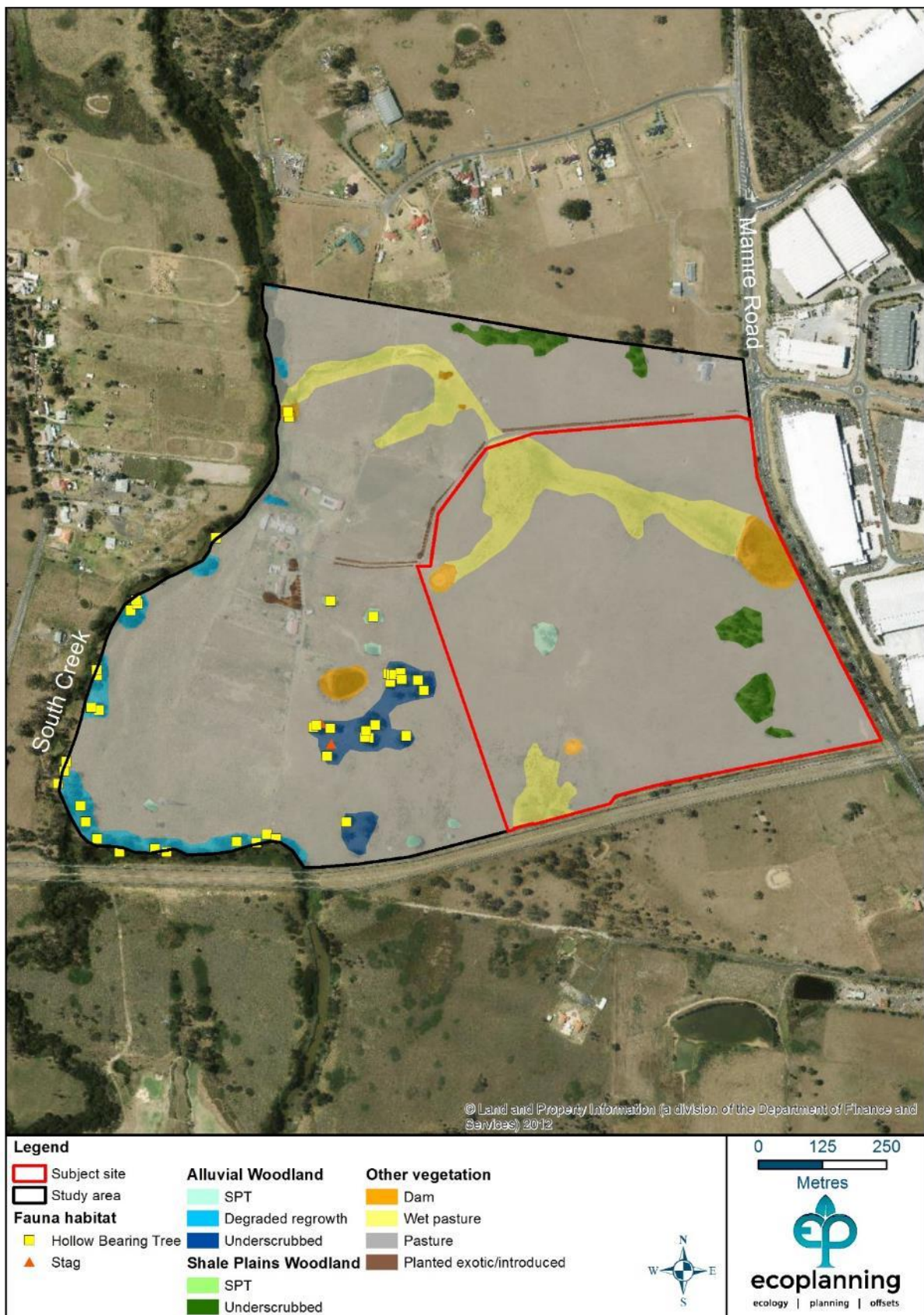


Figure 3.2: Field validated vegetation and fauna habitat.



Figure 3.3: A large farm dam onsite, colonised by native and exotic aquatic and semi-aquatic flora.



Figure 3.4: Wet pasture colonised by native and exotic sedge and rush species.

Shale Plains Woodland

This vegetation type is found as scattered remnants across the study area, usually as underscrubbed scattered paddock trees with little to no native midstorey or understorey (**Figure 3.5**). It is distinguished from the more common Alluvial Woodland by the presence of *Eucalyptus moluccana* (Grey Box), and also retains individuals of the canopy species, *E. tereticornis* (Forest Red Gum) and *E. amplifolia* (Cabbage Gum). All species are also associated with Alluvial Woodland, but the presence of *E. moluccana* appears to correspond closely to the distribution of shale derived soils and geology and has consequently been mapped as Shale Plains Woodland by NPWS (2002). Further analysis of the vegetation assemblage was not possible due to the highly degraded and depauperate state of the vegetation. This vegetation is mostly regrowth <80 years of age, with few hollows observed in the remnants surveyed.

Groundcover vegetation is dominated by introduced and exotic grasses including, *Pennisetum clandestinum** (Kikuyu), *Paspalum dilatatum** (Paspalum), *Ehrharta erecta** (Panic Veldtgrass), *Hordeum vulgare** (Barley), *Axonopus fissifolius** (Carpet Grass) and *Cynodon dactylon* (Couch). *Cynodon dactylon* is a cosmopolitan species, with the species recorded onsite considered to most likely be an introduced form of the species due to the dense mat forming habit and association with other species common to pasture improved paddocks.

A number of exotic herbs/shrubs are also present such as, *Cirsium vulgare** (Spear Thistle), *Conyza* spp. (Fleabane), *Hypochaeris radicata** (Catsear), *Taraxacum officinale** (Dandelion), *Stellaria media** (Chickweed), *Trifolium* spp.*, *Modiola caroliniana** (Red-flowered Mallow), and *Plantago lanceolata** (Lamb's Tongue).



Figure 3.5: Remnant trees of underscrubbed Shale Plains Woodland within the subject site.

Alluvial Woodland

This vegetation type is found in association with the riparian corridor and alluvial soils on the terraces of the associated floodplain (**Figure 3.6**). The community is dominated by *E. amplifolia*, with *Casuarina glauca* (Swamp Oak) and *C. cunninghamiana* (River Oak) occurring as sub-dominants on the banks of South Creek. *Angophora floribunda* (Rough-barked Apple) is also present, which is indicative of this vegetation type. Small stands containing *E. moluccana* have been distinguished from the Alluvial Woodland as described above.

This community is also found as underscrubbed canopy trees and scattered paddock trees, but is predominantly in the form of degraded regrowth along the South Creek river bank. In this form it is dominated by regrowth *Acacia mearnsii* (Black Wattle), *A. parramattensis* (Parramatta Wattle) and *Bursaria spinosa* subsp. *spinosa* (Native Blackthorn), and exotic shrub species including, *Rubus fruticosus** (Blackberry), *Ligustrum* spp.* (Privet), *Cestrum parqui** (Green Cestrum), *Solanum mauritianum** (Wild Tobacco Bush), *Senecio madagascariensis** (Fireweed) and *Verbena* spp.* (Purpletop).

The groundcover is dominated by exotic species, with the underscrubbed and scattered paddock tree vegetation very similar to the Shale Plain Woodland following pasture improvement. The area mapped as degraded regrowth on the riverbanks retains a more diverse assemblage dominated by exotic species including herbs/shrubs, *Conyza* spp.* (Fleabane), *H. radicata**, *Soliva sessilis* (Bindyi), *Sonchus oleraceus** (Common Sowthistle), *Brassica* sp.* (Brassica), *Stellaria media** (Chickweed), *Tradescantia fluminensis** (Wandering Jew), *Rumex crispus** (Curled Dock), *Trifolium* spp.*, *Vicia sativa** (Vetch), *M. caroliniana**, *P. lanceolata**, sedge/rushes and grasses including, *Cyperus eragrostis** (Umbrella Sedge), *A. fissifolius**, *Chloris gayana** (Rhodes grass), *Ehrharta erecta** (Panic Veldtgrass), *Eragrostis curvula** (African Lovegrass), *H. vulgare**, *P. dilatatum**, *P. clandestinum** (Kikuyu) and *Phalaris aquatica** (Phalaris).

The groundcover does retain some native resilience with species present in low abundance including sedges/rushes, *Lomandra longifolia* (Spiny-headed Mat Rush), *Juncus usitatus* and *Carex appressa* (Tall Sedge), grasses, *Austrostipa rudis* and *Imperata cylindrica* (Blady Grass), and herbs/climbers *Centella asiatica* (Indian Pennywort), *Dichondra repens* (Kidney Weed) and *Clematis aristata* (Old Man's Beard).



Figure 3.6: Underscrubbed Alluvial Woodland in the north-east of the site, with some regrowth vegetation to the left.

3.2.2 Key Fish Habitat

Strahler Stream Order for the reach of South Creek within the subject site was predetermined prior to field surveys with results showing South Creek at this location is of Fifth Order (see **Section 2.5**).

Assessment of KFH attributes recorded the presence of pool/riffle sequences and large woody debris > 300 mm in diameter and longer than 3 m along the reach of South Creek. Due to the presence of these attributes this reach of South Creek is identified as a *Type 1 – Highly Sensitive Key Fish Habitat* (DPI 2013) (**Table 3.2**).

The reach of South Creek within the study area is a permanently flowing fresh waterway. Therefore, following the DPI (2013) criteria for the classification of fish passage, the reach of South Creek is classified as *Class 1 – Major Key Fish Habitat* (**Table 3.2**).

Table 3.2: Key Fish Habitat Classification for South Creek, Mamre West Precinct.

	Strahler Stream Classification	Creek Type*	Creek Class*
South Creek	5 th Order	<i>Type 1 – Highly Sensitive Key Fish Habitat</i>	<i>Class 1 – Major Key Fish Habitat</i>

*As described in “Policy and Guidelines for Fish Habitat Conservation and Management “(DPI 2013)

As recommended by DPI (2013), in-situ water quality parameters of temperature, dissolved oxygen, pH, electrical conductivity (EC) and turbidity were recorded at one location along South Creek within the study area (**Figure 3.1**). Results show all water parameters, with exception of dissolved oxygen, were compliant with the ANZECC (2000) water quality guidelines for lowland rivers of south east Australia (**Table 3.3**). Low dissolved oxygen is common to streams on the urban and peri-urban fringe of the Sydney basin that are exposed to urban runoff (e.g. Wright et al 2011, Tippler et al 2012, Belmer et al 2015).

Table 3.3: Water quality results for South Creek, Mamre West Precinct.

Site	pH	Electrical Conductivity (uS/cm)	Dissolved Oxygen (% Saturation)	Turbidity (NTU)	Temperature (°C)
South Creek 1	7.98	1726	58.7	28.8	7.8
ANZECC*	6.50-8.00	125-2200	85-110	5-50	N/A

*ANZECC lowland river default guidelines for south east Australia (ANZECC 2000)

3.2.3 Riparian Vegetation and Creek Channel Condition

The riparian buffer observed along South Creek was generally > 40 m, however in the section adjacent to the Mandalong Park homestead it decreases to approximately 15 m. Land use along South Creek is predominantly pasture with bushland patches increasing toward the north of the subject site.

Inspection of the South Creek revealed a deeply incised channel with bedding materials predominantly consisting of fine clays. Patches of coarse bedding material were evident in shallow reaches however these appeared to be derived from sources other than the surrounding geology (i.e. road base and builders rubble).

Results of the RRA assessment show creek channel and riparian condition to range from “fair” to “poor”. Two sites were assessed as “fair” and two were assessed as “poor” (**Figure 3.7**).

The riparian vegetation community at points assessed as “fair” contained remnant native canopy trees often with native understorey species. However, most understorey and groundcover layers were densely colonised by invasive species with species such as *Rubus fruticosus* spp. aggr.* (Blackberry), *Conyza* spp.* (Fleabane), *Cestrum parqui** (Green Cestrum), *Ligustrum* spp.* (Privet), *Tradescantia fluminensis** (Wandering Jew), *Verbena* spp.* (Purple Top), *Foeniculum vulgare** (Fennel), *Rumex* spp. (Dock) and *Sida rhombifolia** (Paddy’s Lucerne).

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

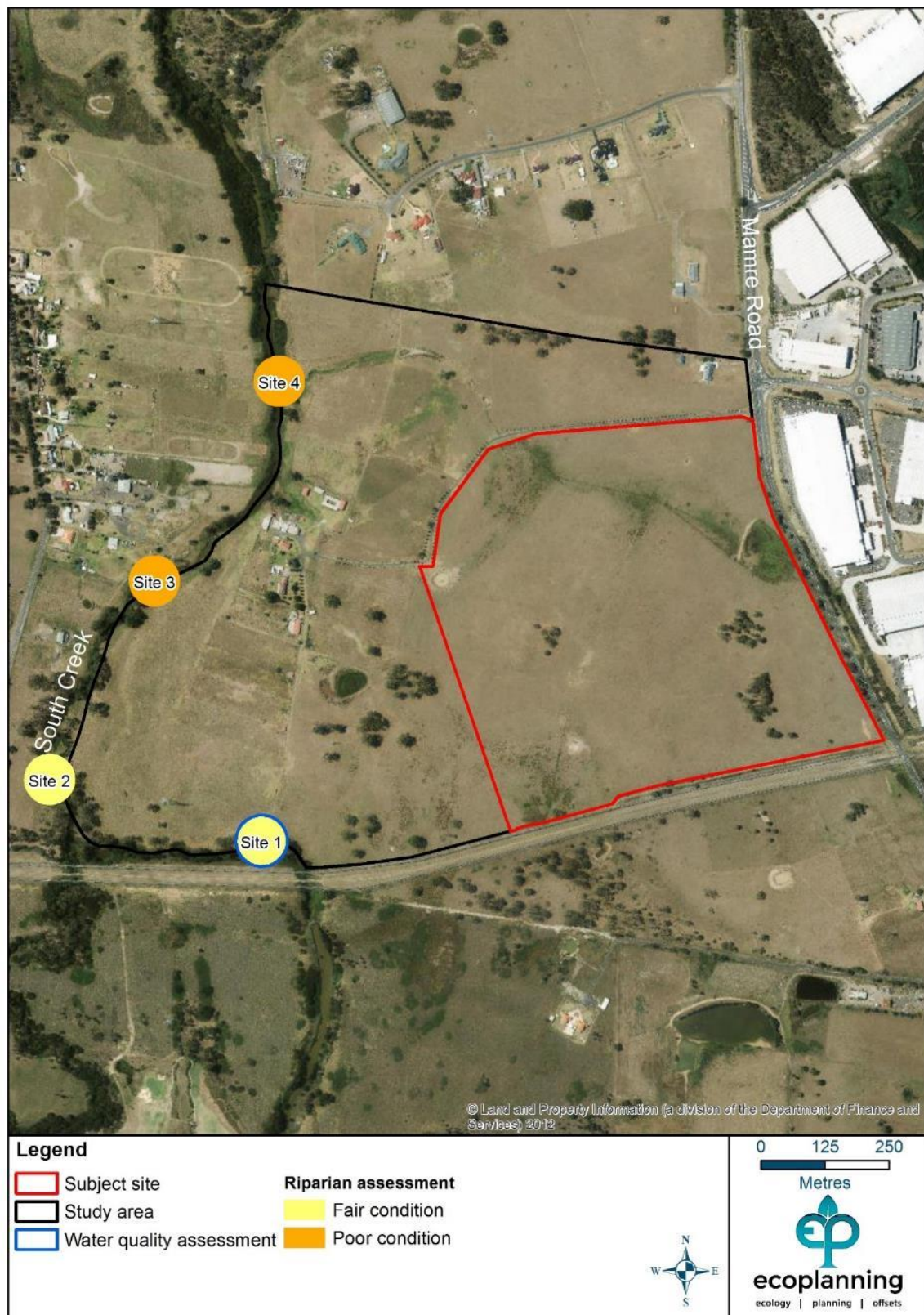


Figure 3.7: Rapid Riparian Appraisal (RRA) assessment sites with 50 m assessment buffer, corresponding assessment condition and water quality monitoring sites, South Creek, Mamre West Precinct.

The riparian vegetation community at points assessed as 'poor' contained isolated remnant native canopy trees however understorey and ground cover had been cleared due to livestock grazing which has resulted in pasture grass species such as *P. clandestinum** and *P. dilatatum** becoming dominant.

Numerous hollow bearing trees and dead stag trees were present along the South Creek riparian corridor and floodplain and large woody debris was found to be prolific within the creek channel.

Bank erosion was evident along the length of South Creek with bank slump, bank undercutting and bank erosion recorded at most assessment sites. The most severe erosion was evident at Site 2 where the presence of a well-used stock crossing has caused significant erosion to both creek bed and bank. These results indicate the current condition of South Creek along this reach is a significant departure from what would be considered an undisturbed waterway in a natural state with intact riparian and floodplain vegetation communities.

Table 3.4 provides a results summary of creek attributes, condition of riparian and instream habitat and RRA scores and condition. Site photos and detailed results for each assessment site can be found in **Appendix A**.

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area

Table 3.4: Results of Riparian and Creek Channel Assessment using RRA method (Findlay et al 2011).

Assessment Site	RRA Score x/87	RRA Condition	Riffle/Pool Habitat	Large Woody Debris	Width of Riparian Buffer	Riparian Weed Cover on Banks	Overhanging Vegetation	Bank Slump	Bank Undercutting
Site 1	10.9	Fair	Absent	High (>10)	>40 m	Severe (> 70%)	Moderate (>30<60%)	Minor (<10% of bank)	Severe (>30% of bank)
Site 2	22.1	Fair	Present	Moderate (4-10)	>40 m	Light (< 40%)	Moderate (>30<60%)	Severe (>30% of bank)	Severe (>30% of bank)
Site 3	-1.6	Poor	Absent	Moderate (4-10)	>40 m	Light (< 40%)	Low (<30%)	Minor (<10% of bank)	Severe (>30% of bank)
Site 4	5.6	Poor	Absent	High (>10)	>40 m	Severe (> 70%)	Low (<30%)	Minor (<10% of bank)	Moderate (10-30% of bank)

4. Conclusion

4.1 Groundwater Dependent Ecosystems

Review of groundwater mapping for the Hawkesbury-Nepean Catchment (Serov et al 2012) showed no groundwater sources to be present within or adjacent to the study area. In addition, a review of the GDE Atlas (BOM 2012), also showed no GDE's to be present within the subject site.

Although there are multiple constructed dams within the subject site water supply for these is derived from rainfall and resulting overland flows and stormwater runoff from the adjacent industrial estate. Therefore, the ecological communities found within these dams and associated drainage depressions are not groundwater dependent.

Several degraded and isolated patches of Shale Plains Woodland and Alluvial Woodland occur within the subject site (Ecoplanning 2015). Although this vegetation maintains year round green foliage the most likely water source to these is rainfall.

Historic rainfall records (1970 -2015) for the Orchard Hills area (BOM 2016) show consistent falls are recorded throughout the year and therefore would provide a reliable water source to these vegetation patches even throughout what could be considered "dry spells". Therefore, it is considered that these small, isolated and degraded patches of vegetation are not groundwater dependent.

Review of the GDE Atlas (BOM 2012) showed South Creek as being reliant on the surface expression of groundwater. The riparian community of Cosgrove Creek is identified as having high potential for groundwater interaction. Both of these GDE's are located outside of the subject site and study area, and lie within South Creek 'Floodway' as defined by the NSW Floodplain Development Manual: The Management of Flood Liable Land (April 2005).

Due to the absence of known groundwater sources and GDE's within the study area, the proposal will not impact on GDE's adjacent to the study area.

4.2 Riparian assessment

4.2.1 Key Fish Habitat

Following the framework outlined by Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI 2013) this assessment concludes the reaches of South Creek and Cosgroves Creek are Type 1, Class 1 KFH. As a result, a riparian setback of 100 m from top of bank is recommended by *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI 2013) (**Table 4.1**). This riparian setback does not intersect with the subject site.

Table 4.1: Waterway class, type and recommended riparian buffer.

Waterway	Waterway Type	Waterway Class	Recommended Riparian Buffer
South Creek	Type 1 – Highly Sensitive KFH	Class 1 – Major KFH	100 m from Top of Bank

¹Taken from Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013)

4.2.2 Riparian corridors

Consistent with the *Guidelines for Riparian Corridors on Waterfront Land* (DPI 2012a) the riparian corridors, or 'buffers', required for each creek were determined based on Strahler Stream Order. Riparian corridor buffer widths as recommended by DPI (2012a) are summarised in **Section 2.5.2**. Riparian corridors do not intersect with the subject site and no impacts to the bed and bank will occur from the proposal.

The Concept Civil Works Plan for the subject site (Costin and Rowe 2015) shows a drainage easement will be constructed to move stormwater from subject site to South Creek. A drainage easement has been formalised to follow the existing path of the drainage depression that joins the north-west corner of the subject site to South Creek (**Appendix B**).

5. Recommendation

This study identified three farm dams within the subject site, and although not considered GDE's, these are likely to provide habitat to native fauna species. Of particular note is the large dam located adjacent to Mamre Rd and the smaller dam located on the western boundary of the subject site. Both of these dams are connected to South Creek by a low ephemeral constructed/modified drainage depression connecting the dams to a First Order stream. This drainage area provides a corridor for species native aquatic and semi-aquatic fauna (such as turtles and eels) to move between habitat refuges. It is recommended a dewatering plan be developed for the removal of these dams from the subject site.

The Concept Civil Works Plan for the subject site (Costin and Rowe 2015) shows a drainage easement will be constructed to move stormwater from subject site to South Creek. A drainage easement has been formalised to follow the existing path of the drainage depression that joins the north-west corner of the subject site to South Creek (**Appendix B**).

The upper section of the proposed drainage easement follows an existing drainage depression, becoming a mapped (un-named) First Order stream as it approaches South Creek. A 14 m easement encompassing this degraded First Order stream and drainage depression has been negotiated with the adjacent landholder to accommodate the proposed construction works required to complete this stormwater flowpath. Although this short section of creek is degraded, further consultation with NSW Office of Water (NOW) will be necessary with respect to Controlled Activity under the WM Act. Advice received to date from NOW (Gina Potter, Water Regulation Officer), has been that the proposal will be assessed as Integrated Development following submission of this Development Application.

References

ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, the guidelines / Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand.

Australian Bureau of Meteorology (2015) The Atlas of Groundwater Dependent Ecosystems <http://www.bom.gov.au/water/groundwater/gde/>

Bannerman S.M. and Hazelton P.A., (1990) Soil Landscapes of the Penrith 1:100,000 Sheet map and report, Soil Conservation Service of NSW, Sydney.

Belmer, N., Wright I.A and Tippler C. (2015) Urban geochemical contamination of high conservation value upland swamps, Blue Mountains, Australia. *Water, Air, and Soil Pollution*, (In press).

Clark N.R. and Jones D.C. (1991) Penrith 1:100 000 Geological Sheet 9030, 1st edition. Geological Survey of New South Wales, Sydney.

Ecoplanning (2015) Ecological and Riparian Assessment – Mamre West Precinct, Orchard Hills, Western Sydney Employment Area (v. 1.2). Prepared for ALTIS Property Partners Pty Ltd.'

Findlay, S., Davies, P., Taylor, M. and Fletcher, A. (2011) Development and Application of a Rapid Assessment Tool for Urban Stream Networks. *Water and Environment Journal*, pp. 2-12.

NSW National Parks and Wildlife Service (NPWS) (2002) Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney, Final Edition NSW NPWS, Hurstville.

NSW Department of Primary Industries (DPI) (DPI2012a) Office of Water Controlled Activities on Waterfront Land – Guidelines for Riparian Corridors on Waterfront Land.

NSW Department of Primary Industries (DPI) (DPI2012b) Office of Water Guidelines for Vegetation Management Plans on Waterfront Land.

NSW Department of Primary Industries (2013). Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (update).

Serov P., Kuginis L. and Williams J.P (2012) Risk Assessment Guidelines for Groundwater Dependent Ecosystems, Volume 1 – The Conceptual Framework. NSW Department of Primary Industries, Office of Water, Sydney

Richardson S. (2011) Australian Groundwater Dependent Ecosystem Toolbox Part 1: Assessment Framework, Waterlines Report, National Water Commission, Canberra.

Tippler C., Wright I.A and Hanlon A. (2012). Is catchment imperviousness a keystone factor degrading urban waterways? A case study from a partly urbanised catchment (Georges

River, South-Eastern Australia). *Water, Air, and Soil Pollution*, Vol. 223, Issue 8, pp. 5331 – 5344.

Urbis (2016). Development Control Plan – Mamre West Land Investigation Area (February 2016).

Wright, I. A., Davies, P. J., Findlay, S. J., and Jonasson, O. J. (2011). A new type of water pollution: concrete drainage infrastructure and geochemical contamination of urban waters. *Marine and Freshwater Research* 62, 1355–1361.

Appendix A: Riparian site assessment results



CT ENVIRONMENTAL SITE ASSESSMENT

Assess Date 10/08/2015
Assess Time 1:33 pm
Assessed By Carl Tippler

South Creek Site 1

Site Condition
and Score

fair
10.9

notes

The site is in fair condition, with a score of 10.9 overall.

In-situ Water Quality
pH- 7.98
EC- 1726 uS/cm
DO- 58.7 %
Turbidity- 28.8 NTU
Temp- 7.8 C

landuse

Within the 50 meter assessment radius, left bank land use is 10% bushland, 90% pasture, approximately. Right bank land use is 40% bushland, 60% pasture, approximately. This is included in the site features score.

vegetation

Within the 50 meter assessment radius, left bank vegetation structure is 10% shrubland, 20% open woodland, 70% open grass/pasture, approximately. Right bank vegetation structure is 10% shrubland, 20% open woodland, 60% open grass/pasture, 10% native grassland, approximately. This is reflected in the vegetation structure subtotal.

upstream



downstream



extraction	absent
excavation	absent
litter	low 1-5
sewer line/stormwater outlet	absent
odour	normal/none
turbidity	high

Land Use	Subtotal	3.5
Site Features	Total	3.5

channel shape	straightened/deepened
pool riffle sequence	absent
meanders	unconfined yes
large woody debris	high >10
overhanging vegetation	mod <30>60%

Channel Features	Total	6
------------------	-------	---

benches	absent
islands	absent
channel bars	absent

Deposition	Total	0
------------	-------	---

bedrock exposure	absent
within channel	absent
undercutting	severe >30% bank
bank slumps	minor <10% bank
knick point	absent
bank erosion	absent

Erosion	Total	-4
---------	-------	----

riparian buffer width left	over 40m
riparian buffer width right	over 40m

Riparian Vegetation	Subtotal	20
---------------------	----------	----

Vegetation Structure	Subtotal	5.4
----------------------	----------	-----

weed density left bank	severe over 70%
weed density right bank	severe over 70%

Weeds	Subtotal	-20
-------	----------	-----

Vegetation	Total	5.4
------------	-------	-----

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area



CT ENVIRONMENTAL SITE ASSESSMENT

Assess Date 10/08/2015
Assess Time 2:18 pm
Assessed By Carl Tippler

South Creek Site 2

Site Condition
and Score

fair
22.1

notes

The site is in fair condition, with a score of 22.1 overall.

Heavily grazed banks have resulted in lower weed cover. Dominant ground cover includes a majority of pasture grass species.

landuse

Within the 50 meter assessment radius, left bank land use is 10% bushland, 90% pasture, approximately. Right bank land use is 20% bushland, 80% pasture, approximately. This is included in the site features score.

vegetation

Within the 50 meter assessment radius, left bank vegetation structure is 10% open woodland, 90% open grass/pasture, approximately. Right bank vegetation structure is 20% open woodland, 80% open grass/pasture, approximately. This is reflected in the vegetation structure subtotal.

upstream



10/08/2015 2:21:57 PM

downstream



10/08/2015 2:22:19 PM

extraction	absent
excavation	absent
litter	absent
sewer line/stormwater outlet	absent
odour	normal/none
turbidity	medium

Land Use Subtotal 1.3

Site Features Total 5.3

channel shape	widened/infilled
pool riffle sequence	present
meanders	unconfined yes
large woody debris	moderate 4-10
overhanging vegetation	mod <30>60%

Channel Features Total 7

benches	absent
islands	absent
channel bars	no restriction

Deposition Total 1

bedrock exposure within channel	absent
undercutting	severe >30% bank
bank slumps	severe >30% bank
knick point	absent
bank erosion	gully/rill

Erosion Total -9

riparian buffer width left	over 40m
riparian buffer width right	over 40m

Riparian Vegetation Subtotal 20

Vegetation Structure Subtotal 3.8

weed density left bank	light up to 40%
weed density right bank	light up to 40%

Weeds Subtotal -6

Vegetation Total 17.8

Groundwater Dependent Ecosystem, Key Fish Habitat and Riparian Assessment
585-649 Mamre Road, Orchard Hills, Western Sydney Employment Area



CT ENVIRONMENTAL SITE ASSESSMENT

Assess Date 10/08/2015
Assess Time 2:35 pm
Assessed By Carl Tippler

South Creek Site 3

Site Condition
and Score

poor
-1.6

notes

The site is in poor condition, with a score of -1.6 overall.

Heavy grazing on left and right banks has limited weed invasion. Dominant species include pasture grass species.

landuse

Within the 50 meter assessment radius, left bank land use is 100% peri-urban mixed use, approximately. Right bank land use is 100% pasture, approximately. This is included in the site features score.

vegetation

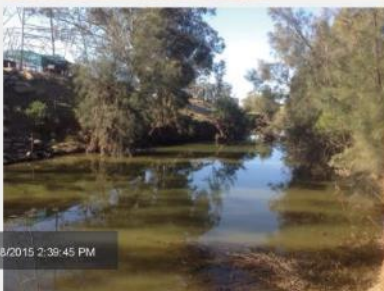
Within the 50 meter assessment radius, left bank vegetation structure is 100% open grass/pasture, approximately. Right bank vegetation structure is 10% shrubland, 90% open grass/pasture, approximately. This is reflected in the vegetation structure subtotal.

upstream



10/08/2015 2:39:27 PM

downstream



10/08/2015 2:39:45 PM

extraction water
excavation absent
litter low 1-5
sewer line/stormwater outlet absent
odour normal/none
turbidity medium

Land Use Subtotal -3

Site Features Total -5

channel shape straightened/deepened
pool riffle sequence absent
meanders unconfined yes
large woody debris moderate 4-10
overhanging vegetation low <30%

Channel Features Total 4

benches absent
islands absent
channel bars absent

Deposition Total 0

bedrock exposure within channel absent
undercutting severe >30% bank
bank slumps minor <10% bank
knick point absent
bank erosion gully/rill

Erosion Total -7

riparian buffer width left 10-20m
riparian buffer width right over 40m

Riparian Vegetation Subtotal 10

Vegetation Structure Subtotal 2.4

weed density left bank light up to 40%
weed density right bank light up to 40%

Weeds Subtotal -6

Vegetation Total 6.4

Appendix B: Concept Civil Works Plan for stormwater

