Attachment L: Threatened Dragonfly Species Survey Plan

ARCADIS Design & Consultancy for natural and built assets

Moorebank Precinct West

Threatened Dragonfly Species Survey Plan Report

SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 4, Division 4.1, State Significant Development

September 2016

TACTICAL GROUP
MOOREBANK PRECINCT WEST

Threatened Dragonfly Species Survey Plan Report

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Report No	001	
Date	26/09/2016	
Revision Text	Final	

REVISIONS

Revision	Date	Description	Prepared by	Approved by
001	26/09/16	For submission to DPI Fisheries	Adam Costenoble	Ketan Patel

CONTENTS

EXECUTIVE SUMMARY

This report presents the findings of a threatened dragonfly habitat assessment that Arcadis ecologists conducted in September 2016. This assessment was undertaken in accordance with Condition of Approval D19 (SSD_5066) for the Moorebank Precinct West (MPW) project in Moorebank, NSW, which is situated directly adjacent to the Georges River. Two threatened dragonflies, Adam's Emerald Dragonfly and Sydney Hawk Dragonfly, were the target species for this assessment. A desktop review was completed and approved by DPI Fisheries in August 2016 as part of the Threatened Dragonfly Species Survey Plan.

Two Arcadis ecologists traversed the survey area by kayak in order to carry out the habitat assessment along the banks of the river. The assessment involved a systematic visual search for habitat features that could accommodate the larval stages of the targeted species throughout the survey area.

The character of the Georges River within the survey area is markedly different from known habitat for the targeted dragonfly species. No habitats for either Adam's Emerald Dragonfly or Sydney Hawk Dragonfly were detected in the survey area. It is thus highly unlikely that threatened dragonflies occur in the survey area and therefore no impact to these species is expected to occur as a consequence of the MPW project.

Considering the absence of suitable habitat within the survey area, it is the recommendation of this assessment that no further investigation or targeted exuviae surveys are required.

1 INTRODUCTION

1.1 Project Overview

On the 3 June 2016 Concept Plan Approval (SSD 5066) was granted, under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to develop the Moorebank Precinct West Project (MPW Project) on the western side of Moorebank Avenue, Moorebank, in south-western Sydney (the MPW site).

The MPW Project involves the development of intermodal freight terminal facilities (IMT), linked to Port Botany, the interstate and intrastate freight rail network. The MPW Project includes associated commercial infrastructure (i.e. warehousing), a rail link connecting the MPW site to the Southern Sydney Freight Line (SSFL), and a road entry and exit point from Moorebank Avenue.

The MPW site is generally bounded by the Georges River to the west, Moorebank Avenue to the east, the East Hills Railway Line to the south and the M5 Motorway to the north (Figure 1).

Figure 1 Project boundary.

1.2 Purpose of this report

This report has been prepared with due regard for condition D19 of the Moorebank Precinct West (MPW) Concept Plan Approval (SSD_5066) which states:

The Applicant shall prepare and implement a 'Threatened Dragonfly Species Survey Plan' to determine the presence or absence of threatened dragonfly species listed under the Fisheries Management Act 1994 on the Georges River, adjacent to the development site. The plan, including survey methodology, shall be prepared in consultation with DPI Fisheries prior to the commencement of Early Works.

On implementing the plan, the survey results are to be forwarded onto DPI Fisheries. Should threatened dragonfly species be found at this site, DPI Fisheries should be contacted to agree on possible mitigation measures to avoid impacts in accordance with NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management (2013).

The Threatened Dragonfly Species Survey Plan (TSSSP) must be prepared prior to the commencement of Early Works which is defined as follows:

"the demolition of buildings, including services termination and diversion; rehabilitation of the excavation/ earthmoving training area; remediation of contaminated land; removal of underground storage tanks; heritage impact remediation works; and the establishment of construction facilities and access, including site security."

A TDSSP was prepared by Arcadis and accepted by DPI Fisheries on 11 August 2016. This report presents the findings of the habitat assessment carried out in accordance with the TDSSP during September 2016.

1.3 Aims of this Report

The overarching objective of the Threatened Dragonfly Species Survey Plan and this associated report is to assess the presence of threatened dragonflies or their habitat along the Georges River adjacent to the Project site. Two threatened dragonfly species are addressed in this report, Sydney Hawk Dragonfly *Austrocordulia leonardi* and Adams Emerald Dragonfly *Archaeophya adamsi.*

The commitment was made in the TDSSP to carry out a field-based habitat assessment of the Georges River adjacent to the Project site to determine the likelihood that threatened dragonflies occur within the site. The aim of this report is to present the findings of that habitat assessment to DPI Fisheries and to make recommendations regarding further investigations.

1.4 Consultation

The TDSSP was produced in consultation with DPI Fisheries. This report continues that process and provides further opportunity for consultation regarding further actions required. The chronology of correspondence to date is as follows:

- 13/07/16 – Arcadis provided initial overview of methodology to DPI Fisheries in order to identify survey requirements,
- 21/07/16 – DPI Fisheries respond to initial methodology and outline specific expectations for TDSSP,
- 09/08/16 – Arcadis submit TDSSP for DPI review,
- 11/08/16 – DPI Fisheries accept TDSSP with one minor amendment,
- 26/09/16 – Arcadis submit final updated TDSSP to DPI Fisheries with TDSSP Report – Habitat Assessment (this report).

2 METHODOLOGY

The proposed methodology for the Dragonfly surveys as per the TDSSP involves a three-stage process:

1. Desktop assessment
2. Habitat assessment with report (this report)
3. Targeted dragonfly exuviae searches

The first two stages are detailed below; Stage 3 was not undertaken as habitat was not identified (see section 5).

2.1 Desktop Assessment

The desktop assessment involves a detailed review of the scientific literature, government publications and all available database records for each of the target species. This review has been collated in the form of species profiles (see section 3) that have been used to determine the ecology and habitat requirements of the targeted species. This information informs the habitat assessment and targeted searches within the study area. Previous records of the species across the Sydney Basin have been mapped in relation to the survey area (Figure 3).

2.2 Habitat Assessment

2.2.1 Survey area

The survey area comprises a 3.7 kilometre reach of the Georges River between the crossings of Cambridge Avenue and the M5 Southwestern Motorway at Moorebank, NSW (Figure 2). This area includes the 2.7 kilometre stretch of river adjacent to the MPW site plus 500 metres up and downstream of the MPW site.

The survey focused on edge habitats adjacent to the MPW site on the eastern bank of the river but also included any mid-stream habitats (such as riffles or pools) and also comparison to the western bank along the full length of the survey area.

2.2.2 Reference site comparison

The specific qualities of known habitat sites were identified for the targeted species during the desktop review of the scientific literature. Prior to the habitat assessment in the survey area the ecology team visited two of these known habitat sites to gather photographs as a visual reference of quality habitat features that sustain the targeted species. These two sites included:

- Freres Crossing on the Georges River near Campbelltown (34.06137°S, 150.879274°E)
- Floods Creek, Somersby Falls within Brisbane Waters National Park on the Central Coast (33.401363°S, 151.267845°E).

Features that matched the qualities associated with each species were photographed to allow visual comparison of the features within the study area.

Figure 2 Survey area and actual habitat sample locations. The orange line indicates the survey area as proposed in the TDSSP.

2.2.3 Habitat features

The habitat assessment involved a systematic visual search for habitat features that are known to accommodate the larval stages of the targeted species throughout the survey area (as listed in Table 1). Larval habitats were targeted because it is in this development stage that the species spends the majority of its life-cycle and it is these habitats that the adults return to for breeding. These habitat features have been determined based on the results of the comprehensive literature review (Section 3) and through consultation with DPI Fisheries.

Table 1 Habitat features that were searched for within the survey area

Species	Habitat features
Sydney Hawk Dragonfly *Austrocordulia leonardi*	• Deep riverine pools with cool water • Permanently flowing rocky river with steep sides that provide shady rest areas • Rocks for larvae to shelter beneath • Representative habitats depicted in Figure 10 and Figure 11
Adam's Emerald Dragonfly *Archaeophya adamsi*	• Small to moderate sized creeks with gravel or sandy bottom • Narrow shaded riffle zones with moss and abundant riparian vegetation • Canopy cover • Representative habitats depicted in section 4.2

2.2.4 Survey effort

The survey area was traversed by two Arcadis ecologists, Laura Hoffman and Adam Costenoble, using kayaks in order to facilitate efficient access to mid-stream and edge habitats along the eastern bank of Georges River. The bank of this section of the Georges River is steep and heavily vegetated in parts and this access method ensured uninhibited access to the survey area. This assessment was carried out on 13 September 2016 in accordance with the commitments made in the TDSSP. Conditions on the day were dry, warm and mostly overcast.

A systematic survey approach was employed to ensure thorough assessment of the survey area.

Edge habitats were sampled where the qualities of the edge habitat changed, or at 50-100 metre intervals along stretches where the edge habitat remained consistent. In total, 60 sample points were taken along the 3.7 kilometre eastern bank of the survey area. Ten metres of bank habitat along the water's edge were considered at each sample point location. The survey area was traversed from south to north starting with GR01 at the most upstream position near Cambridge Avenue to GR60 just north of the South-Western Motorway bridge, (see Figure 2 for sample density and actual sample points).

A change in edge habitat was characterised by variation of the following features:

- bank slope (flat to steep or undercut)
- riparian vegetation structure (wetland, paddock, forest)
- change in degree of overshading from riparian vegetation
- noticeable change in substrate material (mud/silt to gravel, sand or rock)
- change in river flow velocity (straight channel becomes beach-like embayment)
- change in turbidity (areas where water visibility changes)

- bend in the river
- creek junction
- other visible changes (to be determined on site)

No mid-stream habitats such as riffles or pools were detected, thus the survey consisted primarily of edge habitat assessment.

2.2.5 Data collection

Each survey location was marked by GPS and mapped (see Figure 2). A photograph was taken at each sample point location. At each survey point a datasheet pro-forma was filled out to thoroughly consider the habitat features at each point (see Appendix A). This pro-forma has been selectively adapted from the AUSRIVAS Physical Assessment Protocol to target abiotic and biotic river features that relate to the targeted threatened dragonfly species.

Photographs and a general overview of the river conditions was also carried out in the upper (GR01-GR20), mid (GR21-GR40) and lower sections (GR41-GR60) of the survey area.

2.2.6 Habitat assessment reporting

This document forms the TDSSP Report that was proposed in section 3.2.6 of the TDSSP. Its purpose it to communicate the results of the field habitat assessment of the study area and to make recommendations regarding the need for further investigations, if required. See section 4 and section 5 for the results of the habitat assessment of the study area.

3 DESKTOP ASSESSMENT – THREATENED DRAGONFLIES SPECIES PROFILES

There are three dragonfly species currently listed under the *Fisheries Management Act 1994* (FM Act):

- Adams Emerald Dragonfly (*Archaeophya adamsi*) - Endangered
- Sydney Hawk Dragonfly (*Austrocordulia leonardi*) - Endangered
- Alpine Redspot Dragonfly (*Austropetalia tonyana*) – Vulnerable

These species are not listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Both Adams Emerald Dragonfly and the Sydney Hawk Dragonfly are known from the Sydney basin with the closest historic records of the species occurring within 35km and 12.5km from the Project site respectively. The Alpine Redspot Dragonfly is only known to occur at altitudes above 600 metres and is thus excluded from this survey plan as the Project site is less than 10m above sea level. An additional dragonfly species, the Giant Dragonfly (*Petalura gigantea*), is listed under the TSC Act but is not included in this study since it does not occur in the Sydney metropolitan area.

The target species are the rarest in Australia. These species are sparsely distributed within known habitat and little is known about their biology. A comprehensive review on the available background information including species descriptions, habitat preferences and distribution (Figure 3) has been collected through desktop literature review and database searches. This review is presented in the remainder of this section.

Figure 3 - Records of threatened dragonflies across the Sydney Basin as sourced from the Atlas of Living Australia database, Theischinger et al. (2009) and Theischinger et al. (2011).

3.1 Adam's Emerald Dragonfly - *Archaeophya adamsi*

3.1.1 Description

A member of the Gomphomacromiidae family (formerly part of Corduliidae).

The Adam's Emerald Dragonfly is a moderately large, robust Dragonfly. Larvae grow to about 23mm in length and have a large two-lobed frontal plate on the head, which distinguishes them from any other species found in NSW (Figure 6). The adults have a brown-black body with yellow markings, and a slight green or bluish metallic reflection on some parts (Figure 4, Figure 5 & Figure 7). The abdomen length is around 46 mm and wingspan around 75 mm (DPI Fisheries 2013).

Figure 4 Archaeophya adamsi, teneral male and exuvia. Photo: G. Theischinger.

Figure 5 Archaeophya adamsi, female, dorsal view. Photo: L.Müller

Figure 6 Archaeophya adamsi, larva. Photo: S. Jacobs

Figure 7 Archaeophya adamsi, female, lateral view. Photo: L. Müller

3.1.2 Distribution

Adam's Emerald Dragonfly is one of Australia's rarest dragonflies. Only a small number of adults have ever been collected, and the species is only known from a few sites in the greater Sydney region. These sites include a number of creeks near Galston Gorge at Hornsby, Somersby Falls in Brisbane Waters National Park on the Central Coast and a few creeks in the Blue Mountains and Wollemi National Parks (Figure 3).

Despite there being limited records for the species the potential distribution includes all of the Sydney basin and thus includes the Project site (Figure 8).

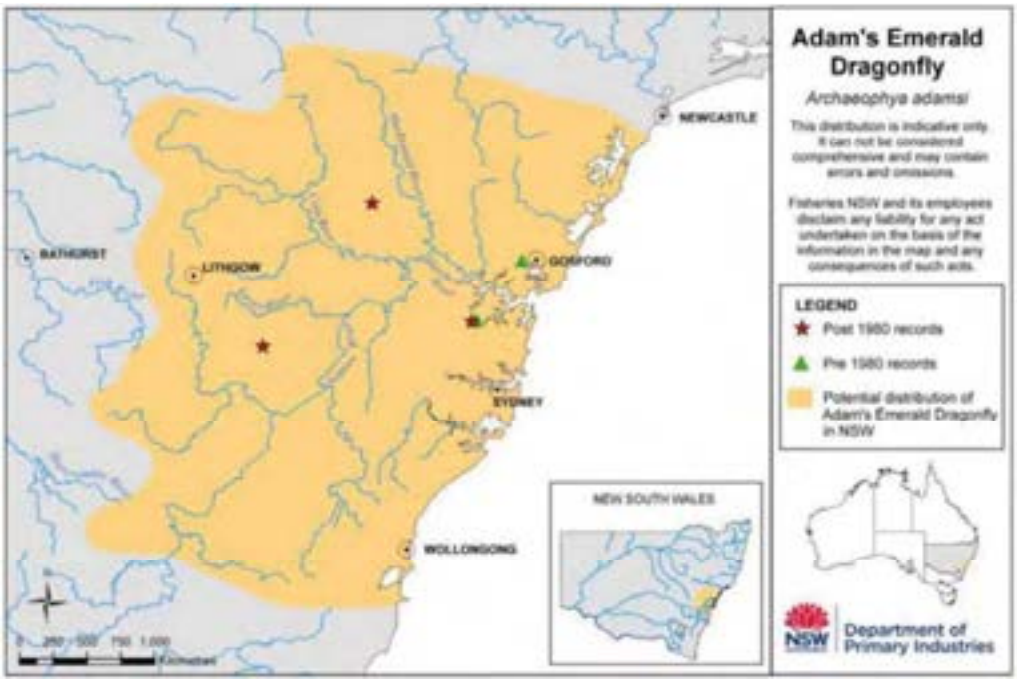

Figure 8 Potential distribution of Archaeophya adamsi (Fisheries NSW)

3.1.3 Habitat

Adam's Emerald Dragonfly larvae have been found in narrow, shaded riffle zones with moss and abundant riparian vegetation (often closed canopy) in small to moderate sized creeks with gravel or sandy bottoms (DPI Fisheries 2013). Adults can be found on rocks or in litter among the stream margins or in riffle situations (Theischinger and Hawking, 2006). The majority of sightings for this species have occurred in undisturbed, well-vegetated habitats which are mostly located in national parks or reserves (Theischinger *et al.*, 2011).

3.1.4 Life history

Adam's Emerald Dragonfly may live up to 7 years and undergo various moults as a larvae before metamorphosing into a flying adult. Adult dragonflies generally fly away from the water to mature before returning to breed. Males fly actively at breeding sites and often guard a territory. Females probably lay their eggs into the water. The lifespan of an adult is limited to a few months duration.

This species has a low natural rate of recruitment and limited dispersal abilities.

3.2 Sydney Hawk Dragonfly - *Austrocordulia leonardi*

3.2.1 Description

A member of the Austrocorduliidae family (formerly part of the Corduliidae family).

The Sydney Hawk Dragonfly is a black and yellow dragonfly with clear wings spanning 60-70mm, and with an adult abdomen length of 35-40mm (Figure 9). The aquatic larvae have a body length of 22-24mm and are distinguished from the similar Eastern Hawk dragonfly, *Austrocordulia refracta*, by a uniformly arched abdomen and distinctive abdominal colour pattern (Figure 12) (DPI Fisheries 2016).

Figure 9 A. leonardi. Photo: G. Theischinger

Figure 10 A. leonardi habitat. Photo: A. Bruce

Figure 11 A. leonardi habitat. Photo: G. Theischinger

Figure 12 Final instar exuvia, dorsal view of A. leonardi. Photo: G. Theischinger

3.2.2 Distribution

Until recently the known distribution of Sydney Hawk Dragonfly has been extremely limited, being found in only three locations in a small area south of Sydney, from Audley to Picton including the Hawkesbury-Nepean, Georges River and Port Hacking drainages. First discovered in the Woronora River and Kangaroo Creek, south of Sydney it was later recorded from the Nepean River, Maldon Bridge near Wilton. Recent sightings have shown that the species also occurs beyond the Sydney Basin north of the Hunter River (Theischinger *et al.* 2013). Recent habitat searches within the Sydney Basin have found additional sightings of the species on the upper reaches of the Georges River in Heathcote National Park near Campbelltown approximately 18km upstream from the Project site (Theischinger *et al*. 2009) (Figure 3).

Despite there being limited records for the species the potential distribution includes south and southwest Sydney with the Project site situated on the northern edge of this potential range within the Sydney Basin. Intensive surveys by Theischinger and colleagues have failed to detect the presence of any of the life stages of Sydney Hawk Dragonfly in previously known habitats along the Woronora River (DPI Fisheries 2005); however, the species persists in the Kangaroo River within the Royal National Park (Theischinger, 2009).

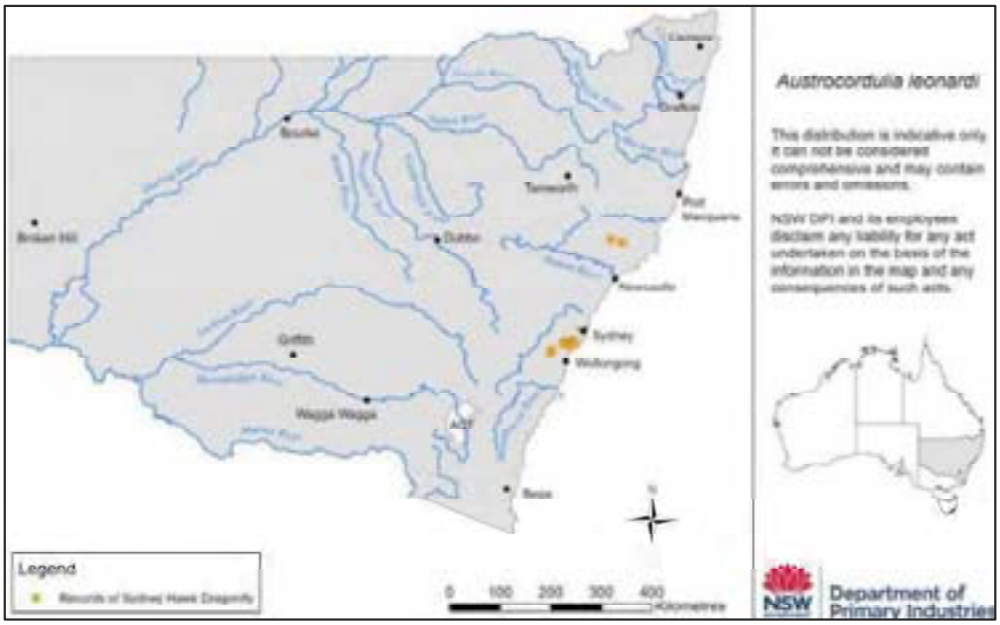

Figure 13 Potential distribution of Austrocordulia leonardi in Sydney Basin (DPI Fisheries 2016)

3.2.3 Habitat

This species has specific habitat requirements, including deep pools in permanently flowing rocky rivers with steep sides that provide shady resting areas. All specimens collected came from deep riverine pools with cooler water (along the Woronora River, Kangaroo Creek and Nepean River). The site of first discovery of the species is a deep pool above the weir at Heathcote in the Woronora River. Larvae can be found under rocks where they may coexist with the similar Eastern Hawk dragonfly *Austrocordulia refracta*. Representative images of potential habitat are depicted in Figure 10 and Figure 11 above.

3.2.4 Life history

Austrocordulia leonardi is a rare species. While many exuviae (the moulted shell of the larvae from which the adults emerge) have been found, only 11 adult specimens have been discovered. Most of the life cycle of this species is spent as an aquatic larva, while adults are present for only a few weeks. It is strictly a diurnal dragonfly that requires open, sunlit space (DPI Fisheries 2016).

4 REFERENCE SITE COMPARISON

4.1 Freres Crossing, Freres Crossing Reserve

Freres Crossing was visited as a comparison site of known habitat for the Sydney Hawk Dragonfly *(Austrocordulia leonardi). Austrocordulia leonardi* were recorded during surveys in the Georges River at Freres Crossing in February 2009 (Theischinger *et al*. 2009). The site is situated approximately 18km upstream from the survey area and was chosen for comparison because of its ease of access and its proximity to the survey area.

The Georges River at this location borders the small suburb of Kentlyn (near Campbelltown) to the west and Holsworthy Army Reserve on the east. The river at this location is characterised as an upland mountain stream in a river valley. The river at this location is approximately 40 above sea level (ASL) and is surrounded by 80-90 metre ridgelines and naturally vegetated woodland slopes. The western slope is well vegetated up to Kentlyn on the ridge and a large expanse of bushland continues on the east throughout the army reserve.

Freres Crossing itself is the site of the remains of a historic bridge on a road that once formed part of the 1917 highway connecting Campbelltown and Newcastle. A rock platform at this location forms somewhat of a natural weir at a narrowing of the river (Figure 14) which has resulted in a number of deep wide pools either side of it. These pools, which have a gravel/rock substrate and steep shaded sides, are characteristic of habitat for *A. leonardi* (Figure 15 and Figure 16).

Figure 14 Freres Crossing

Figure 15 Deep pool with steep shaded sides and rocky bottom just upstream from Freres Crossing

Figure 16 Rocky bottom pool upstream from Freres Crossing

4.2 Floods Creek, Somersby Falls

Floods Creek at Somersby Falls was visited as a comparison site for known habitat of Adam's Emerald Dragonfly (*Archaeophya adamsi*). This location is frequently cited as known habitat for *A. adamsi* (DPI, 2013).

Floods Creek and Somersby Falls are situated in Brisbane Water National Park at Somersby on the Central Coast. At the top of the falls Floods Creek is a shallow and narrow clear water mountain stream that flows over bare sandstone. The falls drop approximately 100 metres in a series of cascades to a steep and narrow lush rainforest canyon that continues to flow southward until it meets Mooney Mooney Creek, a tributary of the Hawkesbury River.

Downstream of Somersby Falls, Floods Creek is abundant in characteristic features of *A. adamsi* habitat. The stream is located below a closed canopy, with numerous riffle zones, mossy boulders and riparian vegetation. The substrate of the stream varied between bare sandstone, gravel and sand.

Figure 17 Floods Creek, habitat for A. adamsi. Narrow stream with shaded riffle zones, moss, riparian vegetation and sandy/gravel substrate.

Figure 18 Floods Creek riffle zone.

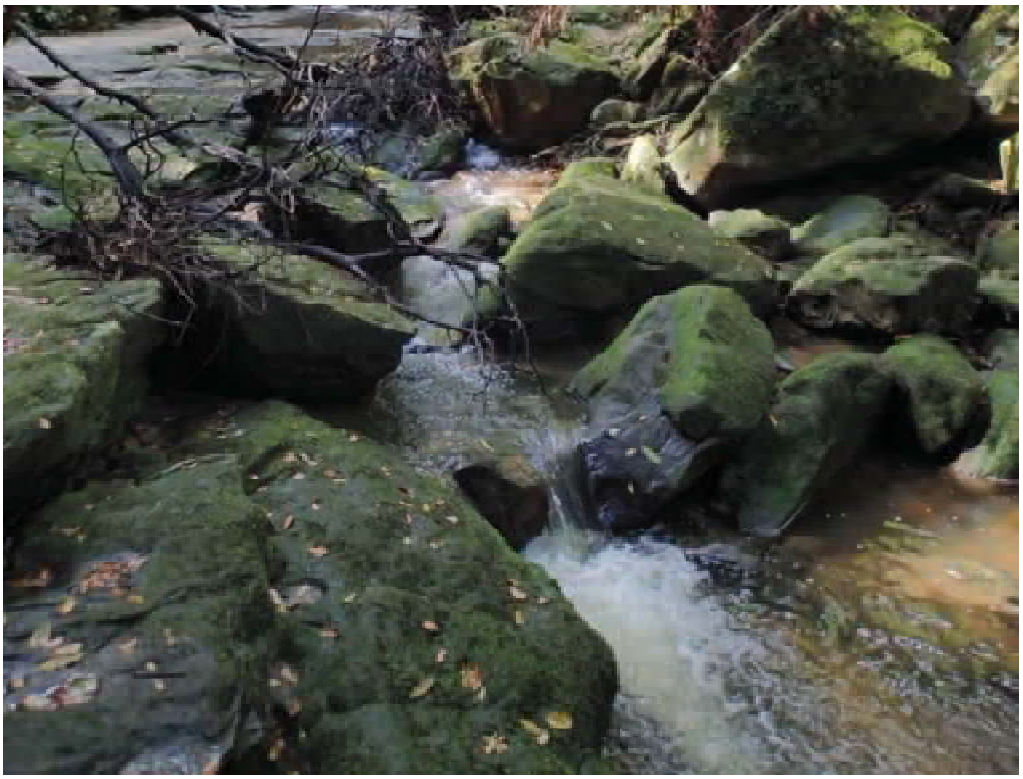

Figure 19 Floods Creek riffle zone.

5 HABITAT ASSESSMENT RESULTS

The Georges River within the survey area differs significantly from the character of the reference sites. The river at this location is characteristic of a lowland river on alluvial plains. The width varies between 25-45 metres, the channel is a continuous run and riffles or pools are absent. The water is turbid, the substrate consists of a fine mud and sand matrix and shading of the channel is minimal (<5%). Erosion of the riverbank varies from minor to severe; in some places, the entire bank has collapsed. The exposed banks are devoid of vegetation and the loose substrate is subject to further erosion.

Riparian vegetation is characterised by an open forest community that is degraded by dense infestation of exotic species, including several species declared as noxious weeds for Liverpool Local Government Area. Riparian vegetation generally did not overhang or shade the river. The canopy to 15 metres is dominated by *Eucalyptus botryoides x saligna,* with occasional occurrences of *Angophora subvelutina* (Broad-leaved Apple) and *Casuarina glauca* (Swamp Oak). Exotic trees such as *Jacaranda mimosifolia* (Jacaranda) and *Cinnamomum camphora* (Camphor Laurel) were recorded in low abundances.

The understorey is dominated by dense infestation of exotic species, such as *Lantana camara* (Lantana), Broad-leaf Privet (*Ligustrum lucidum),* Small-lead Privet (Ligustrum sinense), *Olea europaea* subsp. *cuspidata* (African Olive), *Arundo donax* (Giant Reed) and *Cardiospermum grandiflorum* (Balloon Vine). Native species occur only occasionally throughout the understorey, predominantly small trees such as *Acacia binervia* (Coast Myall), *Acacia decurrens* (Black Wattle) and *Pittosporum undulatum* (Sweet Pittosporum).

Groundlayer vegetation along the banks of the river is generally absent due to the presence of impenetrable thickets of woody weeds. Native species such as *Pteridium esculentum* (Bracken), *Lomandra longifolia* (Spiny-head Mat-rush) occur in low abundances. Small, discrete patches of emergent vegetation are scattered along the river banks, with commonly occurring species included *Phragmites australis* (Common Reed), *Typha orientalis* (Broadleaf Cumbungi), *Gahnia sp* and *Eleocharis sp.*

Riparian vegetation is most intact in the upstream (southern extent) of the study area (GR01-GR20 see Figure 2) where the average width of the riparian corridor is at least 25 metres (Figure 20 & Figure 21). The canopy cover decreases in the mid-section of the survey area (GR21-GR40). The riparian corridor narrows to less than 25 metres with the occasional wider patch of adjacent woodland in the mid-section (Figure 22 & Figure 23). An intact riparian corridor is generally absent from the northern extent of the study area (GR41-GR60), where vegetation occurring along the banks of the river is limited to exotic grasses and scattered exotic shrubs such as *Solanum mauritianum* (Tobacco Tree) (Figure 24 & Figure 25). The banks of the Georges River beneath the twin bridges of the M5 are stabilised by rock gabion baskets, and vegetation is absent from this area.

The habitat assessment for the 60 sample locations failed to detect suitable threatened dragonfly habitat throughout the survey area (Table 2). Both east and west banks were similar in character, extent and type of riparian vegetation. There were no mid-stream habitat features such as riffles or pools and the substrate throughout the majority of the site is inappropriate for the target species. Frequent snags and woody debris provide some aquatic habitat, however emergent and trailing vegetation is sparse throughout the survey area. For a photo of the habitat at each sample location refer to Appendix B.

No areas of habitat have been identified for targeted dragonfly exuviae surveys within the survey area.

Table 2 Habitat features for target species are absent in the survey area

Species	Habitat features	Present in survey area?
Sydney Hawk Dragonfly *Austrocordulia leonardi*	• Deep riverine pools with cool water • Permanently flowing rocky river with steep sides that provide shady rest areas • Rocks for larvae to shelter beneath	• No • No • No
Adam's Emerald Dragonfly *Archaeophya adamsi*	• Small to moderate sized creeks with gravel or sandy bottom • Narrow shaded riffle zones with moss and abundant riparian vegetation • Canopy cover	• No • No • No

Figure 20 Upper third of the study area looking downstream 1

Figure 21 Upper third of the study area looking downstream 2

Figure 22 Mid-section of the study area looking downstream 1

Figure 23 Mid-section of the study area looking downstream 2

Figure 24 Lower third of the study area looking downstream 1

Figure 25 Lower third of the study area looking toward west bank. M5 motorway to right of frame.

6 CONCLUSION

The character of the Georges River within the survey area is markedly different from known habitat for the targeted threatened dragonfly species. No habitats for either *Archaeophya adamsi* or *Austrocordulia leonardi* were detected in the survey area after an extensive ecological assessment. It is thus highly unlikely that threatened dragonflies occur in the survey area and therefore no impact to these species is anticipated as a consequence of the MPW project.

Considering the absence of suitable habitat within the survey area, it is the recommendation of this assessment that no further investigation or targeted exuviae surveys are required.

7 REFERENCES

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APPENDIX A

Habitat assessment pro-forma and guide

Example of completed pro-forma datasheet.

Date: 13/9/12	Time: 10.32	GPS Waypoint: GR002	Recorder: (LH) AC
Photo ID/s: 0142			
Physical features sandy banks, large fallen tree,			
Habitat feature: (Edge) Riffle Pool Other: _____		Pool/Riffle depth (m): N/A	
		River width at the water surface (m): 50	
Turbidity: Clear Slight (Turbid) Opaque		Substrate Composition (%): Unknown Cobble ___ Pebble ___ Gravel ___ Sand ___ Fines 100	
Bedform at sample location: Run Pool Backwater Riffle Other: Glide		Bank Shape: Concave (Convex) Stepped Wide lower bench Undercut	
In stream features: (Snags) Rocks Debris Algal blooms Other: sand banks			
Riparian Vegetation			
Description (dominant species and community structure): Open forest. Blackbutt, Angophora leiocarpa, acacia binervia, banksia, eucalypts, cotton weed			
Extent of riparian cover (%): Trees: 40 Shrubs 10 Grasses/Ferns/Sedges: 30 Climbers/creepers: 30	Longitudinal extent of riparian vegetation: None Isolated/Scattered Regularly spaced Occasional Clumps (Semi-continuous) Continuous Extent of Native/exotic vegetation Weed dominated (Native dominated)		
Cover of macrophytes (%): Submerged: 5 Emergent: ___ Floating: ___	Extent of trailing bank vegetation: Nil (slight) moderate extensive	Presence of moss at sample site: Yes (No)	
	Shading of channel: (<5%) 6-25% 26-50% 51-75% >76%		

Habitat Assessment Guide (extracted from AUSRIVAS Physical Assessment Protocol)

GPS Waypoint:

Site identifier as mapped

PHYSICAL FEATURES

Habitat Feature:

The surveyed entity type based on likely dragonfly habitat preferences.

Edge includes the bank of the river, riparian and fringing vegetation and the channel substrate.

Pool refers to an open area where stream widens or deepens and current declines. Habitat includes the channel substrate material.

Riffle includes a section with a gradient 1-3°. Moderate currents Surface unbroken but unsmooth

Pool/Riffle depth (m):

The average depth from the surface to the substrate for the mid-stream habitat feature. This variable does not apply to edge habitat features.

Turbidity:

At each sampling site, visually assess the turbidity of the water as one of the following categories:

Category	Description
clear	water very clear in pools and shallows
slight	water slightly turbid in pools and/or shallows
turbid	water moderately turbid in pools and/or shallows
opaque	water very turbid in both pools and shallows

Turbidity refers to the relative clarity of water and measures the extent to which light penetration is reduced from suspended materials such as clay, mud, organic matter or plankton. The presence of dissolved materials derived from plant leachates can also reduce water clarity (e.g. blackwater streams) and in such cases, water will be 'tea' coloured. The type of material causing any reduction in water clarity should be noted on the data sheet at each sampling site.

Substrate Composition:

Within the 10m long sample area, assess the relative percent cover of each of the following size classes:

Sediment category	Size
Bedrock	
Boulder	> 256mm
Cobble	64 – 256mm
Pebble	16 – 64mm
Gravel	2 – 16mm
Sand	0.06 – 2mm
Fines (silt and clay)	< 0.06mm

Bedform at sample location:

Determine the bedform of the river at the sample location based on the following options:

	Riffle Gradient 1-3° Moderate currents Surface unbroken but unsmooth
	Glide Gradient 1-3° Small currents Surface unbroken and smooth
	Run Gradient 1-3° Small but distinct & uniform current Surface unbroken
	Pool Area where stream widens or deepens and current declines
	Backwater A reasonable sized (>20% of channel width) cut-off section away from the channel

Bank Shape:

For edge habitat samples define the bank shape as follows:

	concave
	convex
	stepped
	wide lower bench
	undercut

Habitat Assessment Guide (extracted from AUSRIVAS Physical Assessment Protocol) *Continued*

RIPARIAN VEGETATION

Description:

The riparian zone is defined as the area from the water's edge (under baseflow conditions) to a distance from the bank where the stream still interacts with and influences the type and density of the bank-side vegetation. Where known, include a description of the main species present or the main vegetation types present (e.g. native grasses, rainforest, willows, river red gum, tea tree, casuarina, blackberries, paragrass etc.) in each vegetation component.

Extent of riparian cover (%)

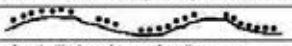
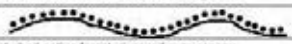
At each sampling site, identify the riparian zone and visually estimate the percentage area of the riparian zone that is covered by each of the following components:

- Trees
- Shrubs
- Grasses/ferns/sedges

Longitudinal extent of riparian vegetation

Along the length of each 10 metre sampling site, visually assess the longitudinal extent, or patchiness, of the riparian zone on target bank. Include only the tree and shrub layer components (native or exotic) in the assessment of longitudinal extent, and disregard the ground cover layer. However, for sites where the riparian zone is naturally composed entirely of native grasses, either along the entire site length or in significant patches, include grasses in the assessment of longitudinal extent.

Assess longitudinal extent of riparian vegetation using one of the following categories:

Category	Description and examples[1] (shown for one bank only)
None	 No trees or shrubs, only exotic grasses or pasture
Isolated / scattered	 Isolated trees or shrubs among exotic grasses or pasture
Regularly spaced, single	 Planted poplars
Occasional clumps	 Clumps of tea tree scrub among exotic grasses or pasture
Semi-continuous	 Native forest with cleared areas of exotic grasses
Continuous	 Undisturbed native forest, river red gum canopy

Cover of macrophytes (%):

Estimate the percentage of macrophyte cover at the sample site:

- Submerged
- Emergent
- Floating

Extent of trailing bank vegetation:

Visually estimate the occurrence and density of trailing bank vegetation along the length of the sampling site as one of the following categories:

- Nil
- Slight
- Moderate
- Extensive

Trailing bank vegetation is the component of the terrestrial riparian vegetation that has direct contact with the water (under baseflow conditions) and which provides habitat and shelter for macroinvertebrates and fish.

Presence of moss at sample site:

Shaded sites with mossy vegetation are characterised as habitat for *Archaeophya adamsi*. Is moss present at the sample site?

Shading of channel:

At each 10 metre edge habitat sampling site, visually estimate the percentage of the stream area that would be shaded by riparian vegetation when the sun is directly overhead.

Extend of shading: < 5% shading (left), >76% shading (right)

APPENDIX B

Sample location photographs

GR01
(33.969898S
150.912534E)

GR02
(33.969537S
150.912538E)

GR03
(33.968949S
150.91258E)

GR04
(33.968388S
150.912673E)

GR05
(33.967872S
150.91269E)

GR06
(33.967255S
150.912868E)

GR07
(33.966737S
150.912817E)

GR08
(33.966208S
150.91298E)

GR09
(33.966043S
150.913068E)

GR10
(-33.965505S
150.913163E)

GR11
(33.965032S
150.913355E)

GR12
(33.9645S
150.913412E)

GR13
(33.96444S
150.913652E)

GR14
(33.963943S
150.913562E)

GR15
(33.963446S
150.913434E)

GR16
(33.962975S
150.913358E)

GR17
(33.962536S
150.913265E)

GR18
(33.962029S
150.913132E)

GR19
(33.961449S
150.91306E)

GR20
(33.960937S
150.91309E)

GR21
(33.960485S
150.913003E)

GR22
(33.960072S
150.913148E)

GR23
(33.959597S
150.913105E)

GR24
(33.958814S
150.912883E)

GR25
(33.958147S
150.912469E)

GR26
(33.957564S
150.912355E)

GR27
(33.957002S
150.912377E)

GR28
(33.95628S
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GR29
(33.955605S
150.912403E)

GR30
(33.954937S
150.912445E)

GR31
(33.954492S
150.912387E)

GR32
(33.953943S
150.912387E)

GR33
(33.953368S
150.912617E)

GR34
(33.952774S
150.912842E)

GR35
(33.952107S
150.913178E)

GR36
(33.951562S
150.913307E)

GR37
(33.950821S
150.913527E)

GR38
(33.950245S
150.913707E)

GR39
(33.949738S
150.913903E)

GR40
(33.949124S
150.914243E)

GR41
(33.948684S
150.914456E)

GR42
(33.948166S
150.914745E)

GR43
(33.947655S
150.915098E)

GR44
(33.947075S
150.915524E)

GR45
(33.946559S
150.916077E)

GR46
(33.946235S
150.916842E)

GR47
(33.945783S
150.917351E)

GR48
(33.945816S
150.917925E)

GR49
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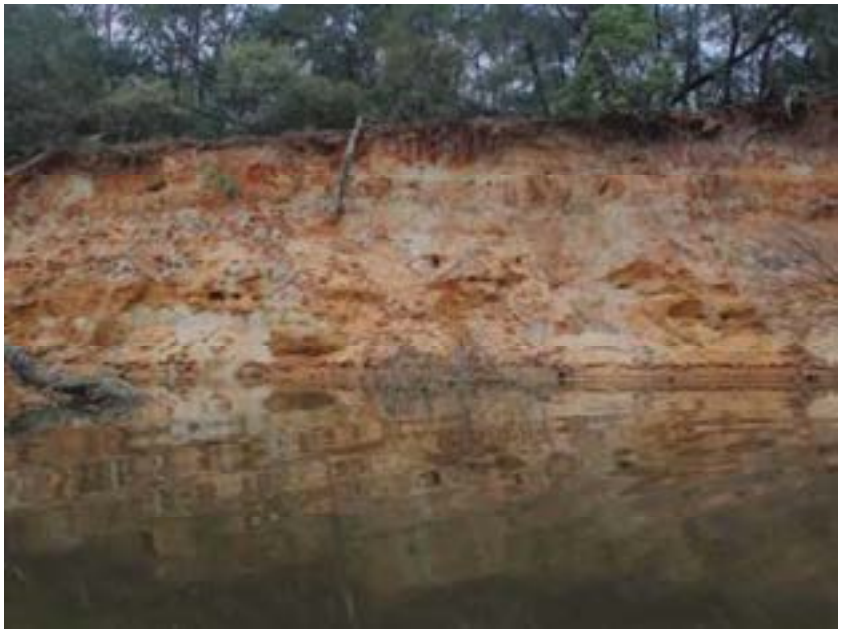
150.918514E)

GR50
(33.944313S
150.918882E)



GR51
(33.943317S
150.919067E)

GR52
(33.942695S
150.91894E)

GR53
(33.94203S
150.918757E)

GR54
(33.941422S
150.918739E)

GR55
(33.940781S
150.918692E)

GR56
(33.940188S
150.9187E)

GR57
(33.939604S
150.918924E)

GR58
(33.938898S
150.919307E)

GR59
(33.938327S
150.919586E)

GR60
(33.937788S
150.919886E)

Attachment M: Riparian Vegetation Management Plan (Hyder 2015)

Refer to Appendix I of the Biodiversity Assessment Report (Appendix J to the Response to Submissions)

SIMTA Intermodal Terminal Facility- Stage 1

Response to Submissions - Riparian Vegetation Management Plan

SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 4, Division 4.1, State Significant Development

September 2015

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SIMTA INTERMODAL TERMINAL FACILITY-STAGE 1 INTERMODAL TERMINAL FACILITY

Riparian Vegetation Management Plan

Author	Jane Rodd, Kate Carroll	[redacted]
Checker	Brad Searle	[redacted]
Approver	Westley Owers	[redacted]
Report No	AA003760	
Date	10 September2015	

CONTENTS

1 INTRODUCTION

This Riparian Vegetation Management Plan (RVMP) has been prepared to guide the restoration of riparian vegetation at the Georges River and Anzac Creek in areas under the management of SIMTA. Crossings are proposed over the Georges River (proposed bridge) and Anzac Creek (proposed culvert) for the Rail link included for Stage 1 of the SIMTA Moorebank Intermodal Terminal Facility (the Proposal).

This document has been prepared to align with the management requirements, provided by the NSW Office of Water (NOW), outlined in Section 1.2 of this RVMP. It is important to note that the content of this document would be reviewed and updated, as necessary prior to construction of the Proposal.

This plan was originally placed on public exhibition (between 28 May 2015 and 26 June 2015) with the EIS (Appendix S) for the Proposal. During this public exhibition period submissions were invited from all stakeholders including members of the community and government stakeholders. An amendment to the Rail link is proposed by SIMTA, in response to submissions received during public exhibition and to reduce the overall environmental impact of the Proposal.

Key agency stakeholder submissions relating to riparian vegetation management received following public exhibition of the RVMP submitted with the EIS for the Proposal were from NSW Office of Water. The comments are summarised as follows:

- Clarifying the riparian corridor widths to be established along Anzac Creek and the Georges River and how they were determined
- Clarification as to why the Georges River management site does not include the adjacent riparian corridor on the western side of the Georges River.
- Details on the proximity of aquatic weeds to the construction site.
- Recommendation to include ongoing maintenance and monitoring, including maintenance of weeds, for the operational life of the Proposal.
- Recommendation to reuse topsoil on the site for revegetation and translocate plants.
- Recommendation to amend management measures to only revegetate temporarily cleared areas.

This RVMP updates that provided with the EIS to address any changes as a result of the amended Rail link and/or in response to submissions. This RVMP supersedes the RVMP provided within Appendix S of the EIS.

This report should be read in conjunction with the following:

- *Biodiversity Assessment Report* (BAR) (Hyder Consulting, September 2015)
- *Biodiversity Offset Strategy* (BOS) (Hyder Consulting, September 2015).

1.1 KEY TERMS

Table 1 provides a summary of the key terms which are included within this report. Figure 1 also provides an indication of the site areas discussed in this table.

Table 1 Key terms

Term	Description
Concept Plan Approval	Concept Plan Approval (MP 10_0193) granted on 29 September 2014 for the development of the SIMTA Moorebank Intermodal Terminal Facility at Moorebank. This reference includes the associated Conditions of Approval (CoA) and Statement of Commitments (SoC) which form the approval documentation for the Concept Plan Approval.
EPBC Approval	Approval (No. 2011/6229) granted under the EPBC Act on March 2014 by the Commonwealth Department of Environment for the development of the SIMTA Moorebank Intermodal Terminal Facility at Moorebank.
SIMTA Project	The SIMTA Moorebank Intermodal Terminal Facility at Moorebank as approved by the Concept Plan (MP_10_0913).
SIMTA site	Includes the former Defence National Storage and Distribution Centre (DNSDC) site, the land owned by SIMTA which is subject to the Concept Plan Approval (refer to Figure 1).
Rail Corridor	Area defined as the 'Rail Corridor' within the Concept Plan Approval. The rail link is also included within this area (refer to Figure 1).
Stage 1 site	The subject of this EIS, the western part of the SIMTA site which includes all areas to be disturbed by the Stage 1 Proposal (including the Operational area and Indicative Construction area) (refer to Figure 1). This area does not include the Rail Corridor.
Construction area	Extent of construction works, namely areas to be disturbed during construction of the Stage 1 Proposal (refer to Figure 1).
Operational area	Extent of operational activities for the operation of the the Proposal (refer to Figure 1).
Proposal site	Includes the Stage 1 site and the Rail Corridor, i.e. the area for which approval (construction and operation) is sought within this EIS.
Rail link	The rail link including the area on either side to be impacted by the construction works included in the Stage 1 Proposal.
Former DNSDC South	The land to the south of the operational footprint of the Intermodal Terminal, to the boundary fence of the former DNSDC.
Southern Boot Land	Commonwealth owned land to the south of Former DNSDC South, and to the north of the RailCorp Land (part of the Boot Land in the MIC proposal).
RailCorp Land	Lot 1 DP 825352 (part of the Rail Corridor) and owned by RailCorp.
The Proposal	Stage 1 of the SIMTA Moorebank Intermodal Terminal Facility including construction and operation of the intermodal terminal facility and rail link, i.e. all works and built form for which approval is sought in this EIS/Technical Report.

Term	Description
MIC Proposal	The development of an intermodal facility, associated commercial infrastructure (warehousing) and a rail link (3 options have been provided) to be located on the MIC site, for which an approval, under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979.* This proposal is currently under assessment by the Department of Planning and Environment.
MIC site	The former School of Military Engineering site to the immediate west of the SIMTA site, across Moorebank Avenue.

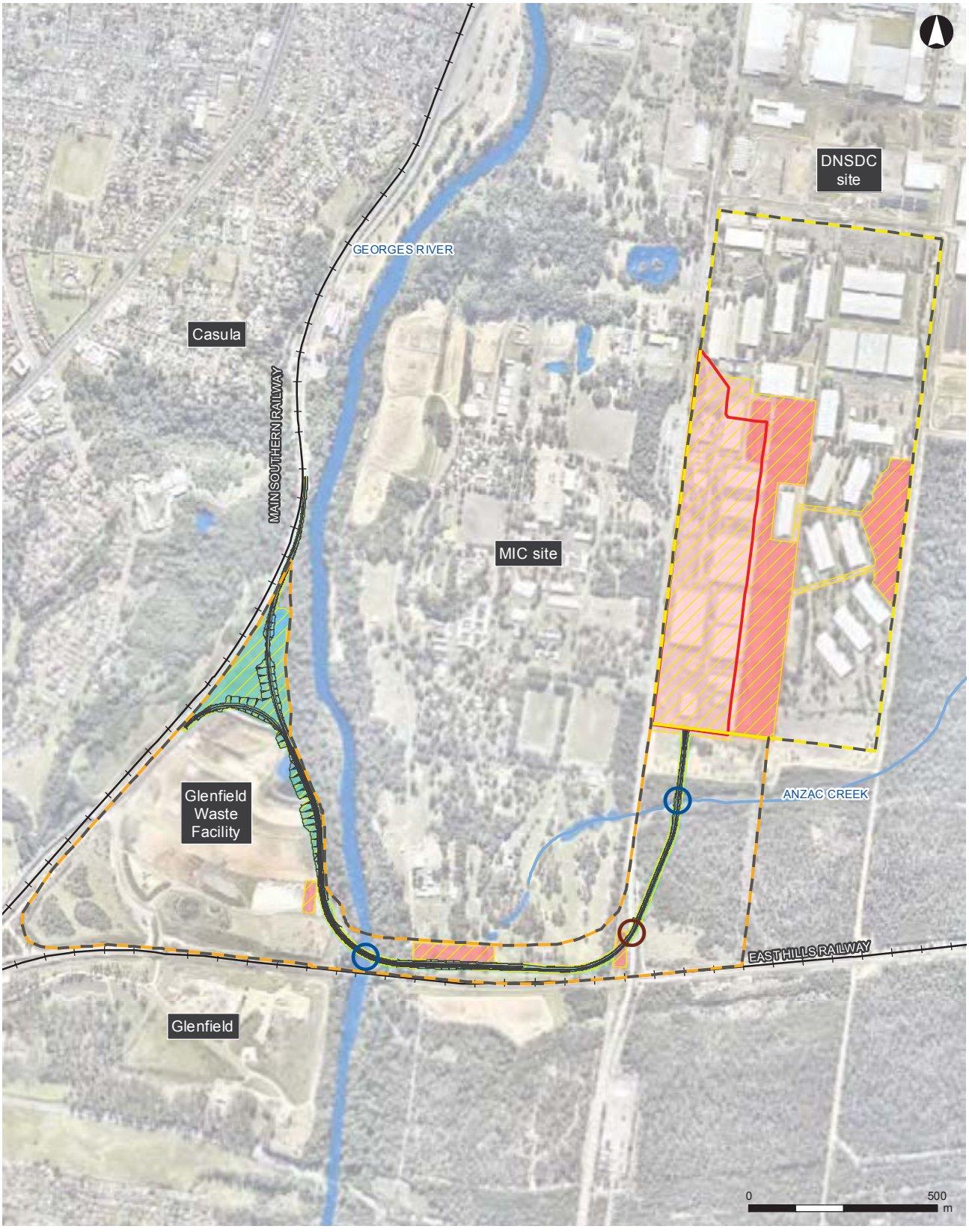
1.2 SITE LOCATION

This RVMP applies to two management sites:

- The stretch of riparian vegetation adjoining both banks (east and west) of the Georges River within the Rail link and riparian vegetation on the eastern bank within the Rail Corridor (the **Georges River management site**). This includes a 50m riparian setback on the eastern bank and riparian vegetation extending further up the bank. The management site ranges in width from 80m to 120m. The management site on the western bank is approximately 30m in width to include the riparian vegetation to be temporarily disturbed for construction of the Rail link. The Glenfield Waste Facility is located on the boundaries of the management site and the remainder of the 50m riparian setback is cleared land. The surrounding lands are subject to management by Glenfield Waste Facility and does not form part of this management site.
- Anzac Creek and a riparian setback either side of the creek within the SIMTA Rail Corridor, ranging in width from 35m to 55m (the **Anzac Creek management site**). A 30m wide riparian corridor along either side of Anzac Creek was prescribed; however, this area includes vegetation that does not form part of the riparian zone. The RVMP applies to the Plant Community Types (PCTs) Coastal Freshwater lagoons of the Sydney Basin and South-east Corner (ME007) and Parramatta Red Gum Woodland on moist alluvium of the Cumberland Plain, Sydney Basin (ME005) within the riparian area. The extents of these PCTs have been determined with reference to the vegetation mapping by DECCW (2009), verified by field survey. Cleared and disturbed areas on the southern bank of Anzac Creek to the west of the proposed Rail link have also been included in the management site. Vegetation outside the ground-truthed riparian zone, but within the 30m setback will be managed under the Threatened Flora Species Management Plan (Appendix J of this RtS) and/or the Biodiversity Offset Management Plan, as stipulated in the Biodiversity Offset Strategy (Appendix J of this RtS).

Figure 2 indicates the location of these two management sites in relation to the Proposal, with more detail of the extent of each site on Figure 3 and Figure 4.

It should be noted that both management sites (excluding the western bank of the Georges River) form part of the proposed offset sites for the Proposal (Appendix J of this RtS). The offset sites will be managed in perpetuity under a Biodiversity Offset Management Plan.



LEGEND

- Project site
- Rail corridor
- SIMTA site
- Operational area
- Proposed rail alignment
- Construction area
- Rail Link (including 20m width and variable buffer)
- Stage 1 site
- Compound sites
- Creek/River crossing
- Road crossing
- Existing railway
- Watercourse

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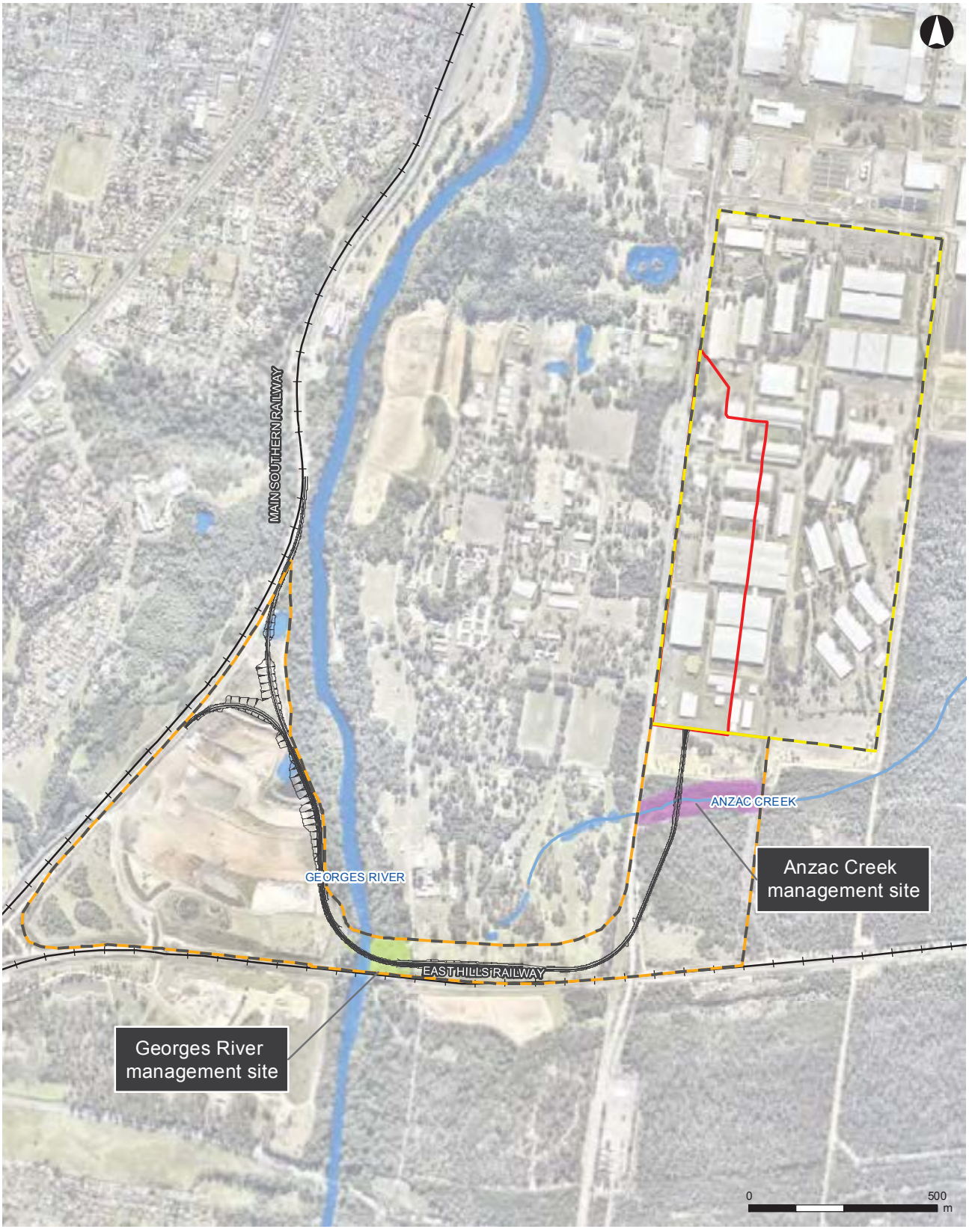
Figure 1: Site map

Date: 8/09/2015 Path: \\hc-aus-ns-fs-01\jobs\AA003760\L-GIS\A_Current\B_Maps\EcologyStage1\RVMP\AA003760_VMP_Stage1_Figure1_SIMTA_overview_A4_r2v1.mxd
Created by : GC
QA by : KC



LEGEND

- Project site
- Rail corridor
- SIMTA site
- Operational area
- Watercourse
- Anzac Creek management site
- Georges River management site
- Proposed rail alignment
- Existing railway

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Figure 2: Location of management sites in relation to the Proposal

Date: 10/09/2015 Path: \\hc-aus-ns-fs-01\jobs\AA003760\L-GIS\A_Current\B_Maps\EcologyStage1\RVMP\AA003760_VMP_Stage1_Figure2_Location_plan_A4_r2v2.mxd
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QA by : KC

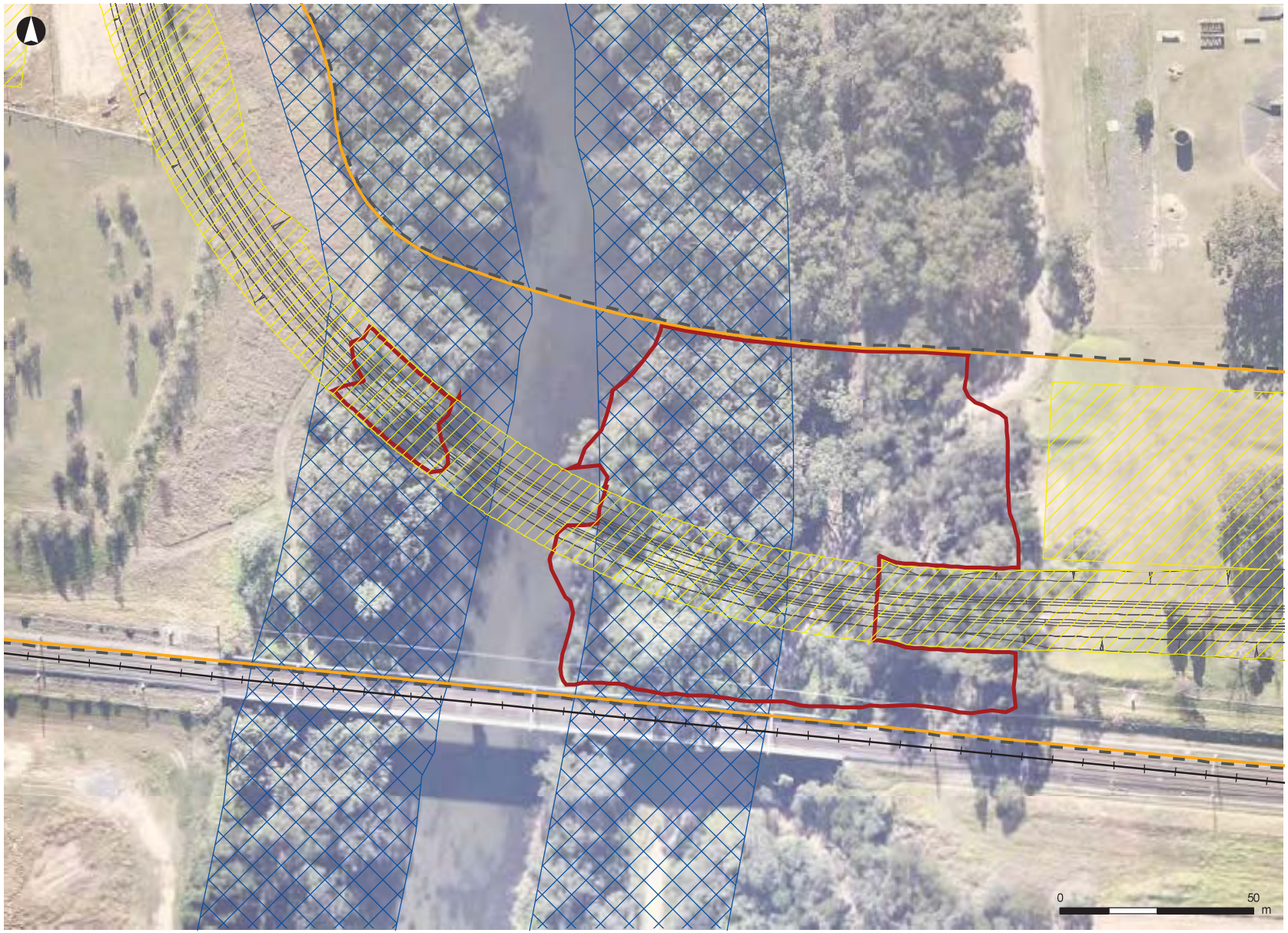

Figure 3: Georges River management site

Date: 10/09/2015 Path: \\hc-aus-ns-fs-01\jobs\AA003760\L-GIS\A_Current\B_Maps\EcologyStage1\RVMP\AA003760_VMP_Stage1_Figure3_GeorgesRiverMS_A4_r2v3.mxd
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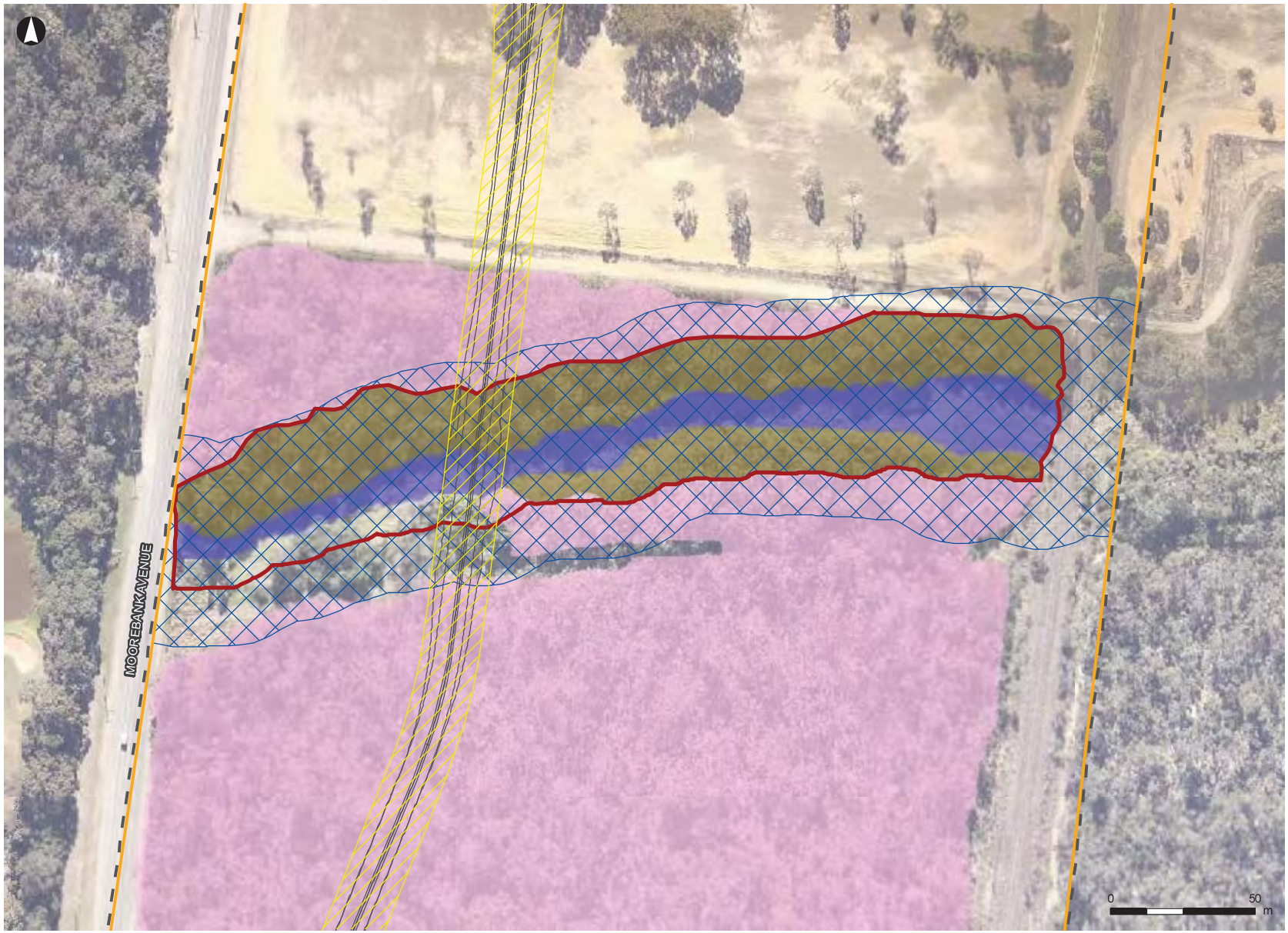
QA by : KC



LEGEND

- Project site
- Rail corridor
- Anzac Creek management site
- 30m riparian setback

Plant Community Types

- Coastal Freshwater lagoons of the Sydney Basin and South-east Corner (ME007)
- Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain Sydney Basin (ME003)
- Parramatta Red Gum Woodland on moist alluvium of the Cumberland Plain Sydney Basin (ME005)
- Construction area
- Proposed rail alignment

DATA SOURCES
nearmap

SIMTA

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Figure 4: Anzac Creek management site

Date: 8/09/2015 Path: \\hc-aus-ns-fs-01\jobs\AA003760\L-GIS\A_Current\B_Maps\EcologyStage1\RVMP\AA003760_VMP_Stage1_Figure4_AnzacCreekMS_A4_r2v2.mxd
Created by : GC
QA by : KC

1.3 MANAGEMENT PLAN REQUIREMENTS

NSW Office of Water

The NSW Department of Planning and Environment (DPE) issued Secretary's Environmental Assessment Requirements (SEARs) for the Proposal in December 2014 (SSD 14-6766). Condition 12(c) of the SEARs states that the Flora and Fauna Assessment is to include a Vegetation Management Plan that has been prepared in consultation with the NSW Office of Water (NOW).

NOW provided correspondence dated 16 April 2015, including the following advice:

> *Riparian corridors along the Georges River and Anzac Creek*
>
> *…approximately 0.22 hectares of riparian vegetation would be removed at the river banks for the installation of the bridge and abutments and 0.08 hectares of riparian vegetation would be impacted by the installation of the culvert/rail link at Anzac Creek. It is recommended the EIS includes:*
>
> - *details on the existing and proposed riparian corridor widths to be established along the river and Anzac creek (measured from top of bank)*
> - *a scaled plan which shows the proposed crossing options, existing riparian vegetation, the riparian corridor width and the riparian corridors that will be affected by the crossings*
>
> *Riparian corridors along the Georges River and Anzac Creek that are affected by the project should be appropriately revegetated to restore the ecological functional and habitat values. The EIS should provide details on the riparian corridor widths to be established to inform the riparian areas that are proposed to be disturbed by the project and areas that need to be revegetated/rehabilitated with local providence species.*
>
> *A Vegetation Management Plan (VMP) should be prepared which details the riparian corridor areas affected by the proposal and the regeneration/rehabilitation of riparian vegetation.*

Other relevant Management Plans (MIC site)

Parsons Brinckerhoff (2014) prepared a Management Plan for Restoration of the Riparian Zone of the Georges River as part of the Ecology Assessment for the MIC Proposal. The management plan was prepared for the riparian lands adjacent to the eastern bank of the Georges River within the MIC site. The riparian area addressed in the MIC management plan includes the Georges River management site in this plan. This plan has been prepared to maintain consistency with the MIC plan, where feasible and reasonable.

1.4 OBJECTIVES

The objectives of the RVMP are to:

- Restore, conserve and enhance the riparian vegetation in the Georges River and Anzac Creek site that fall within the SIMTA Rail Corridor
- Long term eradication of weed species from the management sites
- Maintain an adequate width of riparian vegetation adjoining Georges River and Anzac Creek
- Protect and enhance fauna habitat connectivity along the Georges River and Anzac Creek riparian zone.

1.5 APPROACH

This RVMP has been prepared in accordance with the following:

- *Guidelines for vegetation management plans of waterfront land*, NSW Office of Water
- *SIMTA Intermodal Terminal Facility – Stage 1 Biodiversity Assessment Report* (Hyder Consulting 2015).

This RVMP also aims to be complementary to, and consistent with, the adjacent Management Plan for Restoration of the Riparian Zone of the Georges River prepared as part of the *Ecological Impact Assessment* for the MIC Proposal prepared by (Parsons Brinckerhoff,2014).

1.6 STRUCTURE OF THIS PLAN

This RVMP has been structured according to the following:

- Section 2 outlines legislation and guidelines applicable to this RVMP
- Section 3 provides an overview of the site context, including landuse, landform, soil conditions and vegetation
- Section 4 establishes management strategies for rehabilitation of the riparian corridor, including protection of native vegetation, weed management and general habitat management and restoration
- Section 5 details the adaptive management and continual improvement framework which applies to this plan.
- Section 6 defines roles and responsibilities associated with the plan.

2 LEGISLATION AND GUIDELINES

2.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (MNES). MNES identified in the Act include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Threatened species and communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines).

The part of the site on the eastern bank of the Georges River is located within Commonwealth Land, and therefore all impacts on the environment of this section of the site are governed by the EPBC Act.

Also of relevance the EPBC Approval (No. 2011/6229) granted in March 2014 for the impact of the SIMTA Project on listed threatened species and communities (sections 18 and 18A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) and Commonwealth land (sections 26 and 27A of the EPBC Act). This approval facilitates, subject to state approval, the construction of the proposed Georges River and Anzac Creek crossings.

2.2 THE AUSTRALIAN WEEDS STRATEGY

The Australian Weeds Strategy (Natural Resource Management Ministerial Council 2006) replaces the National Weeds Strategy, providing a national framework for the reduction of the economic, environmental, and social impacts of weeds. Weed management is recognised as essential to the sustainable management of natural resources, the economy, the environment, human health and amenity. The Strategy addresses the prevention of new weed problems, abatement of existing weed problems, and the enhancement of capacity to combat weed problems.

The Strategy aims to complement and guide the efforts of state, territory, regional, and local government strategies and initiatives by providing a national framework. Building on the National Weeds Strategy created in mid-1997, the Australian Weeds Strategy continues the core objective of the National Weeds Strategy by identifying Weeds of National Significance (WONS) and the resultant coordinated actions across Australia. Weeds of National Significance are determined by the following four criteria:

- level of invasiveness
- environmental impacts
- potential for spread

- socio-economic and environmental values (Natural Resource Management Ministerial Council 2006).

Of relevance to the managements sites within the Proposal site which are the subject of this RVMP are the management guidelines for the WONS which occur on the Proposal site.

2.3 NSW THREATENED SPECIES CONSERVATION ACT 1995

The NSW *Threatened Species Conservation Act 1995* (TSC Act) provides for the protection and management of threatened species, populations and ecological communities listed under schedules 1, 1A and 2 of the Act. The TSC Act also lists Key Threatening Processes (KTPs) that "threaten or could threaten the survival or evolutionary development of species, populations or ecological communities". They are listed under Schedule 3 of the TSC Act and may adversely affect threatened species, populations or ecological communities or could cause species, populations or ecological communities that are not threatened to become threatened. KTPs identified as potentially associated with management of riparian and aquatic values on the site include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion of native plant communities by exotic perennial grasses
- Invasion and establishment of exotic vines and scramblers
- Invasion, establishment and spread of *Lantana camara*
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Loss of hollow-bearing trees.

2.4 NSW WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) provides for the sustainable and integrated management of the water sources of NSW. The WM Act regulates controlled activities carried out in, on or under waterfront land through a requirement for a permit; clause 89J of the EP&A Act provides an exemption for these permits for SSD assessed under Part 4, Division 4.1 of the EP&A Act (under which approval of the Proposal is sought).

When a proposed controlled activity disturbs or substantially modifies the riparian corridor, a VMP detailing how restoration or rehabilitation of the corridor will be carried out would be required. Although a controlled activity permit is not required for the Proposal, management of riparian corridor values would maintain consistency with the guidelines issued by NOW for vegetation management plans on waterfront land.

2.5 NSW NOXIOUS WEEDS ACT 1993

The *Noxious Weeds Act 1993* (NW Act) aims to reduce the negative impact of weeds on the economy, community and environment and to provide for the monitoring of and reporting on the effectiveness of the management of weeds in NSW. The NW Act provides for the identification, classification and control of noxious weeds, and imposes obligations on occupiers of land to control noxious weeds declared for their area.

3 CURRENT SITE CONDITIONS

3.1 LAND USE

The vegetation of the Georges River site adjoins the Glenfield Waste Facility to the west, and the RAE Golf Course currently on the MIC site to the east. The Georges River management site is located immediately to the north of the East Hills railway line.

The Anzac Creek management site is within the Southern Boot Land to the south of the SIMTA site and Stage 1 site. The Southern Boot Land supports native vegetation with some historical disturbance. Anzac Creek flows east across the northern section of the Southern Boot Land, with native vegetation adjoining the drainage line to the north and south. The creek passes through a culvert beneath an existing rail spur that runs north-south across the eastern edge of the Rail corridor.

3.2 LANDFORM

The Georges River management site is characterised by the floodplain and banks of the section of Georges River which the management site adjoins. The approximately 100 metre extent of the riparian corridor in the management site comprises:

- A flat alluvial terrace of variable width, only slightly elevated above the river
- A moderately to steeply sloped embankment
- A gently sloped to flat upper bank and floodplain.

The eastern bank of the Georges River within the management site is generally higher and with a steeper embankment than the western bank.

The section of Anzac Creek within the management site consists of a shallow muddy waterbody, with gently sloping creek banks.

3.3 HYDROLOGY

Georges River

The Georges River is located within the Georges River catchment and the Liverpool District sub-catchments and Mid Georges River catchment. It enters the Liverpool LGA from the south on the western side of the Defence Lands at Holsworthy and flows north, meeting with Glenfield Creek at Casula. From here the Georges River continues to flow north past the Liverpool City Centre, under Newbridge Road, past Lighthorse Park and over the Liverpool Weir. Downstream of the Liverpool Weir, the Georges River becomes slightly salty (estuarine) and is more subject to tidal influences.

Anzac Creek

Anzac Creek originates from within the Royal Engineers Golf Course, to the west of Moorebank Avenue, and flows in a north-east direction across the Rail Corridor, just south of the SIMTA site and Stage 1 site. The creek flows north past the adjoining suburbs of Wattle Grove and Moorebank before draining into Lake Moore in Chipping Norton, which in turn flows into the Georges River.

3.4 SOIL CONDITIONS

The soil landscapes of the Penrith 1:100 000 sheet were mapped by Bannerman and Hazelton (1990). The features and locations of the mapped soil landscapes of the management sites are detailed in Table 2.

Table 2 Soil landscapes mapped in management sites by Bannerman and Hazelton (1990)

Soil Landscape	Features (Bannerman and Hazelton 1990)	Location in Proposal site
Berkshire Park (Fluvial)	Orange heavy clays and clayey sands, often mottled; ironstone nodules common. On dissected, gently undulating rises on the Tertiary terraces of the Hawkesbury/Nepean river system.	Eastern bank of Georges River and Anzac Creek site.
Richmond (Fluvial)	Poorly structured orange to red clay loams, clays and sands; ironstone nodules may be present. Landscape is Quaternary terraces of the Nepean and Georges Rivers, mainly flat.	100m wide strip adjoining western bank of Georges River.

3.5 AQUATIC ENVIRONMENT

An aquatic ecology assessment was undertaken as part of the *Flora and Fauna Assessment* (Hyder Consulting, 2011) for the Concept Plan Approval.

The aquatic survey conducted in the proximity of the proposed Georges River railway crossing, identified two species of fish, including one specimen of the native Flathead Gudgeon (*Philypnodon grandiceps*) and the introduced Gambusia (*Gambusia holbrooki*) (Hyder Consulting 2011). The AUSRIVAS macroinvertebrates results for the Georges River rated the sampling site in Band C, suggesting that it is 'severely impaired' with fewer macroinvertebrate families observed than expected.

The Georges River in the vicinity of the Proposal site was 40 to 60 metres wide, and the bank dropped rapidly to a depth of 1.2 metres before falling away at a steadier grade. Aquatic habitats present included soft substrate pool habitat, large woody debris and extensive macrophyte cover. Overhanging vegetation, fallen logs, mats of sticks, submerged (*Elodea canadiensis*) and floating aquatic plants (*Azola* sp., *Salvinia molesta*) were present throughout the Proposal site and reach along the bank.

Fish surveys of Anzac Creek identified only one species, introduced Gambusia (*Gambusia holbrooki*). The overall AUSRIVAS rating for macroinvertebrates in Anzac Creek was Band B indicating that the macroinvertebrate community was 'significantly impaired'.

3.6 VEGETATION

3.6.1 VEGETATION COMMUNITIES

Georges River management site

The land within approximately 100 metres of the eastern bank of the Georges River supports forest vegetation. On the steep slope adjacent to the riverbank was severely degraded riparian vegetation, currently reduced to mature trees of *Eucalyptus saligna* x *botryoides* (Blue Gum/Bangalay hybrid) and *Eucalyptus longifolia* (Woollybutt) with an understorey dominated by

Ligustrum sinense (Small-leaved Privet) and smothered by exotic weeds, mainly *Cardiospermum grandiflorum* (Balloon Vine), *Lantana camara* (Lantana) and *Delairea odorata* (Cape Ivy) (Plate 1, Plate 2).

The vegetation was less disturbed upslope and included a mixed native and exotic understorey with mature trees of *E. saligna* x *botryoides.* Given the relatively low native diversity coupled with low exotic cover in upslope areas, it is possible that there has been weed removal in this area and that the native understorey is regenerating.

Plate 1. Degraded riparian vegetation on eastern bank of Georges River

Plate 2. Degraded riparian vegetation

On the western bank of the Georges River, adjacent to the Glenfield Waste Facility, the vegetation was similar in structure and condition to that on the eastern bank. The riparian vegetation within the management site is approximately 30 metres in width. The riparian forest supported a canopy dominated by *Eucalyptus saligna x botryoides* to 20 metres in height (Plate 3).

The understorey on the river flats near the existing rail bridge consisted of a mixture of local native shrub, herb and grass species and some dense stands of *Olea europaea* subsp. *cuspidata* and *Lantana camara,* with *Tradescantia fluminensis* dominating the ground layer in some areas.

Plate 3. Edge of riparian vegetation on western bank of Georges River in south of site

The vegetation adjoining the Georges River in the management site was classified as Plant Community Type ME018: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin, based on previous regional mapping as an equivalent vegetation type, landscape position, and absence of any other appropriate equivalent

PCT in the VIS database. This vegetation meets the criteria for the endangered ecological community River-flat Eucalypt Forest as listed under the TSC Act.

Riparian vegetation associated with Georges River maintains connectivity with riparian vegetation to the north and south, including the Holsworthy Military Area. This riparian corridor may facilitate the movement of less mobile species, including cover-dependent species, larger terrestrial mammals and arboreal mammals. The riparian vegetation also forms potential habitat for a number of threatened fauna species identified as potentially occurring in the Rail Corridor.

Anzac Creek

The section of Anzac Creek within the management site consists of a shallow muddy waterbody, with limited standing water observed at the time of survey, supporting dense stands of *Typha orientalis* (Broad-leaf Cumbungi) and *Bolboschoenus fluviatilis* (Club-rush) with *Alternanthera philoxeroides* (Alligator Weed) abundant in the lower stratum. In 2011 and 2012, a dense infestation of *Salvinia molesta* (Salvinia) was observed on the creek surface immediately to the west of the existing railway line (Plate 4, Plate 5). This was not observed during vegetation surveys in 2014.

Plate 4. Anzac Creek to west of existing rail spur, showing *Salvinia molesta* infestation in foreground and native sedges and rushes further upstream

Plate 5. Ground layer of wetland in Anzac Creek

Fringing Anzac Creek is a narrow band of swamp woodland dominated by *Melaleuca linariifolia* (Flax-leaved Paperbark); the understorey of this forest varied from sedges, especially *Leptocarpus tenax* which dominated in patches, to ferns, grasses and dense shrubs. To the south of the eastern part of Anzac Creek there were occasional emergent trees of *Angophora subvelutina* (Broad-leaved Apple) and *Eucalyptus sclerophylla.*

Adjoining the southern bank of the western section of Anzac Creek the vegetation is disturbed and dominated by exotic vegetation, with a large stand of *Phyllostachys aurea* (Golden Bamboo), thickets of *Acacia decurrens* (Black Wattle) and *Pennisteum clandestinum* forming a carpet over a raised, uneven ground surface, likely to be fill material deposited in this location decades ago (Plate 6). Exposed soil beneath a fallen tree showed soil mixed with broken concrete tiles (Plate 7). *Agave americana* (Century Plant) and *Aloe maculata* (Common Soap Aloe) were also growing in this location, suggesting dumped landscape or garden waste.

Plate 6. Disturbed area south of Anzac Creek: *Pennisetum clandestinum, Agave americana* and *Phyllostachys aurea*

Plate 7. Exposed fill material in disturbed area

3.6.2 WEEDS

Noxious Weeds

There are 11 plant species recorded in the riparian management zones listed as noxious weeds in the Liverpool City Council LGA (Table 3). Six of the noxious weeds are also listed as Weeds of National Significance under the National Weeds Strategy (Thorp and Wilson 2012).

Table 3 Noxious weeds recorded in the management sites

Scientific name	Common name	Noxious weed control class	Weed of National Significance	Location
Alternanthera philoxeroides	Alligator Weed	3	Yes	Well established throughout Anzac Creek, wetlands on western side of Georges River
Asparagus asparagoides	Bridal Creeper	4	Yes	Banks of Georges River
Lantana camara	Lantana	4	Yes	Banks of Georges River
Ligustrum lucidum	Broad-leaved Privet	4	No	Western bank of Georges River
Ligustrum sinense	Small-leaved Privet	4	No	Banks of Georges River
Ludwigia peruviana	Peruvian Primrose	3	No	Anzac Creek, in wetland on western side of Georges River
Olea europaea subsp. *cuspidata*	African Olive	4	No	Banks of Georges River
Opuntia sp.	Prickly Pear	4	Yes	Banks of Georges River

Scientific name	Common name	Noxious weed control class	Weed of National Significance	Location
Phyllostachys aurea	Golden Bamboo	4	No	Southern bank of Anzac Creek
Rubus fruticosus agg. spp. (includes *R. anglocandicans*)	Blackberry	4	Yes	Banks of Georges River, in disturbed bushland south of Anzac Creek
Salvinia molesta	Salvinia	2	Yes	On Anzac Creek upstream of the existing culvert during 2012 surveys. This infestation was not present in 2014/2015 surveys. The species was not identified in the vicinity of the proposed works.

The most severe weed infestations were on the lower slopes adjoining the banks of the Georges River, where there were large stands of privet *Ligustrum sinense* (Small-leaved Privet) and *Lantana camara* (Lantana).

The control requirements for the classes of noxious weeds recorded in the management sites are presented in Table 4.

Table 4 Weed control classes and requirements

Control Class	Weed type	Control requirements
Class 2	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.
Class 3	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.	The plant must be fully and continuously suppressed and destroyed.
Class 4	Plants that pose a potentially serious threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

Environmental Weeds

In addition to the declared noxious weeds on the management site, there are a number of weedy exotic species which pose a threat to the biodiversity values of the management sites (Table 5).

Table 5 Environmental weeds recorded in the management sites

Scientific name	Common name
Asparagus aethiopicus	Asparagus Fern
Bidens pilosa	Cobblers Pegs
Cardiospermum grandiflorum	Balloon Vine
Chloris gayana	Rhodes Grass
Delairea odorata	Cape Ivy
Ehrharta erecta	Panic Veld-grass
Eragrostis curvula	African Lovegrass
Lonicera japonica	Honeysuckle
Ochna serrulata	Mickey Mouse Plant
Sida rhombifolia	Paddy's Lucerne
Tradescantia fluminensis	Wandering Jew

4 VEGETATION MANAGEMENT MEASURES

Management and restoration strategies for the site include:

- Protection of remnant native vegetation
- Site preparation, including demolition of structures and clearing
- Weed control
- Revegetation
- Soil erosion control and drainage works
- Fauna habitat enhancement.

Each of these strategies includes a number of specific actions designed to meet the objectives of the plan, namely to:

- restore and revegetate the riparian zone to be consistent with and complementary to areas of remnant indigenous vegetation within the Georges River Corridor
- eradicate weed species on the sites, with a particular focus on priority weeds
- maintain an adequate width of riparian vegetation adjoining Georges River and Anzac Creek.
- improve habitat for aquatic fauna as well as terrestrial species
- protect and enhance fauna habitat, including habitat for threatened species.

4.1 SITE ESTABLISHMENT AND PROTECTION OF NATIVE VEGETATION

Prior to commencement of on-site works, all areas of retained riparian forest not within the Proposal footprint will be identified and marked on site. Exclusion fences will be installed and maintained around this vegetation for the duration of the construction period of the Proposal.

Vegetation clearing will be carried out to the extent required for the proposed bridge and culvert construction. Clearing of the Construction area should avoid spread of weed propagules into adjoining retained vegetation. It will be important to remove as much of the existing weed source as possible prior to clearing if reserved topsoil and/or mulched vegetation are to be re-used within management sites as part of the restoration process.

Site preparation undertaken prior to planting will ensure that bank stabilisation is not compromised.

4.2 SOIL EROSION CONTROL AND DRAINAGE WORKS

Soil stabilisation may be required for riparian areas where bank erosion is deemed a risk and advice will be sought from the Engineering Manager or Environmental Officer as to whether stabilisation is a requirement in areas where construction is occurring adjacent to the creek banks, or where weed removal may result in bank instability. Where required, a thick jute mesh or suitable alternative will be applied to these areas, which will also act as a weed suppressant. Should invasive bank stabilisation works be required along the riparian embankment, this will occur after primary weed control.

The risk of bank erosion may also be reduced through revegetation. Hydromulching using native grass seeds may be effective for initial erosion control of recently cleared areas. When undertaking tubestock planting of slopes, selection of hardy, deep-rooted native shrub species should further contribute to bank stability.

4.3 WEED CONTROL

4.3.1 PRIMARY WEED CONTROL

Primary weed control will be carried out prior to the commencement of the proposed bridge and culvert construction works. Planning would allow for sufficient time to remove target weeds or treat them with herbicide to achieve a complete kill (i.e. root death).

Weed management of the site requires the continual suppression of noxious and invasive weeds, with a focus on weed species that are currently present in dense infestations on the sites, namely:

- *Alternanthera philoxeroides* (Alligator Weed) – abundant cover in Anzac Creek
- *Cardiospermum grandiflorum* (Balloon Vine) – smothering native vegetation on east bank of Georges River
- *Lantana camara* (Lantana) – dense cover in riparian forest on both banks of the Georges River.
- *Ligustrum lucidum* and *L. sinense* (Privet) – dense cover on both banks of the Georges River.

It is important to avoid disturbance, where possible, to the unstable alluviums which form the banks of the Georges River by removing the stabilising vegetation. As much of the stabilising vegetation currently comprises woody weeds and exotic grasses, progressive removal of weed thickets is recommended.

To reduce impacts on water quality, soil disturbance and herbicide use in proximity to waterways should be minimised. Silt traps downstream of any soil disturbance should reduce sediment and nutrient pollution. The use of “cut and paint” techniques is preferable to broad spectrum spraying as they will minimise the potential transport of herbicide into waterways.

The aim of weed management is the long-term eradication of noxious and invasive weeds from the management sites, which will contribute to regional management outcomes for the Georges River riparian corridor. Successful long-term weed management will require long-term maintenance as it is likely that weeds will be re-introduced to the site from upstream areas, given the wind, water and animal-assisted dispersal abilities of many of the weed species present on the site. Restoration of native vegetation on the site should eventually result in lower weed densities and will require regular monitoring and spot-treatment of weed infestations.

4.4 WEED CONTROL METHODS

Table 6 provides a summary of the priority weeds and the strategies for their removal from the management sites. Table 7 identifies other noxious weeds and associated control strategies.

Table 6 Priority weeds and proposed control strategies

Weed species	Location and extent of species within management sites	Control strategy
Alternanthera philoxeroides Alligator Weed	Present in high abundance in the channel of Anzac Creek and has also been recorded in the Georges River management site.	This species is difficult to control and may require an integrated long-term management approach using both physical removal and chemical control techniques. Removal of this weed from Anzac Creek may be problematic as it is an established infestation and has formed large aquatic mats across the water surface, interspersed with native sedges. The recommended method for ongoing suppression of an infestation of the size in Anzac Creek is a long-term program of annual herbicide application using metsulfuron-methyl (DPI 2007). It should be noted that metsulfuron-methyl products are registered only for use on terrestrial alligator weed, and they may be applied to aquatic infestations only under the conditions of a current Australian Pesticides and Veterinary Medicines Authority (APVMA) permit.
Cardiospermum grandiflorum Balloon Vine	Forms a dense layer smothering vegetation on the flats and steep eastern bank of the Georges River.	A combination of manual and chemical control is recommended. Areas of dense infestation should be sprayed with herbicide, targeting vines at the base of native trees as a priority. Cut vine stems and paint with herbicide. Remove canopy growth if possible with a brush hook or similar tool.
Lantana camara Lantana	Dense stands present on both banks of the Georges River.	Mechanical control of dense infestations may be undertaken where practicable, otherwise manual removal is recommended. Follow up with herbicide control and ongoing spot-spraying while native vegetation re-establishes.
Ligustrum lucidum and *L. sinense* Privet	Dense stands present on both banks of the Georges River.	A range of manual and chemical control methods should be used for both Privet species, including strategic hand removal of small to medium plants and stem injection or frilling and pasting of herbicide for larger individuals. Long term integrated management of these species will be necessary.

Table 7 Other noxious weeds and proposed control strategies

Scientific name	Management site	Control methods
Asparagus asparagoides Bridal Creeper	Georges River	Ongoing herbicide control.
Ludwigia peruviana Peruvian Primrose	Anzac Creek, Georges River	Manual removal or chemical control.
Olea europaea subsp. *cuspidata* African Olive	Georges River	Manual removal of small to medium plants and cutting and painting with herbicide for larger individuals.
Opuntia sp. Prickly Pear	Georges River	Manual removal followed up with spot spray.
Rubus fruticosus agg. spp. (includes *R. anglocandicans*) Blackberry	Georges River	Manual removal and chemical control.
Salvinia molesta Salvinia	Anzac Creek	The infestation of this weed in Anzac Creek observed in 2011 and 2012 appears to have been significantly reduced in 2015 observations. Further control should focus on monitoring and containing any new infestations.

4.4.1 SECONDARY WEED CONTROL

Given that weed species are likely to be re-introduced to the management sites from adjoining and upstream areas, ongoing maintenance will be required. There is also likely to be a large amount of weed seed stored in the soils of the sites, particularly at the Georges River management site. Controlling weeds in their early stages of growth is preferable.

Secondary weed control will be undertaken quarterly with consideration given to the life cycle of the species and will follow the requirements as described for primary weeding. Weed control effort will increase as growth is accelerated in the warmer seasons. As weeds in the riparian zone may have been transported from upstream areas, opportunities to co-ordinate site weed control activities with regional weed control programs will be investigated through contact with Liverpool and Campbelltown Councils and Greater Sydney Local Land Services.

4.4.2 PREVENTING FURTHER SPREAD OF WEEDS

All construction machinery used within the construction site and/or management sites to clear weed-infested vegetation or to remove weeds is to be thoroughly cleaned by removing all plant material and soil (potentially containing weed seeds and propagules) prior to leaving site.

Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the management sites to minimise the likelihood of transferring any plant material and soil.

4.4.3 HERBICIDES

The type of herbicides used will be in accordance with the *NSW Pesticides Act 1999* and follow the species specific recommendations made in the *Noxious and Environmental Weed Control Handbook - A guide to weed control in non-crop, aquatic and bushland situations* (6th Ed) (NSW DPI 2014). Only herbicides registered for aquatic use should be applied in areas adjacent to waterbodies. Additionally, the use of herbicides must comply with label instructions and the Material Safety Data Sheet (MSDS) for the product.

4.5 REVEGETATION

Plants will be propagated from native seed collected from the management sites and surrounding areas prior to vegetation clearing. Revegetating the site with local provenance species will maximise the recovery potential of the site as these are adapted to the local environmental and climatic conditions. Where species cannot be sourced from the site but are required to assist in regeneration, these should be collected from within 5 kilometres of the site. Material collected from native vegetation to be cleared for bridge construction, such as seed-bearing branches and mulched native vegetation, should be used as far as is practicable. Collection of seed will be undertaken in accordance with Florabank Guidelines and by an experienced Bushland Regenerator in possession of the appropriate licenses under the *National Parks and Wildlife Act 1974.*

Where possible, topsoil in the riparian areas removed for the Proposal would be reused for revegetation. This would only occur if the following conditions are met:

- Topsoil is sourced from an area with low densities of weed
- Topsoil would only be reused for revegetation of the same PCT as its source

The 20 m wide Rail link would be stabilised following construction with local topsoil with growth of groundcover encouraged. This corridor would be managed by removing weeds and reducing the fuel load.

A potential species list or planting list for the site has been prepared, based on the native species recorded within and adjacent to the management sites at the time of survey (Table 8). The final planting list will be based largely on the seed available to be collected from the site and the suitability of the seed stock to be germinated and propagated under nursery conditions.

Table 8 Indicative species list for revegetation

Species	
Canopy trees	**Herbs and groundcovers**
Eucalyptus saligna x botryoides	*Dichondra repens*
Eucalyptus longifolia	*Einadia hastata*
Casuarina glauca	*Gahnia clarkei*
	Lomandra longifolia

Species	
Small trees and shrubs	*Oxalis perennans*
Acacia binervia	*Plectranthus parviflorus*
Acacia decurrens	*Pratia purpurascens*
Acacia floribunda	**Climbers and twiners**
Breynia oblongifolia	*Billardiera scandens*
Bursaria spinosa	*Cassytha pubescens*
Exocarpos cupressiformis	*Clematis aristata*
Leucopogon ericoides	*Clematis glycinoides*
Melaleuca linariifolia	*Glycine clandestina*
Notelaea longifolia	*Glycine tabacina*
Ozothamnus diosmifolius	*Parsonsia straminea*

Planting methods should include a combination of direct seeding, branch spread, and tubestock planting. Hydromulching of highly disturbed, unstable slopes with native grass seeds may be undertaken if considered appropriate.

Tubestock planting

- Tubestock should be planted in spring or autumn.
- Tubestock is to be planted in a mixed species order. One tree or shrub and four groundcovers are to be planted per square metre (possibly more on steep slopes). Given that patches of remnant vegetation are already present on the site, tubestock planting will prioritise those areas where large numbers of weeds have been removed.
- Protect tubestock with guards and mulch well to minimise weeds and retain moisture. Mulch is to be sourced from the site and certified not to contain weed species.
- Water in well and replant failed plants as necessary after 1 month. Water weekly if conditions are hot.
- Maintain weed control in planted areas.
- A watering program is to be implemented for established plants and continued for at least 12 months.

4.6 FAUNA HABITAT ENHANCEMENT

Georges River

The vegetation of the Georges River riparian corridor forms an important habitat linkage for native fauna species. The Biodiversity Assessment report for the Proposal (Hyder Consulting, 2015) found:

- Canopy trees supporting small to medium-sized branch hollows are located on the western bank of the Georges River. These hollows offer potential nesting and roosting habitat to hollow-dependent fauna. Decorticating bark of eucalypts on both sides of the river offers potential roosting habitat to microchiropteran bat species.
- Dense infestations of weedy shrubs such as *Lantana camara* and *Ligustrum* spp. offer potential sheltering and foraging habitat to native birds.
- Leaf litter and small ground timber offers shelter and foraging habitat to small terrestrial mammals and reptiles.

The construction of the bridge over the Georges River will require clearance of a 20 metre wide corridor across the riparian zone. The bridge abutments are located approximately 60 to 70 metres from the water's edge on either side of the Georges River, and two groups of piers will be installed on either side of the river between the abutments and the water.

The gap between the East Hills Rail Line bridge and the proposed 11.3 metres wide rail bridge will be between 20 and 30 metres on the eastern bank of the Georges River and between 50 and 70 metres on the western side of the Georges River. The vegetation between the two bridges will be retained and the eastern side would be managed under this plan. The area beneath and adjoining the proposed rail bridge which would be cleared for construction will be revegetated with the objective of maintaining and enhancing fauna habitat.

Revegetation of the 20 metre wide gap cleared for the bridge will be primarily with shrub, small tree and groundcover species. Planting and management of adjacent areas on the eastern bank will ensure that trees are located as close as possible to the bridge, without posing a safety risk to the operation of the Rail link. Species in the revegetation area will be selected to provide habitat resources for native fauna, such as structural habitat components or food sources.

Additional measures proposed to enhance fauna habitat in the Georges River corridor include:

- Installation of nest boxes in retained native vegetation. A Nest Box Management Plan would be prepared which would outline the installation and monitoring requirements of the nest boxes.
- Placement of cut logs and branches cleared from the construction zone into retained vegetation to provide fauna habitat components.

Anzac Creek

The proposed Anzac Creek culvert is an eight cell concrete box culvert, each cell being 1800 mm high and 2100 mm wide. It features six wet cells, following the natural contours of the creek, to allow for fish passage and two dry cells, one on either end of the culvert, to allow for terrestrial fauna passage. The dry cells would be constructed by filling the two concrete cells with rock to a height of 800 mm. This would allow a height of one metre from the roof of the cell to the fill surface for dry passage. The dry cells are located adjacent to the wing walls at the creek bank. Provision of the dry cells should maintain fauna connectivity across the rail corridor to the north and south of Anzac Creek.

4.7 SUMMARY OF VEGETATION MANAGEMENT MEASURES

Table 9 provides a summary of the vegetation management activities to be undertaken as part of this RVMP, as well as information on the proposed timing, frequency and expected outcomes of each action.

Table 9 Summary of vegetation management measures

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
Site establishment and protection of native vegetation								
Clearly identifying sensitive areas ('no-go areas') which cannot be impacted by construction and manage clearing such that clearing activities are constrained to these approved areas only.	✓	✓		Once only and then maintained	✓	✓	Prevent over clearing	Construction contractor and Stage 1 Proposal operator
High visibility plastic fencing is to be installed to clearly define the limits of the Construction area, including the Rail link and works areas around watercourse crossings.	✓	✓		Once only and then maintained	✓	✓	Prevent disturbance or over clearing of fauna habitat and native vegetation outside the development footprint	Construction contractor
The extent of vegetation clearing is to be clearly identified on construction plans.	✓			Prior to construction	✓	✓	Prevent impacts to fauna habitat and native vegetation outside the development footprint	Construction contractor or Site Operator
Instream works at Georges River and Anzac Creek would be minimised as much as possible, including disturbance to aquatic vegetation. Disturbed areas (within the riparian corridors) would be contained to the 20m wide Rail Corridor.		✓		As clearing occurs	✓	✓	Minimise harm to fish habitat.	Construction contractor

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
Weed control								
Primary weed control of the management sites	✓	✓	✓	Monthly prior to and during construction period and for a 12 month period following construction.	✓	✓	Removal of dense weed cover from management sites (where practicable)	Bush regeneration contractor
Follow-up weed control and inspection			✓	Quarterly for a three to five year period following construction.	✓	✓	Ongoing suppression of weeds	Bush regeneration contractor
Management of noxious weeds is to be undertaken in accordance with the *Noxious Weeds Act* 1993.	✓	✓	✓	As per weed control frequency.	✓	✓	Prevent weed establishment and invasion	Construction contractor and Site Operator
Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the management site to minimise the likelihood of transferring any plant material and soil.	✓	✓	✓	As per weed control frequency.	✓	✓	Prevent weed establishment and invasion	Construction contractor and Bush regeneration contractor
Soil stripped and stockpiled from areas containing known weed infestations are to be stored on cleared land at least 40 m from native vegetation.		✓		As soil disturbance occurs.	✓	✓	Prevent weed establishment and invasion	Construction contractor

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
Soil excavated from the Anzac Creek corridor must be disposed of in accordance with the guidelines in the *Alligator Weed Control Manual* (DPI 2007), as it will likely contain fragments of Alligator Weed.		✓		As excavation occurs.		✓	Prevent further spread of the noxious weed *Alternanthera philoxeroides*	Construction contractor
Revegetation								
Undertake seed collection, where possible, at least 12 months prior to the commencement of revegetation.	✓	✓	✓	Initial seed collection period prior to and during construction. Further collections may be required over time for replacement of tubestock planting.	✓	✓	Maintain genetic integrity of native vegetation in management sites.	Bush regeneration contractor
Propagation of tubestock from collected seed	✓	✓	✓	For initial planting and ongoing replacement planting	✓	✓	Provision of healthy, viable local native plants for revegetation	Bush regeneration contractor
Planting and direct seeding in areas of retained vegetation after completion of primary weed control works		✓	✓	Initial planting and then as required	✓	✓	Revegetation of disturbed areas using local native plants	Bush regeneration contractor
Where possible, topsoil in the riparian areas removed for the Proposal would be reused for		✓	✓	Initial revegetation	✓	✓	Revegetation of disturbed areas using local native plants	Construction contractor or Bush

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
revegetation. This would only occur if the following conditions are met: ▪ Topsoil is sourced from an area with low weed density ▪ Topsoil would only reused for revegetation of the same PCT as its source								regeneration contractor
Riparian areas that are temporarily cleared for construction adjoining the Georges River would be revegetated as soon as practicable upon completion of bridge works.			✓	Initial planting with ongoing replacement planting to be determined through ongoing.quarterly/annual monitoring.	✓		Retain habitat connectivity along riparian corridor of the Georges River	Construction contractor or Bush regeneration contractor
The 20m wide Rail link would be stabilised following construction with local topsoil with growth of groundcover encouraged. The corridor would be managed by removing weeds and reducing the fuel load.		✓	✓	Initial stabilisation works and management as per weed control frequency.			Prevent weed establishment and invasion and retain Rail link in a low fuel state	Construction contractor or Bush regeneration contractor
Fauna habitat enhancement								
Fauna microhabitat such as logs should be removed from areas to be cleared and relocated to suitable		✓		Once during clearing.	✓		Retain fauna habitat resources	Construction contractor

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
nearby bushland areas in the presence of an ecologist.								
Install nest boxes in retained native vegetation in the riparian corridor of the Georges River and the woodland in the Boot Land prior to clearing of hollow-bearing trees. A plan including nest box management procedures would be prepared which would outline the installation and monitoring requirements of the nest boxes.	✓	✓		Once prior to clearing, with annual monitoring and maintenance.	✓		Replace lost hollow resources in the landscape	Construction contractor
Large woody debris would be retained in watercourses where possible. In the event large woody debris are to be impacted they would be relocated in consultation with an ecologist.		✓		Ensure minimal disturbance during construction.	✓		Minimise harm to fish habitat.	Construction contractor
Soil erosion control and drainage works								
Install appropriate drainage infrastructure (e.g. sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.	✓	✓		Once during construction, with regular maintenance checks.	✓	✓	Prevent sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Georges River and/or Anzac Creek	Construction contractor

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
Clearing of vegetation is not to be undertaken during overland flow events.		✓		As clearing occurs.	✓	✓	Prevent sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Georges River and/or Anzac Creek	Construction contractor
Locate soil or mulch stockpiles away from watercourses and key stormwater flow paths and include appropriate erosion and sediment controls to limit potential transport of these substances into the watercourses via runoff.		✓		As clearing occurs.	✓	✓	Prevent soil and mulch reaching waterways	Construction contractor
Dust suppression activities to be undertaken where appropriate.		✓		As clearing occurs.	✓	✓	Prevent sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Georges River and/or Anzac Creek	Construction contractor
Stabilisation of temporarily disturbed areas, including revegetation, is to be undertaken as soon as practicable after disturbance.		✓	✓	As clearing occurs and as required during 12 month maintenance period.	✓	✓	Prevent sedimentation and erosion leading to a reduction in water quality and degradation of aquatic	Construction contractor and Stage 1 Proposal operator

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
							habitats in Georges River and/or Anzac Creek	
Approvals and permits								
Permit to collect seed and plant propagules from River Flat Eucalypt Forest EEC under S132C of the *National Parks and Wildlife Act 1974* (from OEH).	✓			Once only unless personnel change	✓	✓	Collection of seed in accordance with regulations.	Construction contractor or Bush regeneration contractor
Permit to undertake revegetation and restoration works within River Flat Eucalypt Forest and Freshwater Wetlands EECs under S132C of the *National Parks and Wildlife Act 1974* (from OEH).	✓			Once only unless personnel change	✓	✓	Revegetation and restoration in accordance with regulations	Construction contractor or Bush regeneration contractor
Appropriate APVMA permits for herbicide use, particularly if a non-registered use is proposed (i.e. for Alligator Weed)	✓			Once only unless personnel change	✓	✓	Use of herbicide in accordance with regulations.	Construction contractor or Bush regeneration contractor
Monitoring and reporting								
Preparation of monitoring reports during the construction and maintenance period		✓	✓	Quarterly during construction period and for the following 12	✓	✓	Determine whether the restoration works are achieving performance	Ecologist/Bush regeneration contractor

Action	Timing			Frequency	Location		Outcome	Responsibility
	Pre-clearing	Construction/ clearing	Maintenance		Georges River	Anzac Creek		
				months upon completion of construction, then annual reports thereafter as part of offset management.			criteria, implementing corrective actions as required.	

5 ADAPTIVE MANAGEMENT AND CONTINUAL IMPROVEMENT

5.1 MONITORING, REVIEW AND REPORTING

Monitoring and review of the implementation of the RVMP against established performance criteria will be undertaken by a qualified ecologist at intervals of six months for the first three years of the management period, and subsequently at 12 month intervals. The primary intent of the monitoring program is to demonstrate compliance with the RVMP via compliance with performance criteria for the restoration works.

Issues may arise in the implementation of the plan which would require actions to be modified or additional actions to be implemented. The monitoring program will be designed to detect issues at an early stage such that appropriate adaptations can be made to ensure that objectives are met.

5.2 PERFORMANCE CRITERIA

Performance criteria applicable to this RVMP include:

- Certification that all plant stock used for revegetation are of local botanical provenance
- Gradual improvement of native plant establishment with the aim of achieving 80% cover of native vegetation after five years following initial planting
- Gradual reduction in weed density to 5% of total area of each management site (eastern bank of Georges River and Anzac Creek only)
- Reduction in weed density to 5% of total area of management site 5 years after construction (western bank of Georges River only)
- Gradual extension of native plant cover in each management site through natural regeneration
- Stability of riparian banks, including maintenance or reduction of erosion within management sites
- Re-establish and maintain connectivity for fauna habitat, particularly in the Georges River management site.

5.3 REPORTING AND TIMING

Reporting would be required annually to assess the success of works in accordance with the performance criteria outlined above. Reporting undertaken during maintenance inspections of each management site will be undertaken by the Contractor's bush regeneration representative and ecologist.

6 ROLES AND RESPONSIBILITIES

Key roles and responsibilities associated with the implementation of this Plan are presented in Table 10. Broadly, the management and implementation of the RVMP will be the responsibility of a qualified and experienced ecologist reporting directly to the applicant, with on-ground regeneration works and maintenance the responsibility of a qualified and experienced Bush regeneration contractor. Specific management actions associated with each role are identified in Table 9.

Table 10 Roles and responsibilities

Role	Responsibility
Site Operator	Co-ordination of RVMP with Construction contractor and bush regeneration contractor and ecologist (where required). Completion of site management to ensure ongoing protection of regenerated sites post-construction period.
Construction Contractor	Co-ordination of RVMP associated conditions with the clearing and construction works ensure native vegetation is protected and enhanced through the life of the Proposal. Completion of site management to ensure ongoing protection of management sites during construction period. Compliance with the relevant conditions of the RVMP
Bush Regeneration Contractor	On-ground works associated with the RVMP, maintenance inspections and meeting of performance criteria, where required. Certification of supply and installation of local provenance native seed.
Ecologist	Management and implementation of RVMP, including performance indicator monitoring, provision of technical advice and statutory reporting.

7 REFERENCES

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Attachment M: Riparian Vegetation Management Plan (Hyder 2015)

Refer to Appendix I of the Biodiversity Assessment Report (Appendix J to the Response to Submissions)