

## 6.5 RIPARIAN ASSESSMENT

A number of significant waterways are present in the study area including Mullet Creek, Duck Creek, Marshall Mount Creek and Macquarie Rivulet (DIPNR 2004) (**Figure 8** and **Figure 9**). Elevations within this area are effectively bounded by the north-south oriented escarpment ridgelines range from approximately 360 metres (m) AHD at the top of the Calderwood Valley, falling away in an easterly direction to sea level closer to Lake Illawarra.

Watercourses in the Wollongong local government area have been assessed by DIPNR (2004) in the Riparian Corridor Management Study which uses 3 categories to describe the long term outcomes for the riparian zone categorises watercourses into 3 categories and provides objectives for the long term management. The width of the riparian zone is measured from the Top of Bank. Whilst this had been mapped indicatively by DIPNR (2004), detailed ToB mapping was undertaken by ELA using a combination of Lidar data analysis (GIS mapping) and field verification using a differential Geographic Positioning System). This detailed mapping was undertaken where watercourse crossings occurred in the Project Application area only.

**Table 15 Riparian Corridor Management Study categories**

	Objective	Buffer zone
Category 1	Environmental Corridor	40m Core Riparian Zone + 10m Vegetated Buffer
Category 2	Terrestrial and Aquatic Habitat	20m Core Riparian Zone + 10m Vegetated Buffer
Category 3	Bed and bank Stability	10m Vegetated Buffer

Representative riparian reaches for each RCMS type in both 'cleared' and 'uncleared' areas were given a rating between 1-5, where 1 indicates poor condition and 5 indicates excellent condition (**Table 16**). Overall, riparian condition is variable between RCMS categories: Category 1 streams (highest environmental importance) are in better condition than Category 2 and Category 3 streams; and sites in 'uncleared' areas are markedly better than those in 'cleared' areas. Validation at an additional 77 sites confirmed that these scores are reflective of the general condition of streams along the proposed pipeline routes. Therefore, a desktop assessment from aerial photography for the remaining riparian sites is considered suitable to evaluate impacts and make recommendations for impact mitigation. For the Field Assessment Area, it can be extrapolated that Category 1 sites in 'uncleared' areas are in good condition, whilst those in 'cleared' areas or of Category 2 and Category 3 are in poor to moderate condition. Two sites were in reaches with no RCMS classification. Both are in 'cleared' areas and received poor condition scores.

GDEs in the Study area are uncommon. Dominant types along the proposed pipeline routes include Coastal Swamp Oak Forest, Riparian River Oak Open Forest and Coastal Freshwater Lagoons. All of these communities are confined to the riparian corridor and adjacent floodplains. With the exception of some freshwater lagoons, the longitudinal shape of these GDEs match the drainage corridor with a rigid proximity to flowing water. This suggests that they are less dependent on groundwater and more dependent of river processes such as nutrients, soil type, base-flows (surface representation of groundwater) and flooding. However, a long history of landscape clearing, reshaping and management may also regulate the potential extent of these communities. Nonetheless, given the current extent, potential impacts to these communities will be equivalent to those on other riparian vegetation.

Freshwater lagoons are depressions in the floodplain, either in shallow drainage lines or separated by small levees. Their low-lying position in the landscape implies they may be dependent on water table levels, but

also over-bank flooding and localised ponding. Artificial changes to the micro-topography surrounding these wetlands may alter the holding capacity, resulting in a loss or increase of wetland habitat.

## 6.6 AQUATIC HABITAT ASSESSMENT

Surveyed sites were given a rating between 1-5; where 1 indicates poor condition and 5 indicates excellent condition (**Table 17**). Field surveys at these sites conclude that the overall condition of aquatic habitats is moderate. When tested against riparian condition scores at the same sites, there is a positive (but weak) relationship between riparian and aquatic habitat condition (**Figure 10**), although driving factors influencing aquatic condition will extend upstream and beyond the immediate riparian zone. Validation at an additional 77 sites confirmed that these scores are reflective of the general condition of in-stream habitat along the proposed pipeline routes. Given the highly disturbed nature of the Study area and the positive relationship with riparian condition, it is considered suitable to use a desktop assessment for the remaining sites to evaluate impacts and make recommendations for mitigation strategies.



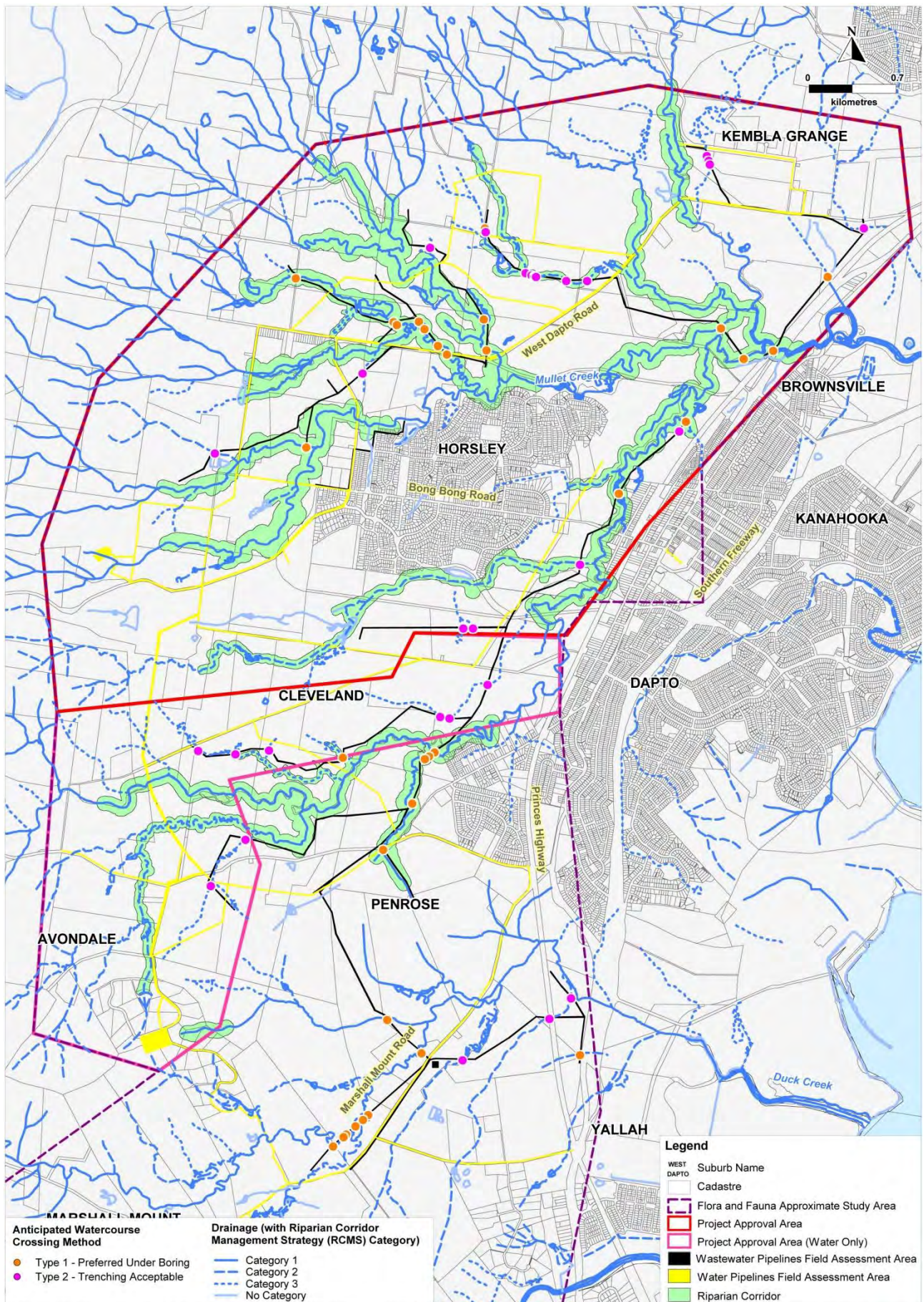


Figure 8: Riparian features of the Study area (north)



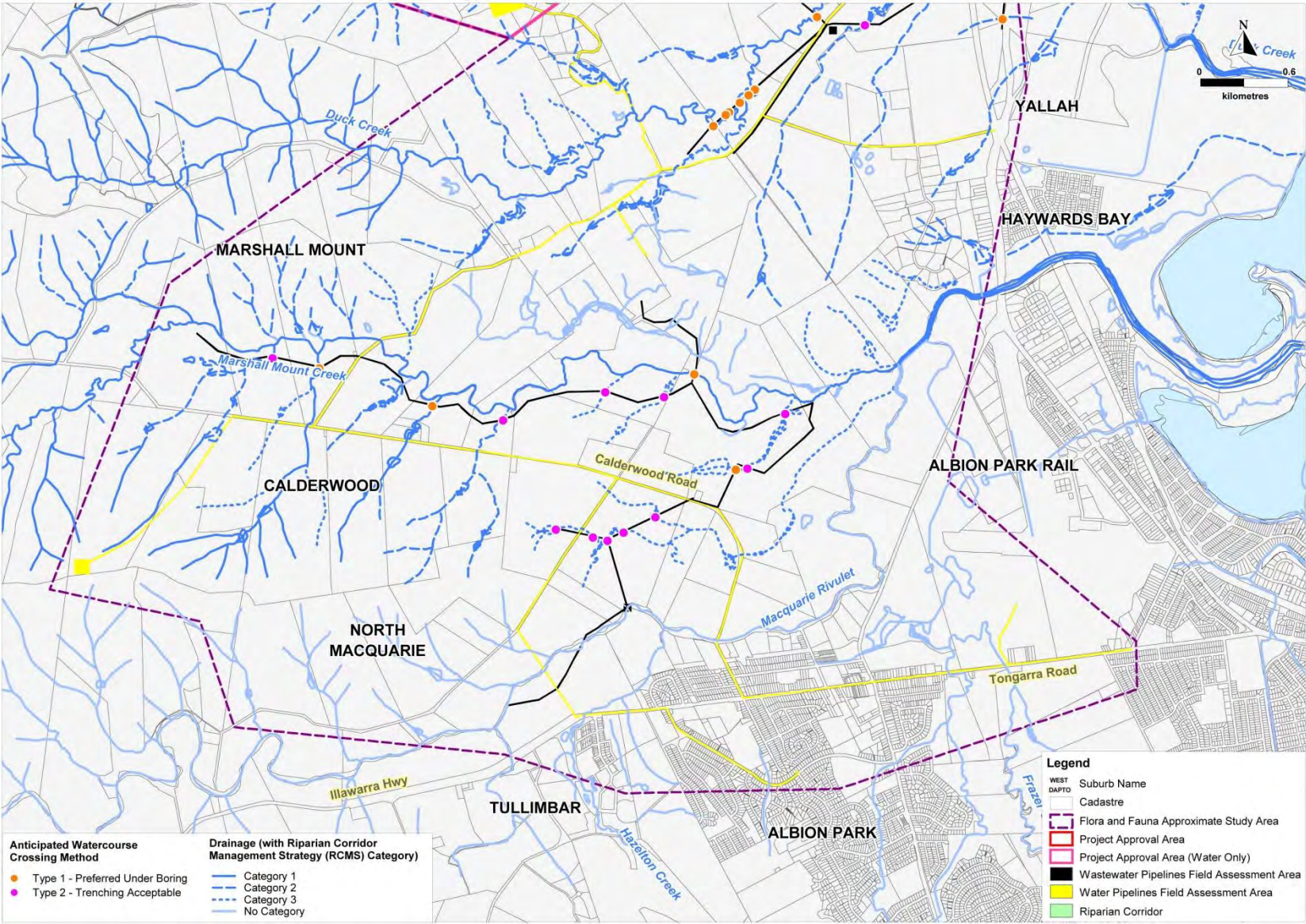


Figure 9: Riparian features of the Study area (south)

Table 16: Riparian condition scores for 21 representative sites in each RCMS type for 'cleared' and 'uncleared' areas (UTM Zone 56).

RCMS Category	Adjacent land	Site No.	Longitude	Latitude	Area	Spatial Integrity	Nativeness	Structural Integrity	Age Structure	Debris	Average	Overall (1-5)
1	Cleared <sup>1</sup>	16	294811	6182904	Project	2	2	2	2	2	2	1.9
		29	294052	6181514	Project	2	2	2	2	3	2.2	
		94	295108	6183233	Project	2	2	2	2	4	2.4	
		497	295320	6182630	Project	1	1	1	1	1	1	
		520	292943	6180787	Project	2	3	2	2	2	2.2	
		562	292299	6173900	Concept	2	2	2	2	2	2	
		564	292050	6174020	Concept	1	2	2	1	2	1.6	
	Uncleared <sup>2</sup>	200	293499	6182177	Project	5	3	4	5	4	4.2	4.1
		248	295209	6177101	Project	5	3	5	5	5	4.6	
		298	295599	6183070	Project	4	3	3	3	3	3.2	
		337	295150	6177401	Project	5	4	5	5	5	4.8	
		443	294386	6182125	Project	5	3	4	3	4	3.8	
2	Cleared <sup>1</sup>	477	293300	6173980	Concept	1	1	1	1	3	1.4	1.4
	Uncleared <sup>2</sup>	32	294004	6181556	Project	5	3	3	3	4	3.6	3.3
		113	295209	6180501	Project	3	3	4	4	4	3.6	
		563	292376	6174061	Concept	3	3	2	3	2	2.6	
3	Cleared <sup>1</sup>	301	294955	6183506	Project	1	1	1	1	1	1	1.1
		304	295580	6183232	Project	1	1	1	1	2	1.2	
		464	294010	6173297	Concept	1	1	1	1	2	1.2	
	Uncleared <sup>2</sup>	N/A	-	-	-	-	-	-	-	-	-	N/A
Other <sup>3</sup>	Cleared <sup>1</sup>	219	292250	6172048	Concept	2	2	2	2	3	2.2	2.2

		560	295850	6173325	Concept	2	2	2	2	3	2.2	
	Uncleared <sup>2</sup>	N/A	-	-	-	-	-	-	-	-	-	N/A

<sup>1</sup> 'Cleared' = adjacent land on both sides substantially cleared of terrestrial canopy.

<sup>2</sup> 'Uncleared' = at least one side of adjacent land has some terrestrial canopy, although clearing may still be present and dominant.

<sup>3</sup> Other = reach not classified in the RCMS (DIPNR 2004).

**Table 17: Aquatic habitat condition scores for 21 representative sites in each RCMC type for 'cleared' and 'uncleared' areas.**

RCMS Category	Zone	Site No.	Channel Modification	Bank Slope	Erosion	Connectivity	Turbidity	Substrate	Macrophyte Richness	Native Macrophyte Abundance	Debris	Average	Overall	Fish Potential
1	cleared	16	5	4	1	4	3	1	1	1	2	2.4	3.0	Class 2
		29	4	3	1	4	4	5	2	2	1	2.9		Class 2
		94	5	4	1	5	3	3	2	3	5	3.4		Class 2
		497	5	4	1	5	3	1	2	2	1	2.7		Class 2
		520	5	5	5	5	dry	3	1	1	3	3.5		Class 4
		562	4	5	5	2	3	1	4	2	2	3.1		Class 4
		564	4	5	5	2	3	1	2	2	1	2.8		Class 4
	uncleared	200	5	4	4	5	5	4	1	1	5	3.8	3.3	Class 2
		248	5	4	5	4	2	1	2	3	5	3.4		Class 3
		298	5	3	1	5	3	2	1	1	2	2.6		Class 2
		337	5	4	5	4	2	1	5	4	5	3.9		Class 3
		443	5	4	5	5	dry	1	1	1	2	3.0		Class 4
2	cleared	477	5	4	3	2	3	1	4	4	1	3.0	3.0	Class 4
	uncleared	32	3	5	5	3	4	3	2	5	5	3.9	3.3	Class 3
		113	5	5	5	5	3	1	4	2	3	3.7		Class 3

RCMS Category	Zone	Site No.	Channel Modification	Bank Slope	Erosion	Connectivity	Turbidity	Substrate	Macrophyte Richness	Native Macrophyte Abundance	Debris	Average	Overall	Fish Potential
		563	5	5	2	2	1	1	1	1	2	2.2		Class 4
3	cleared	301	3	5	5	3	3	1	3	4	1	3.1	3.1	Class 4
		304	5	5	5	5	1	3	1	1	1	3.0		Class 4
		464	5	5	5	2	2	1	3	4	1	3.1		Class 4
		N/A	-		-	-	-	-	-	-	-	-		N/A
	uncleared	N/A	-		-	-	-	-	-	-	-	-	-	N/A
4	cleared	219	5	4	3	4	4	5	1	1	5	3.6	3.4	Class 4
		560	5	3	3	5	3	3	2	2	3	3.2		Class 1
	uncleared	N/A	-	-	-	-	-	-	-	-	-	-	-	N/A

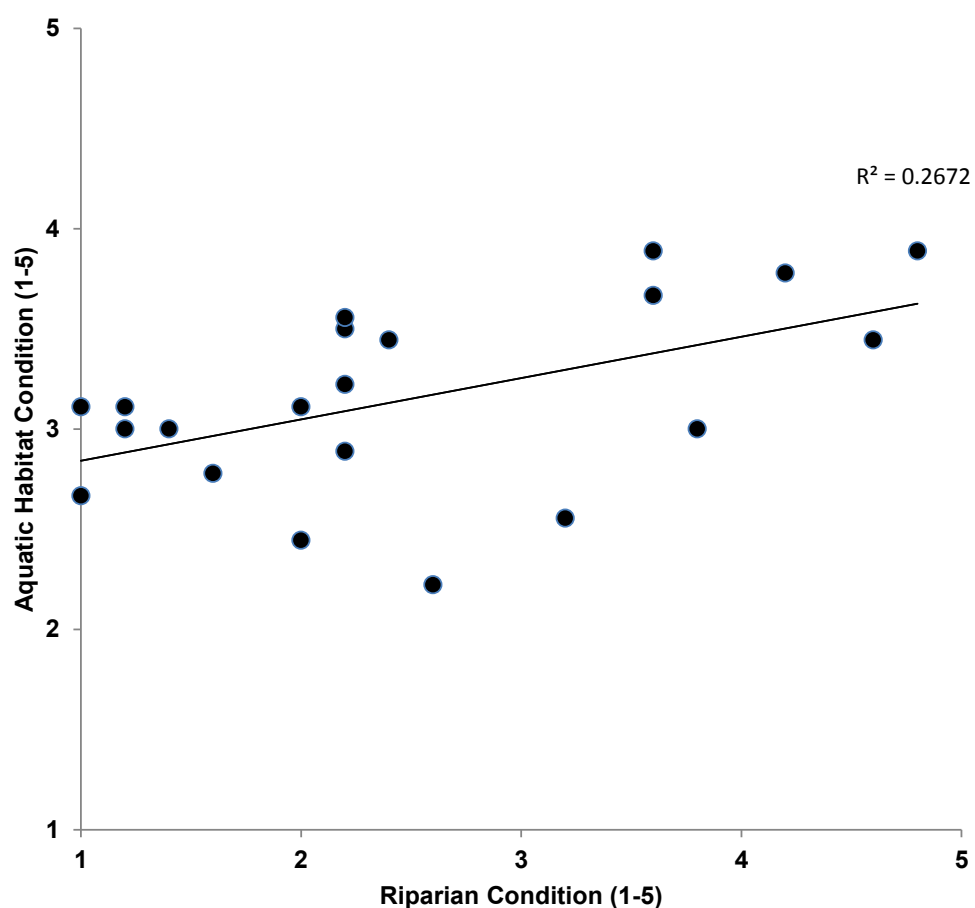


Figure 10: Positive relationship between riparian condition and aquatic habitat condition at 21 field sites along the proposed pipe route; where a score of 1 implies poor condition and 5 implies excellent condition.



## 7 Impact Evaluation

### 7.1 INTRODUCTION

This section of the report outlines the anticipated ecological impacts from the Proposal. Impacts are described for the Project Application area and the Concept Plan area. Note however that the Project Application is a sub-set of the total Concept Plan area. The term **direct impact** is used to describe the area of native vegetation or habitat subject to direct disturbance of the ground surface.

### 7.2 FLORA AND FAUNA

#### 7.2.1 Overview

The Proposal will result in the removal of up to 3.38 ha of native vegetation, including 1.28 ha in the Project Application area. Of this vegetation clearing, one endangered ecological community will be impacted, Illawarra Lowland Grassy Woodlands. **Table 18**, **Table 19** and **Table 20** show the distribution of this potential impact in terms of vegetation type, proposed infrastructure and direct impact area.

**Figure 11** and **Figure 12** highlight the direct impact areas of on native vegetation. Each of these direct impact areas are then further described. The direct impacts will result in:

- A direct reduction in the extent of these communities in the local area
- A loss of fauna habitat
- Potential incidental mortality of threatened bats during clearing
- Temporary minor fragmentation of remnant woodland and grassland vegetation
- Weed invasion from edge effects

**Table 18: Proposed vegetation clearing by vegetation type**

Vegetation type	Area	Proposed clearing (ha)				
		Wastewater	Water	Pumping station	Reservoirs	Total
Illawarra Lowland Grassy Woodlands EEC	Project Appl.	0.15	0.47	0.0	0.34	0.96
	Remaining Concept Plan	0.44	0.65	0.0	0.04	1.13
Other Native Vegetation	Project Appl.	0.0	0.0	0.0	0.32	0.32
	Remaining Concept Plan	0.36	0.36	0.25	0.0	0.97
Total Native Vegetation clearing	Project Appl.	0.15	0.47	0.0	0.66	1.28
	Remaining Concept Plan	0.80	1.01	0.25	0.04	2.10
	Total Concept Area	0.95	1.48	0.25	0.70	3.38

**Table 19: Proposed vegetation clearing by Project Approval or Concept Plan area**

Location	Proposed clearing (ha)		
	EEC	Other native vegetation	Total
Project Application area	0.96	0.32	1.33
Concept Plan only	1.13	0.97	2.1
Totals	2.09	1.29	3.38

**Table 20: Proposed vegetation clearance by Direct Impact Area**

Direct Impact Area	Vegetation type	Proposed clearing (ha)				
		Wastewater	Water	Pumping station	Reservoirs	Total
DIA1	Illawarra Lowland Grassy Woodlands EEC	0.15				0.15
DIA2			0.17			0.17
DIA3			0.30		0.34	0.64
DIA4	Other Native Vegetation				0.32	0.32
DIA5	Illawarra Lowland Grassy Woodlands EEC	0.16	0.20			0.36
DIA6		0.07				0.07
DIA7		0.08				0.08
DIA8		0.10				0.10
DIA9			0.20			0.20
DIA10		0.03				0.03
DIA11	Other Native Vegetation	0.07		0.25		0.32
DIA12		0.18				0.18
DIA13		0.11				0.11
DIA14			0.36			0.36
	Illawarra Lowland Grassy Woodlands EEC		0.25		0.04	0.29
Total Native Vegetation clearing		0.95	1.48	0.25	0.7	3.38

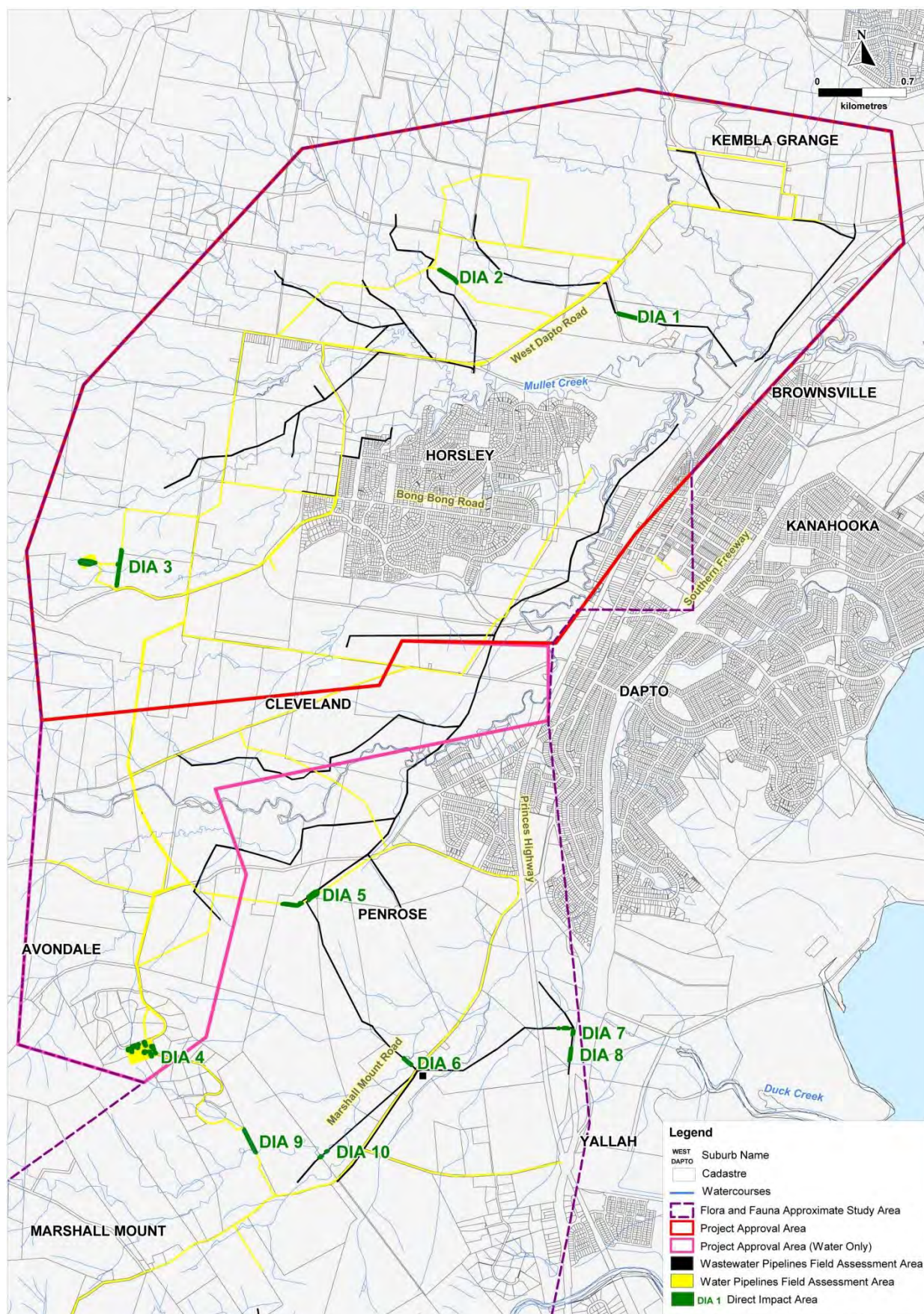


Figure 11: Direct impacts expected from the Proposal



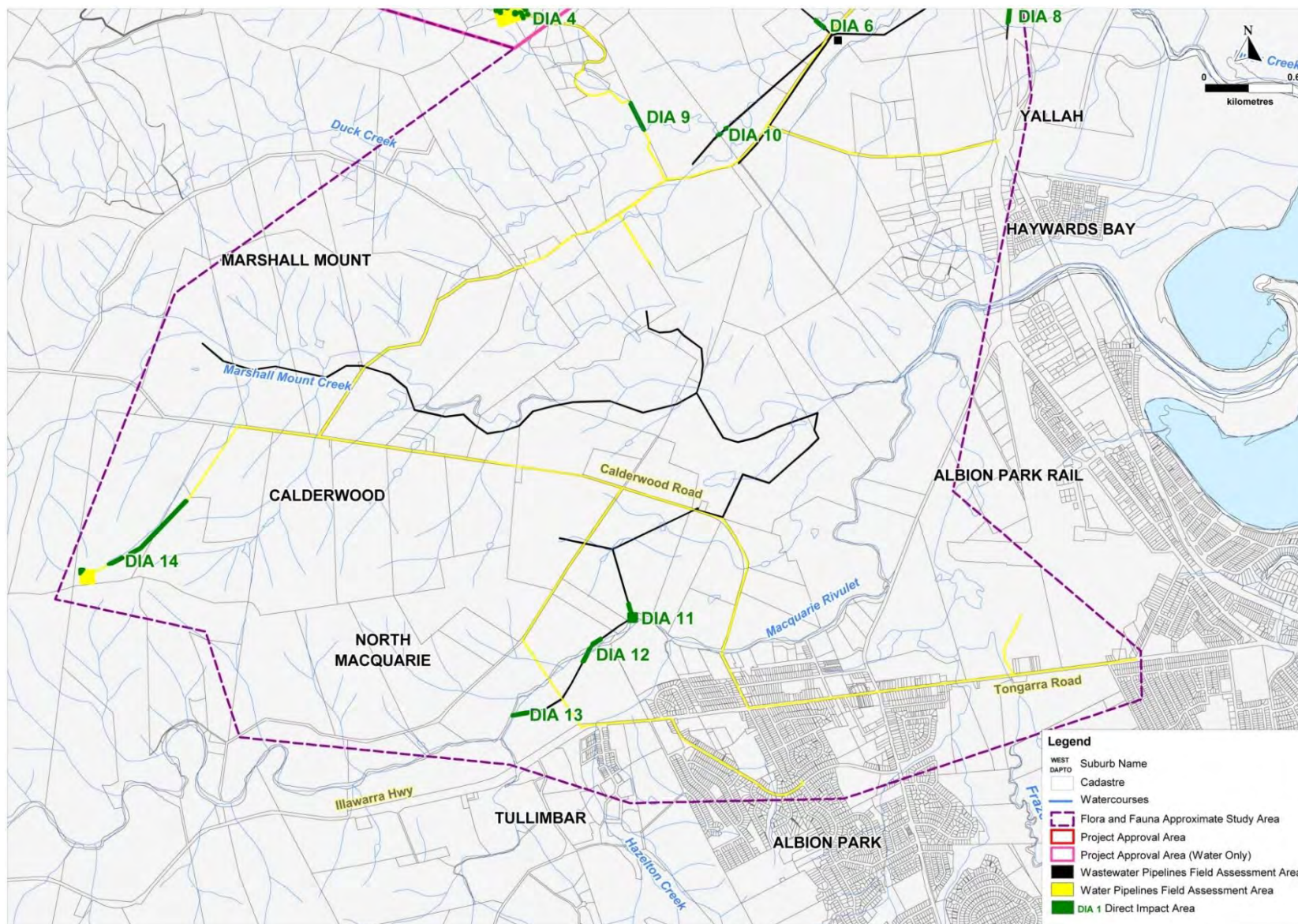


Figure 12: Direct impacts expected from the Proposal



### 7.2.2 Discussion of specific locations

This section describes the impacts to native vegetation and habitat after the avoidance strategies during the pipeline design process were followed.

#### *Project Application Area*

#### *Direct Impact Area 1 – Darkes Rd, Kembla Grange*

Impacts to existing vegetation at this site will be due to construction of a wastewater pipeline (**Figure 13**). Initially the wastewater pipeline in this area was proposed adjacent to Sheaffes Creek, but through a process of consultation, Sydney Water were able to redesign the footprint of this pipeline to avoid the dense forest remnant surrounding Sheaffes Creek, and consequently any incursion the riparian area of this water course.

The final proposed emplacement of this pipeline is almost entirely through managed parkland adjacent to Darkes Rd. Whilst this parkland is considered to be a remnant of the EEC, Illawarra Lowland Grassy Woodland (ILGW), the structure of this remnant is maintained in a significantly reduced condition state, with little or no native grass in the understorey and no shrub layer present. A 10m footprint has been calculated through the mapped remnant vegetation, though the trenching required to install this pipeline will not necessitate the removal of any trees from this EEC. Rather it will solely involve the removal of exotic lawn grasses and the re-emplacement of the soil material.

When an impact area of 10m is considered in this remnant, an area of approximately 0.15 ha of EEC has been considered for impact assessment at this site, though when considered against the above avoidance and minimisation measures, impacts to the EEC at this site are considered negligible.



Figure 13: Direct impact area 1, Darkes Rd, Kembla Grange

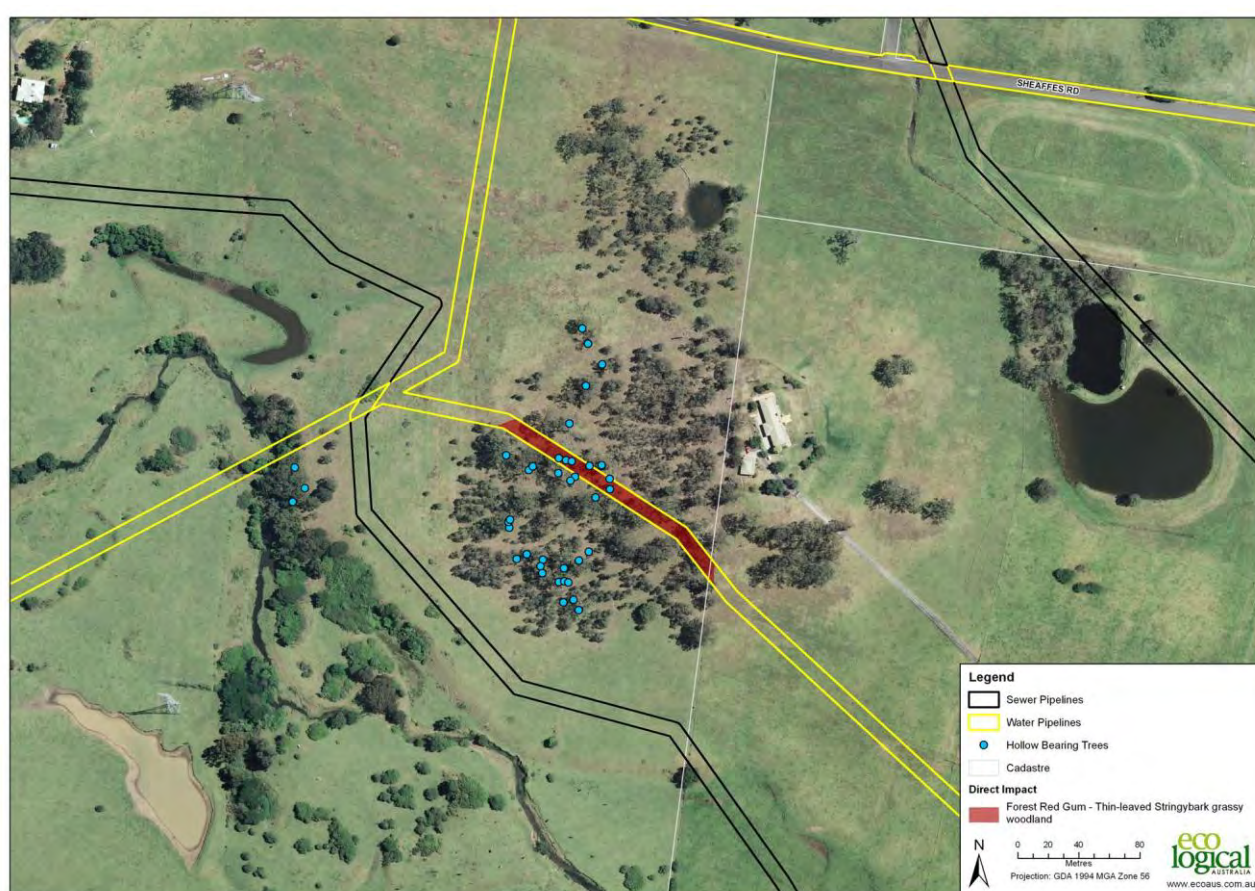
Direct Impact Area 2 – Sheaffes Rd, Kembla Grange

Impacts to existing vegetation at this site will potentially be required for the emplacement of a water pipeline (**Figure 14**). The potential impact will be incurred through a remnant of ILGW EEC (~4ha), at the high point of a grazing property to the south of Sheaffes Rd. This site contains a large number of hollows currently occupied by Rainbow Lorikeets, Galahs and Sugar Gliders, all recorded utilising this habitat resource in the remnant.

Anabat recording were undertaken within this remnant and along the adjacent watercourse, detecting seven species of microbat utilising the area. These species include, Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), *Nyctophilus* sp., Large Forest Bat (*Vespadelus darlingtoni*), Little Forest Bat (*Vespadelus vulturnus*), and the threatened species, Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*), Large-footed Myotis (*Myotis macropus*). With the exception of Eastern Bent-wing Bat, each of these species utilise hollow bearing trees for roosting.

As noted earlier, in order to avoid impacts water pipelines are generally placed in the corridor of existing roadways, or in this case a proposed future roadway. In order to avoid impacts to this vegetation remnant, Sydney Water will not construct any infrastructure through this remnant unless future planning requirements necessitate a roadway through this area. Whilst it is not considered likely, should water infrastructure be required in lieu of a roadway through this area, Sydney Water will underbore the remnant at levels below the root zone of the remnant trees in accordance with the Australian Standard for the Protection of trees on Development Sites (AS 4970-2009).

A potential impact of 0.17 ha of EEC, along with potential impact to seven (7) HBT's have been considered in this assessment (**Appendix 7**).



**Figure 14: Direct impact area 2, Sheaffes Rd, Kembla Grange**

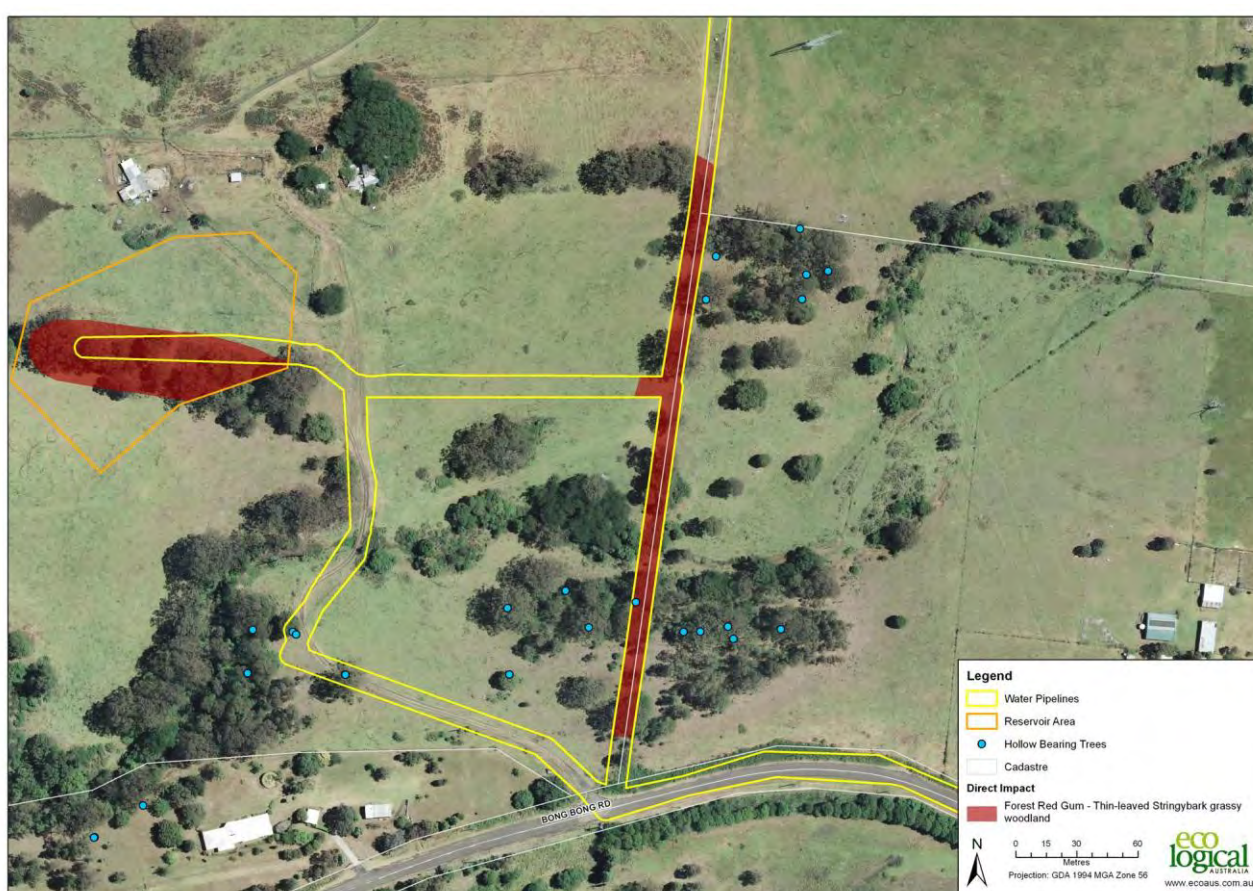


Direct Impact Area 3 – Bong Bong Rd, Avondale

Potential direct impacts at this site will be incurred from water and wastewater pipelines and the Avondale reservoir site (**Figure 15**).

A number of water pipelines are also proposed at this site. As noted earlier, water pipelines are generally proposed along existing or proposed future roadways. In this circumstance, the majority of water pipelines have been confined to existing tracks and cleared exotic pastures, though one arm of the water pipeline will run through an existing patch of ILGW. Considering a 10m impact footprint, this will equate to an impact of approximately 0.30 ha from the water pipeline. Four (4) HBTs have been mapped in the footprint of this pipeline, through directional drilling and trenching impacts will most likely be avoided to these trees.

The final piece of proposed infrastructure at this site is the Avondale Water Reservoir. Up to 0.34 ha of ILGW will be impacted, however the impact of the total 0.34 ha is considered in **Appendix 7**.



**Figure 15: Direct impact area 3, Bong Bong Rd, Avondale**

Direct Impact Area 4 – Marshall Mount Reservoir, Mountainview Terrace, Marshall Mount

The Marshall Mount Reservoir site is currently maintained as cleared open space with 16 remnant Forest Red Gum (*Eucalyptus tereticornis*) trees recorded onsite (**Figure 16**). Eleven of these trees are hollow bearing, and are considered to be an important habitat resource. These trees are likely to be remnants of ILGW, though given the scattered nature of the trees, the absence of an understorey and the managed nature of the site (i.e. exotic lawn grasses), they are not considered to form part of the ILGW EEC. Whilst it is not expected to be necessary to remove all mature trees at the site, the impact of removing all trees has been considered in the clearing statistics for this assessment as a 'worst case scenario'. This impact will equate to approximately 0.32 ha of 'Other native vegetation', and the potential loss of 8 HBTs.



**Figure 16: Direct impact area 4, Marshall Mount Reservoir, Mountainview Terrace, Marshall Mount**



### *Remaining Concept Area*

As in the PA area, the majority of the proposed infrastructure has been located, as far as practicable, adjacent to existing or proposed roads (water pipelines), or located preferentially in areas of lower conservation value, i.e. cleared land and exotic pastures (water reservoirs, wastewater pumping stations (WWPS) and wastewater pipelines).

The placement of infrastructure projected to occur in the CA has not had the same detailed on-site avoidance and mitigation strategies that have taken place for the PA. As such, this impact footprint is considered to be a preliminary footprint subject to further design.

### *Direct Impact Area 5 – Avondale Rd, Penrose*

Impacts at this site will be incurred from both water and wastewater pipelines (**Figure 17**). Considering a 10 m impact footprint, approximately 0.36 ha of Woollybutt - White Stringybark - Forest Red Gum grassy woodland will be incurred (0.20 ha due to water and 0.16 ha due to wastewater). This BVT is a component of the Illawarra Lowland Grassy Woodland EEC.



**Figure 17: Direct impact area 5, south of Avondale Rd, Penrose**



Direct Impact Area 6 – Marshall Mount Rd, Marshall Mount

Impacts at this site will be incurred from a wastewater pipeline (**Figure 18**). Considering a 10m impact footprint, approximately 0.07 ha of Woollybutt - White Stringybark - Forest Red Gum grassy woodland will be incurred. This BVT is a component of the Illawarra Lowland Grassy Woodland EEC.



**Figure 18: Direct impact area 6, Marshall Mount Rd, Marshall Mount**

Direct Impact Area 7 and 8 – adjacent to Princes Highway, Yallah

Impacts at this site will be incurred from a wastewater pipeline (**Figure 19**). Considering a 10m impact footprint, approximately 0.18 ha of Woollybutt - White Stringybark - Forest Red Gum grassy woodland will be incurred. The impact footprint is in an area of scattered trees that are feasibly avoidable during detailed design. This BVT is a component of the Illawarra Lowland Grassy Woodland EEC.



**Figure 19: Direct impact areas 7 and 8, adjacent to the Princes Highway, Yallah**



Direct Impact Area 9 – Marshall Mount Rd, Marshall Mount

Impacts at this site will be incurred from a water pipeline (**Figure 20**). Considering a 10m impact footprint, approximately 0.20 ha of Forest Red Gum – White Stringybark grassy woodland will be incurred. This BVT is a component of the Illawarra Lowland Grassy Woodland EEC.



**Figure 20: Direct impact area 9, Marshall Mount Rd, Marshall Mount**



Direct Impact Area 10 – Marshall Mount Rd, Marshall Mount

Impacts at this site will be incurred from a wastewater pipeline (**Figure 21**). Considering a 10m impact footprint, approximately 0.03 ha of Woollybutt - White Stringybark - Forest Red Gum grassy woodland will be incurred. This BVT is a component of the Illawarra Lowland Grassy Woodland EEC.



**Figure 21: Direct impact area 10, Marshall Mount Rd, Marshall Mount**

Direct Impact Arceas 11 and 12 – North Macquarie Rd, Albion Park

Impacts at these sites will be from wastewater infrastructure, including a wastewater pumping station (**Figure 22**). A 50 x 50m impact footprint has been calculated for all WWPS's, taking into account all previously discussed infrastructure (See **Section 3**).

An impact of 0.25 ha of River-oak Open Forest has been calculated from the WWPS, though it is projected that with further detailed design a setback of 40 m from the top of bank has been recommended to avoid impacts to existing vegetation and riparian areas, consistent with the RCMS (DIPNR 2004) and the WM Act.

Impacts to River-oak Open Forest due to the wastewater pipelines will be approximately 0.25 ha.



**Figure 22: Direct impact areas 11 and 12, North Macquarie Rd, Albion Park**



Direct Impact Area 13 – North Macquarie Rd, Albion Park

Impacts at this site will be incurred from a wastewater pipeline. Impacts to River-oak Open Forest due to the wastewater pipelines will be approximately 0.11 ha.

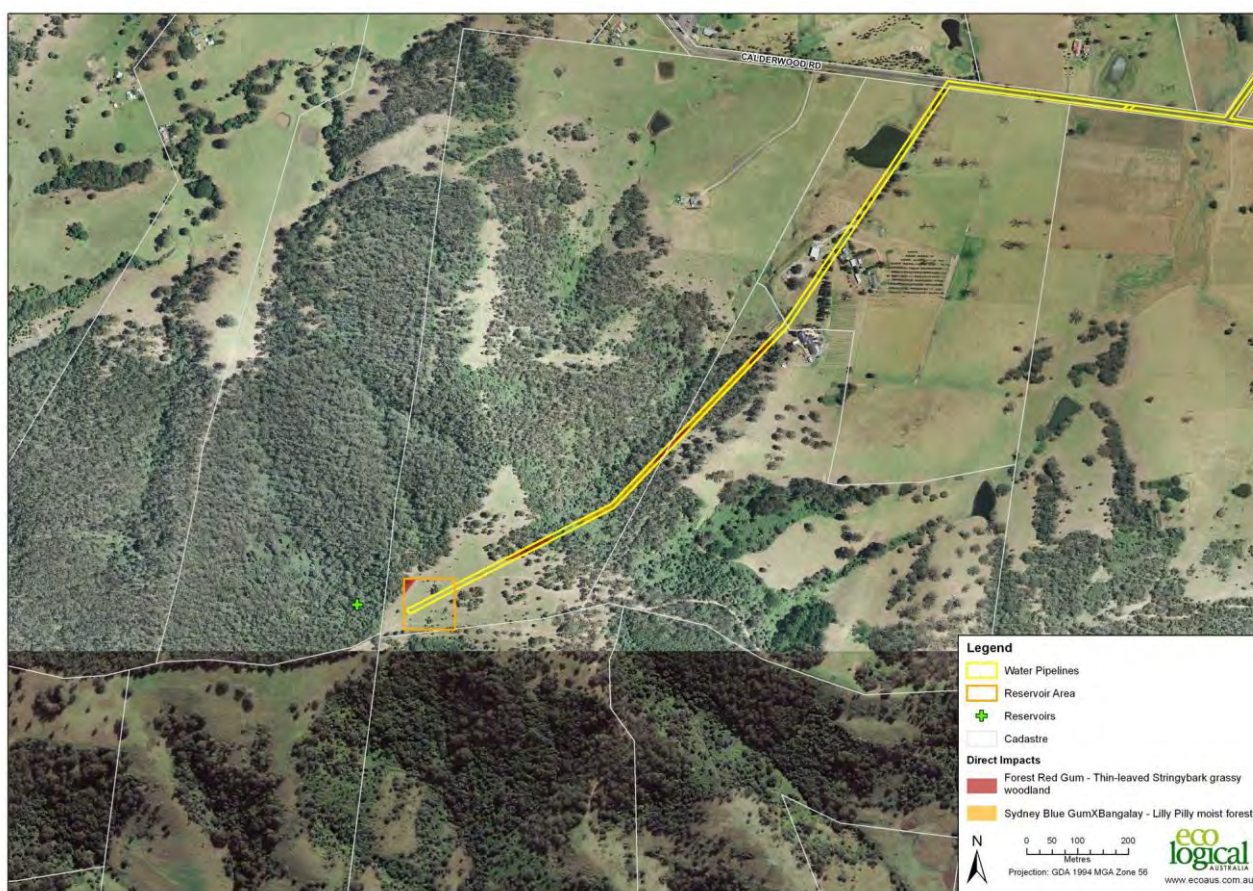


**Figure 23: Direct impact area 13, North Macquarie Rd, Albion Park**

Direct Impact Area 14 – Calderwood Reservoir, Calderwood Rd, Calderwood

Impacts at this site are due to a proposed water reservoir and water pipeline. The Calderwood Reservoir was initially proposed in an area of remnant 'Gully Gum – Sydney Peppermint – Yellow Stringybark moist open forest', though in consultation with Sydney Water it has been confirmed that the construction of this reservoir will be situated in the cleared exotic pasture next to the remnant in order to minimise impacts on native vegetation at this site. Following this movement, the direct impact will be 0.04 ha of ILGW (**Figure 24**).

The water pipeline runs through an area mapped to be either Forest Red Gum – Thin-leaved Stringybark Woodland (ILGW EEC) or Sydney Blue GumXBangalay – Lilly Pilly Moist Forest. Impacts to these vegetation types of 0.25 ha and 0.36 ha respectively are currently projected.



**Figure 24: Direct impact area 14, Calderwood Rd, Calderwood**



### 7.2.3 Assessment of impacts to threatened species and ecological communities

Individual assessments of the potential effects of construction of the pipeline on each threatened species and ecological community recorded in the Proposal area, have been completed in accordance with Appendix 3 of the Draft Guidelines for Threatened Species Assessment (DEC & DPI 2005) (see **Appendix 7**). These assessments have concluded that there will be no significant impacts to threatened species, populations or ecological communities from the Proposal as the potentially unavoidable vegetation clearing is regarded to be minor at each location.

Matters of national environmental significance (matters of NES) relevant to the Proposal were confined to migratory avifauna species. Impact assessments for relevant matters of NES in accordance with 'Matters of National Environmental Significance – Significant Impact Guidelines 1.1' (DEWHA 2009) have been completed (see **Appendix 7**). The assessments determined that there is no potential for significant impact on matters of NES and therefore referral to the Commonwealth is not required.

Species and ecological communities considered in **Appendix 7** are presented in **Table 21**.

**Table 21: Threatened species and ecological communities and migratory species considered for Significant Impacts in Appendix 7**

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS		LIKELIHOOD OF OCCURRENCE
		TSC ACT	EPBC ACT	
ECOLOGICAL COMMUNITIES				
Illawarra Lowland Grassy Woodlands		E	-	Known
AVES				
<i>Ardea alba</i>	Great Egret, White Egret	-	M	Likely
<i>Ardea ibis</i>	Cattle Egret	-	M	Known
<i>Lathamus discolor</i>	Swift Parrot	E	E and M	Potential
<i>Ninox connivens</i>	Barking Owl	V	-	Potential
<i>Ninox strenua</i>	Powerful Owl	V	-	Potential
MAMMALIA				
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	Known
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	-	Known
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V	-	Known
<i>Mormopterus norfolkensis</i>	Eastern Free-tail Bat	V	-	Known
<i>Myotis macropus</i>	Large-footed Myotis	V	-	Known
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Known

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS		LIKELIHOOD OF OCCURRENCE
		TSC ACT	EPBC ACT	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat	V	-	Known
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-	Known

### Threatened Flora

The only threatened flora species recorded within the study area during the 2011 surveys, was an endangered population of *Lespedeza juncea* subsp. *sericea*, along Marshall Mount Rd (outside the Project Approval area). Due to the avoidance measures employed during this assessment, impacts to this population were able to be avoided through the movement of a water pipeline to the opposite side of the road. Other species known to occur in the immediate area and targeted during the survey period include *Chorizema parviflorum*, *Cynanchum elegans* and *Pterostylis gibbosa*, though none were recorded in the field assessment area.

As there will be no direct or indirect impact to this population or these species from the Proposal, it was not necessary to undertake an Assessments of Significance.

### Threatened Fauna

The Proposal has the potential to remove up to 3.4 ha of native vegetation, consisting of approximately 2.1 ha of Illawarra Lowland Grassy Woodland EEC. Impacts on fauna from direct loss or modification of habitat are likely to be minimal as vegetation adjoining the direct impact area would provide similar sheltering, nesting or foraging opportunities. The exception is the loss of hollow-bearing trees, where hollow-dwelling fauna may be reliant on a particular hollow for breeding, nesting or sheltering purposes.

The species most likely to be impacted by the Proposal are hollow dependant micro-bat species. The direct impact on this habitat resource has been estimated to be 18 HBTs across the Project Approval Area. Seven (7) of these expected impacts are in proposed road corridors and impacts would not be incurred unless these roads are constructed. The remaining 11 are found at the site of the proposed Marshall Mount Reservoir, where clearing was estimated as a 'worst case scenario', though it is expected that a large proportion of these HBTs will be retained.

Assessments of Significance concluded that the potential removal of these HBTs will not have a significant impact on these species. The mitigation measures proposed will ensure that any direct impact on these species will be minimised.

Assessments of Significance for the non hollow dependant threatened fauna species concluded that due to little or no potential habitat loss in the Proposal area for these species, no significant impacts will be incurred.

### Recovery Plans

Of the threatened species, populations and ecological communities that will potentially be impacted upon by the Proposal, Recovery Plans exist for the Powerful Owl and Barking Owl. These plans have been considered during the Assessment of Significant process for these species.



*Impacts and Key Threatening Processes*

The Proposal has the potential to contribute to a number of Key Threatening Processes listed under the TSC Act and/or the EPBC Act, both directly and indirectly. These include:

- clearing of native vegetation (leading to habitat fragmentation and barrier effects)
- removal of dead wood and dead trees
- loss of hollow-bearing trees (leading to increased isolation of hollow-dependent fauna)
- invasion and establishment of weeds (various species including exotic perennial grasses)
- alteration of the natural flow regimes of rivers, streams, floodplains and wetlands

These processes have been considered in terms of threatened species, populations and ecological communities during the Significance Assessment process in **Appendix 7**.

*Recovery and Threat Abatement Plans*

There are no Threat Abatement Plans relevant to the Key Threatened Processes identified to occur as part of the Proposal.

*Habitat fragmentation and isolation*

The Proposal will be constructed in a largely cleared landscape with patches of vegetation occurring in amongst farmland and rural residential properties. The Proposal will result in the clearing or partial clearing of some of these patches, which generally have minimal wildlife value in themselves but may provide stepping stone habitat between larger areas of better quality vegetation. Further fragmentation of these areas could have implications for fauna dispersing between treed areas.

Many of the wider ranging threatened fauna will not be impacted by the removal of small patches of woodland, due to the amount of similar habitats for nesting, roosting and foraging in the immediate area.

As well as direct impacts to native fauna, the loss of hollow-bearing trees has the potential to further isolate fauna species that are dependent on hollows for roosting or nesting. This can lead to increased isolation of local populations, which in turn, can result in genetic inbreeding and/or extinction of local populations. Due to the limited number of HBTs (18) to potentially be removed in comparison to the number retained in the Project Approval area, and the disjunct nature of the individual HBTs to be removed, there is unlikely to be a significant impact on hollow-dependent fauna.

*Weed infestation*

A number of noxious weeds and listed exotic species occur within the Proposal area and these have the potential to spread, through disturbance activities and the introduction of weed seed to less disturbed areas. All of the study area has been subject to previous disturbance, most of it suffering fairly high levels of disturbance. It is not expected that construction activities will significantly increase weed levels. However, appropriate mitigation measures will be implemented to minimise the spread of exotic species and pathogenic fungi during construction and post construction works.

*Cumulative Impacts*

The potential impacts of vegetation removal and habitat loss as a result of the Proposal must be considered in the context of the cumulative effects of the development of the WDURA and AGAs. The landscape of the WDURA and AGAs will significantly change over the next 30 to 40 years, with much of the land being developed for other infrastructure, housing, commercial and community service needs. This is likely to have a considerable cumulative impact on biodiversity in the wider area.

Impacts to flora and fauna caused by the Proposal are localised and all <0.4 ha of any particular vegetation type. The cumulative impact of these incremental impacts is 3.4 ha, of which 2.1 ha is EEC. When considered against the size of the impact footprint, the amount of remaining vegetation across the Proposal area and the mitigation and amelioration measures in place, these impacts are not considered to be of a sufficient size warrant further offsetting.

### 7.3 RIPARIAN AND AQUATIC ECOLOGY IMPACTS

The proposed pipeline alignments have been designed to avoid sensitive riparian and aquatic environments wherever possible. This has been achieved through desktop studies during the design phase and field assessment by a specialist aquatic ecologist to confirm alignment adjustments to avoid sensitive environments.

Due to the extensive network of pipelines and the equally extensive network of watercourses, there are numerous locations where the pipelines will cross watercourses. Crossings for water infrastructure will be co-located with roads and/or bridges and for this reason they have not been assessed here or included in **Figure 8** and **Figure 9**. Wastewater pipelines generally cannot be co-located with roads and/or bridges due to engineering and/or hydraulic design constraints. Crossings for wastewater infrastructure are therefore the focus of this assessment and **Figure 8** and **Figure 9**.

The two main wastewater pipeline construction methods used in crossing watercourses are trenching and under boring. Trenching directly impacts on the in-stream environment. Under boring may require the establishment of launch and receiving pads at either end of the bore, but does not directly impact on the in-stream environment. The anticipated spatial application of the construction or watercourse crossing methods in the Proposal area is detailed in **Figure 8** and **Figure 9**.

A representative number of Category 1, 2 and 3 streams from the DIPNR (2004) Riparian Corridor Management Study were assessed in the field. Riparian and aquatic habitat was scored at each location. The results of this assessment showed a relationship between the stream category and aquatic and riparian habitat quality (ELA 2011). This relationship determined the anticipated spatial application of watercourse crossing methods detailed in **Figure 8** and **Figure 9**.

Under boring is anticipated for most Category 1 stream crossings (ground conditions permitting). As such, the Proposal is unlikely to have a significant impact on moderate-good aquatic habitat. Under boring will have no impact on connectivity of flow or fish passage in these streams.

Trenching of Category 2 and 3 stream crossings will directly impact the in-stream environment of these streams. However, these streams are generally in very poor condition, many being drainage lines with no riparian habitat. Temporary diversion or partial bunding of these minor streams during trenching will allow for connectivity of flows and fish passage.

Construction of the Proposal has the potential to indirectly impact aquatic ecology. Indirect impacts as a result of soil erosion and sedimentation due to excavation and the removal of vegetation may occur during construction. Erosion can lead to the degradation of soil substrates. Sedimentation can cause smothering of riparian and aquatic vegetation and eutrophication. Construction management measures for the Proposal include use of sediment controls to avoid this potential impact. None of the proposed construction methods will impact connectivity of flows or fish passage.

Fuels and chemicals entering aquatic ecosystems can result in toxic levels of contaminants and cause fish kills and other impacts on waterway health. Potential impacts from spillage of fuels and chemicals into waterways will be minimised through appropriate storage, handling and disposal of these materials.