

Moorebank Precinct West

Threatened Dragonfly Species Survey Plan Report



SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

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Development

TACTICAL GROUP MOOREBANK PRECINCT WEST

Threatened Dragonfly Species Survey Plan Report

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REVISIONS

Revision	Date	Description	Prepared by	Approved by
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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.

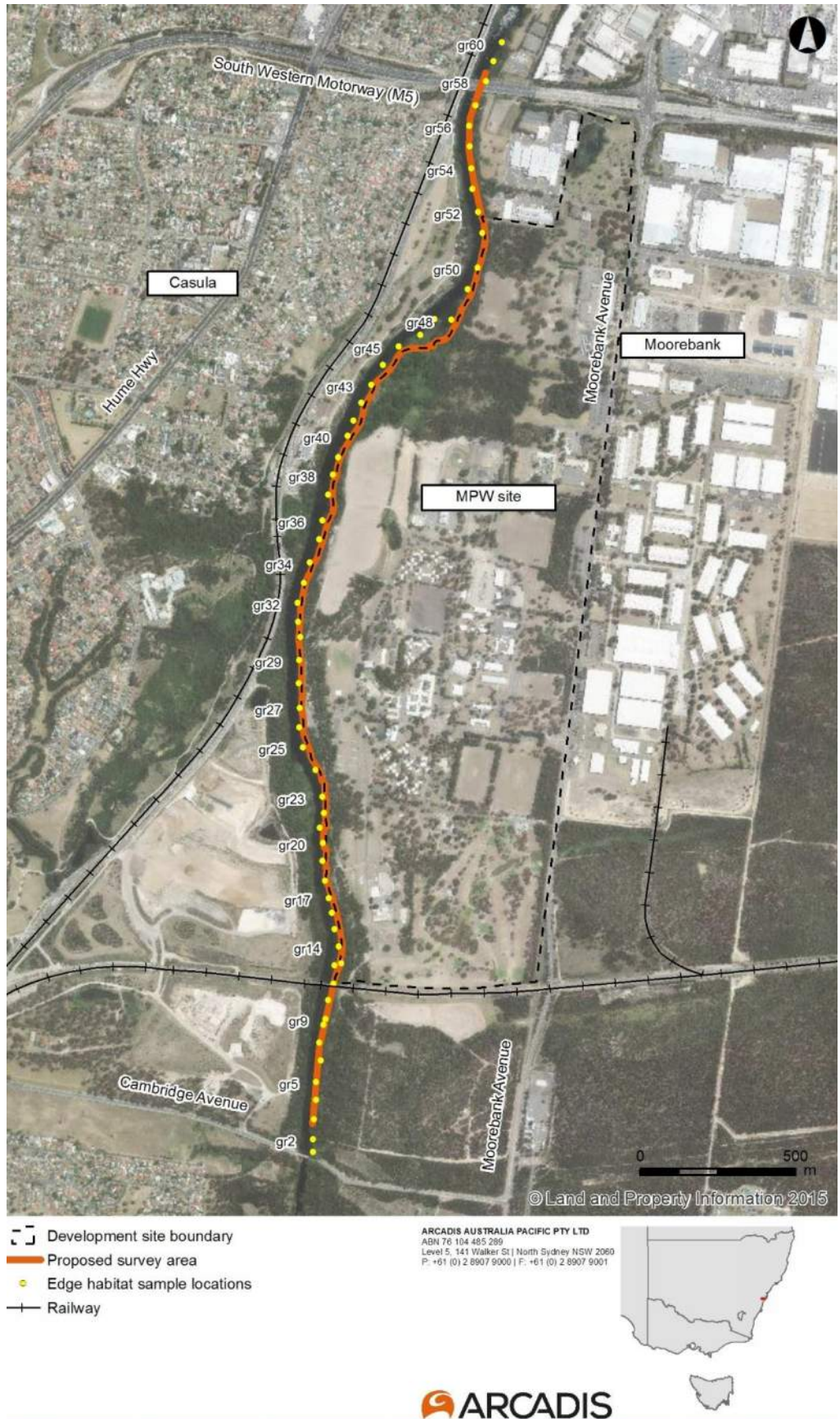


Figure 2 Survey area and actual habitat sample locations. The orange line indicates the survey area as proposed in the TDSSP.

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 <i>Austrocordulia leonardi</i>	<ul style="list-style-type: none"> • 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 <i>Archaeophya adamsi</i>	<ul style="list-style-type: none"> • 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 overshadowing 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 is 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.

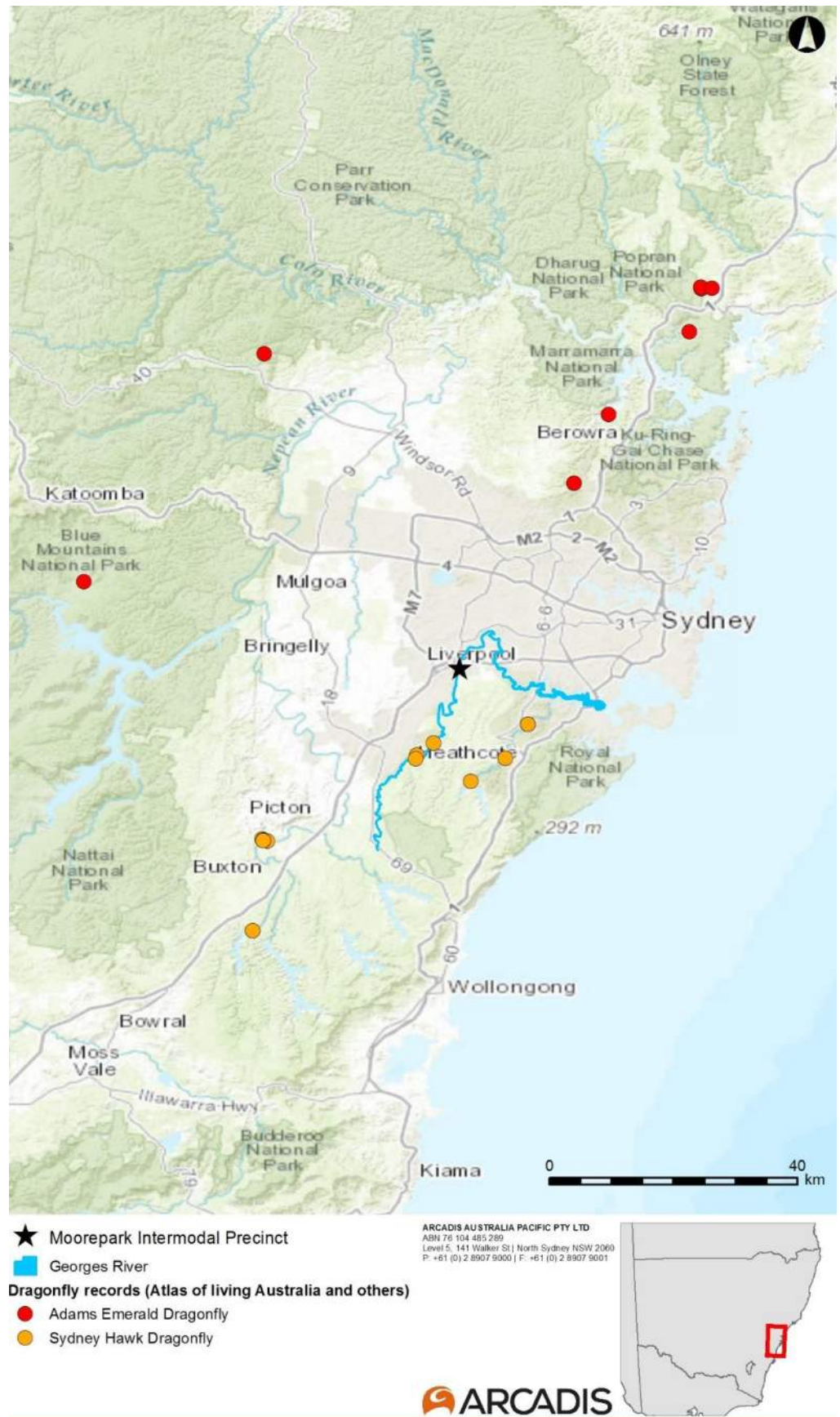


Figure 3 - Records of threatened dragonflies across the Sydney Basin as sourced from the Atlas of Living Australia database, Theischinger et al. (2009) and Theischinger et al. (2011).

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).

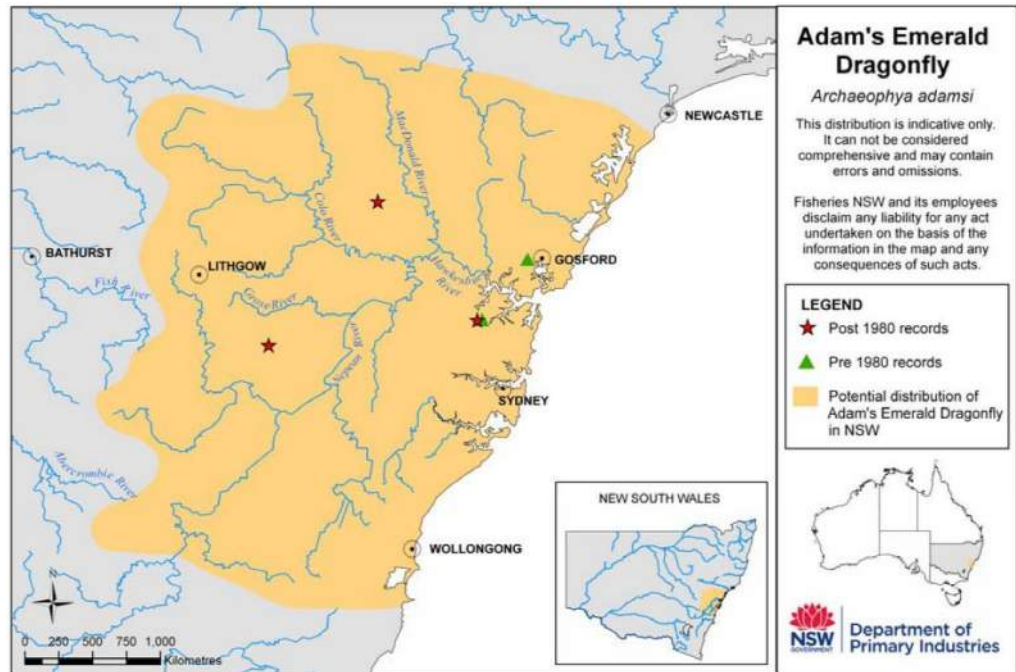


Figure 8 Potential distribution of *Archaeophya adamsi* (Fisheries NSW)

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).

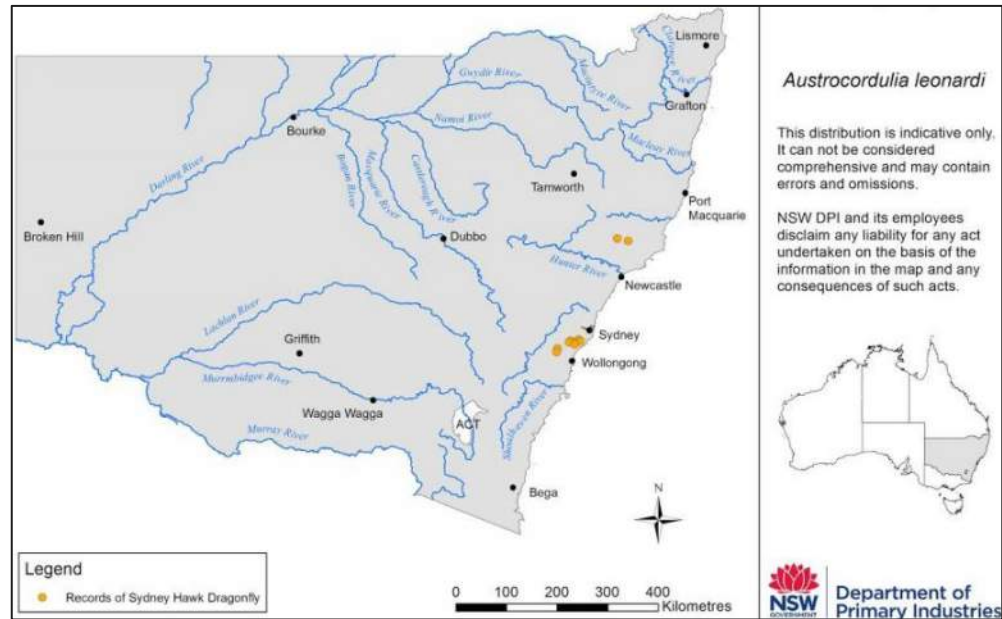


Figure 13 Potential distribution of *Austrocordulia leonardi* in Sydney Basin (DPI Fisheries 2016)

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).

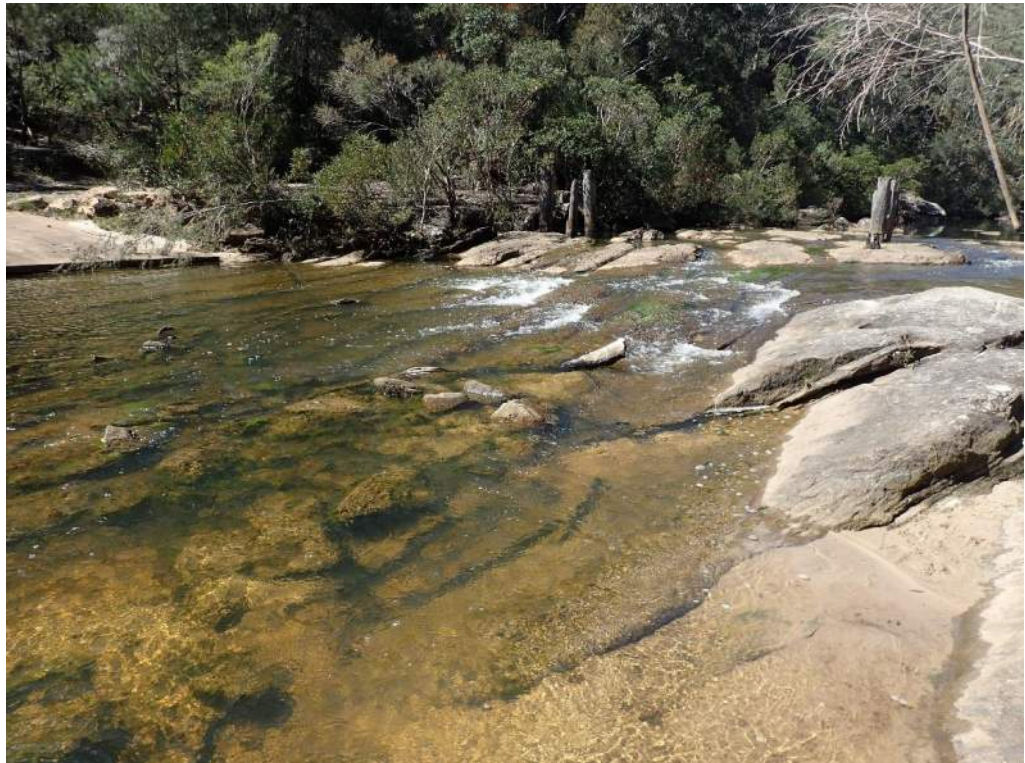


Figure 14 Freres Crossing



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.

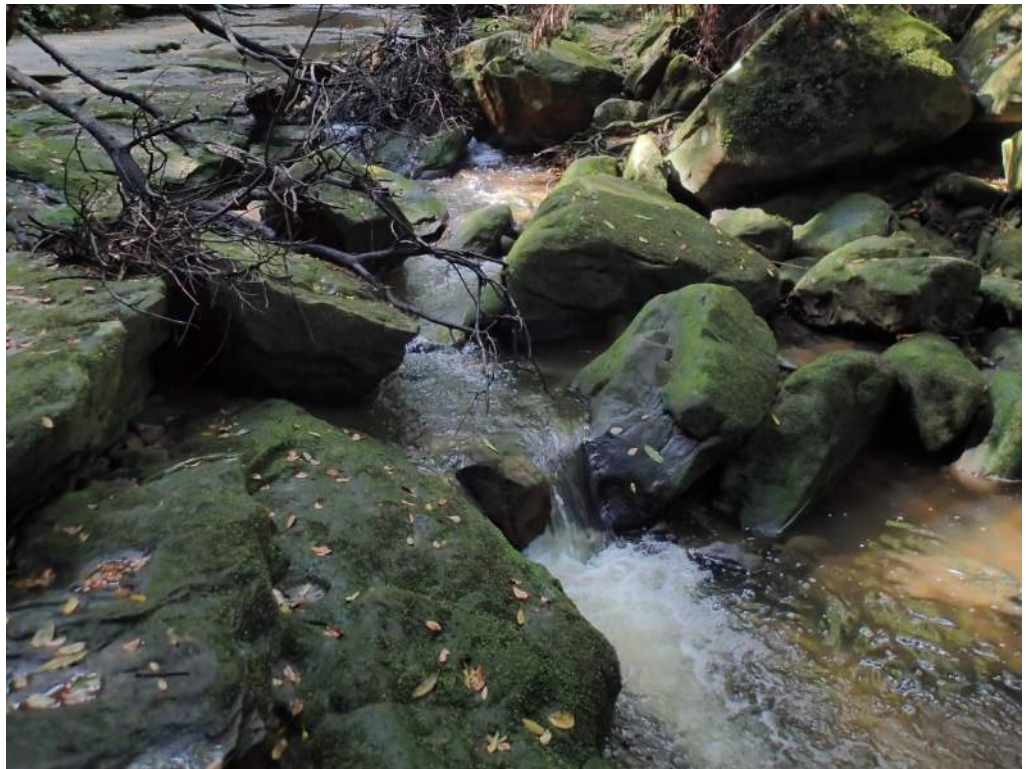


Figure 19 Floods Creek riffle zone.

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-leaf 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 <i>Austrocordulia leonardi</i>	<ul style="list-style-type: none"> • Deep riverine pools with cool water • Permanently flowing rocky river with steep sides that provide shady rest areas • Rocks for larvae to shelter beneath 	<ul style="list-style-type: none"> • No • No • No
Adam's Emerald Dragonfly <i>Archaeophya adamsi</i>	<ul style="list-style-type: none"> • Small to moderate sized creeks with gravel or sandy bottom • Narrow shaded riffle zones with moss and abundant riparian vegetation • Canopy cover 	<ul style="list-style-type: none"> • 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	
Turbidity: Clear Slight Turbid Opaque		River width at the water surface (m): 50	
Bedform at sample location: Run Pool Backwater Riffle Other: glide		Substrate Composition (%): Cobble ___ Pebble ___ Gravel ___ Sand ___ Fines 100	
Bank Shape: Concave Convex Stepped Wide lower bench Undercut		In stream features: Snags Rocks Debris Algal blooms Other: sand bank	
Riparian Vegetation			
Description (dominant species and community structure): Open forest, Blackbutt, <i>Acacia decurrens</i> , <i>Acacia binervia</i> , bracken, cypress, crofton 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	
Cover of macrophytes (%): Submerged: 5 Emergent: _____ Floating: _____		Extent of Native/exotic vegetation: Weed dominated Native dominated	
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%			

Moorebank Precinct West – Appendix A – Dragonfly Habitat Assessment Datasheet and Guide
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

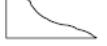




Bedform at sample location:

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

Moorebank Precinct West – Appendix A – Dragonfly Habitat Assessment Datasheet and Guide
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 (%)



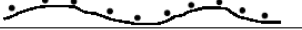

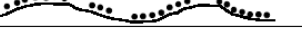

At each sampling site, identify the riparian zone and visually estimate the percentage area of the riparian zone that is covered by each of the following components:

- 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



Moorebank Precinct West

GR01
(33.969898S
150.912534E)



GR02
(33.969537S
150.912538E)



GR03
(33.968949S
150.91258E)



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GR04
(33.968388S
150.912673E)



GR05
(33.967872S
150.91269E)



GR06
(33.967255S
150.912868E)



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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)



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GR13
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150.913652E)



GR14
(33.963943S
150.913562E)



GR15
(33.963446S
150.913434E)



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GR16
(33.962975S
150.913358E)



GR17
(33.962536S
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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
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GR24
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150.912883E)



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GR25
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150.912469E)



GR26
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150.912355E)



GR27
(33.957002S
150.912377E)



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GR28
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150.912358E)



GR29
(33.955605S
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GR30
(33.954937S
150.912445E)



GR31
(33.954492S
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GR32
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GR33
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GR34
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150.912842E)



GR35
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GR36
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GR37
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150.913527E)



GR38
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GR39
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GR40
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150.914243E)



GR41
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GR42
(33.948166S
150.914745E)



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GR43
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150.915098E)



GR44
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150.915524E)



GR45
(33.946559S
150.916077E)



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GR46
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150.916842E)



GR47
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150.917351E)



GR48
(33.945816S
150.917925E)



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GR49
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150.918514E)



GR50
(33.944313S
150.918882E)



GR51
(33.943317S
150.919067E)



GR52
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150.91894E)



GR53
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150.918757E)



GR54
(33.941422S
150.918739E)



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GR55
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150.918692E)



GR56
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150.9187E)



GR57
(33.939604S
150.918924E)



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GR58
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150.919307E)



GR59
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150.919586E)



GR60
(33.937788S
150.919886E)



