Sydney Zoo – Bungarribee South

Biodiversity Management Plan and Cumberland Plain Woodland Management Plan

Prepared for
Sydney Zoo

October 2017

DOCUMENT TRACKING

Item	Detail
Project Name	Sydney Zoo Biodiversity Management Plan
Project Number	16HAR:5863
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Status	FINAL - Amended with agencies comments
Version Number	3
Last saved on	27 October 2017
Cover photo	CPW onsite, photo taken by Tammy Paartalu September 2015

This report should be cited as 'Eco Logical Australia 2017. *Sydney Zoo Biodiversity Management Plan and Cumberland Plain Woodland Management Plan*. Prepared for Sydney Zoo.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Jake Burgess, Sydney Zoo

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Abbreviations

Abbreviation	Description
BAR	Biodiversity Assessment Report
BMP	Biodiversity Management Plan
CEEC	Critically Endangered Ecological Community
CPW	Cumberland Plain Woodland
EEC	Endangered Ecological Community
ELA	Eco Logical Australia
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
ER	Environmental Representative
FFA	Flora and Fauna Assessment
LGA	Local Government Area
LLS	Local Land Services
OEH	NSW Office of Environment and Heritage
REFF	River Flat Eucalypt Forest
RFS	Rural Fire Service
TSC Act	NSW Threatened Species Act
WSP	Western Sydney Parklands

1 Introduction

1.1 Background

Eco Logical Australia (ELA) has been commissioned by Sydney Zoo to prepare management plans for the conservation areas associated with the construction and operation of a zoo (referred to hereafter as the Sydney Zoo) within the Bungarribee Precinct in Western Sydney Parklands.

The proposed development of the Sydney Zoo will include the development of a number of exhibits of native and exotic animals. Additional features of the project include a restaurant, car / bus parking, gift shop and internal roads.

During discussions with agencies as part of obtaining State Significant Development approval the Office of Environment and Heritage (OEH) raised concerns with regards to the viability of native vegetation to be retained within the site, in particular with regards to Cumberland Plain Woodland vegetation. This was addressed by Sydney Zoo proposing the preparation and implementation of an appropriate management plan. This was subsequently picked up in the conditions of consent for a Biodiversity Management Plan, and Cumberland Plain Woodland Plan of Management, as identified below. It is the view of the authors of this document that the native vegetation retained will be viable if the recommendations and management actions identified in this plan are adopted and followed.

Development Consent conditions, under Section 89E of the Environmental Planning and Assessment Act 1979, include:

Biodiversity Management Plan

> *C15. The Applicant shall prepare and implement a Biodiversity Management Plan for the Development to the satisfaction of the Secretary. The plan shall:*
>
> > *(a) be prepared by a qualified ecologist in consultation with the OEH, RFS, Council and Western Sydney Parklands Trust;*
> >
> > *(b) be approved by the Secretary prior to the commencement of any works on the site;*
> >
> > *(c) include measures to be taken to minimise impacts upon flora and fauna; and*
> >
> > *(d) include a Cumberland Plain Woodland Plan of Management (see Condition C16).*

Cumberland Plain Woodland Plan of Management

> *C16. The Applicant shall prepare and implement a Cumberland Plain Woodland Plan of Management for the Development to protect, manage and enhance the Cumberland Plain Woodland on the site and in the immediate surrounds. This plan will form part of the Biodiversity Management Plan in Condition C15 and shall:*
>
> > *(a) be prepared by a qualified ecologist in consultation with the OEH, RFS, RMS, TfNSW and Western Sydney Parklands Trust;*
> >
> > *(b) include detail of the plant species, management zones, vegetation monitoring, weed control measures, planting methodology and regeneration monitoring;*

(c) include detail of all Cumberland Plain Woodland areas on the site of the Development and detail how these areas shall be suitably fenced and environmental qualities recognised (e.g. signage); and

(d) shall be implemented as part of the landscaping works and shall be maintained by or on behalf of the Applicant in perpetuity of the Development.

This report combines the Biodiversity Management Plan (BMP), and the Cumberland Plain Woodland Management Plan (CPW-MP). The CPW-MP portion has been created based off guidelines '*Appendix R, Indicative CPW Management Plan Structure'*, which is largely based upon the vegetation management plan template prepared by Macquarie City Council (February 2012). As the BMP includes the management of River Flat Eucalypt Forest (RFEF) the terminology of BMP has been adopted throughout this documents to encapsulate all natural areas requiring management.

The document is presented in an integrated format. The lands to which the BMP applies are shown in **Figure 1** and **Figure 2**, and includes Cumberland Plain Woodland (CPW), RFEF, and some lands which currently have exotic grassland, but which will serve as buffers or connections for CPW to be retained. The CPW-MP of this document applies only to those lands outside of the RFEF areas.

ELA prepared the Biodiversity Assessment Report (BAR) in December 2015, which assessed and provided advice on the proposed impacts on Biodiversity of the proposed development, including identifying ways to minimise the construction impact, assessing offsetting requirements and identifying other ways to minimise the impact of the proposal on the biodiversity of the site / area. Previous ecological reports have been prepared for the Bungarribee precinct by ELA, including Flora and Fauna Assessment's (FFA) in 2015 and in 2014.

1.2 Objectives of the BMP

The overall aims of the BMP are to conserve the biodiversity values of the site, ensuring that all native vegetation, including CPW is maintained and improved and that measures are undertaken to minimise impacts upon flora and fauna. The objectives of this BMP include:

Table 1: BMP objectives

Objectives	Approach
Improve ecological health and integrity by revegetating with native species	Control woody weeds and noxious weeds Revegetate with native appropriate species Maintenance weed control
Maintain and enhance habitat values	Protect existing native vegetation Weed control Increase native plant cover

1.3 Key terms

For the purpose of this BMP the following terminology has been used:

- *Study area*, refers to the entire site as surveyed by the BAR (ELA 2015)
- *Biodiversity Management Plan or BMP area*, refers to all conservation areas within the site

- *Development site,* refers to the proposed construction footprint. This area is outside of the scope of the BMP.

1.4 Implementation of works

BMP works are to be implemented by experienced bush regeneration contractors with team leaders and trained staff having a minimum TAFE Certificate III in Conservation & Land Management, proven experience working in Western Sydney ecological communities and membership of the Association of Australian Bush Regenerators (or having the necessary prerequisite qualifications and experience for membership). Trained staff should make up a minimum of 30% of each team.

All personnel using herbicide for weed control must be appropriately trained in the identification of natives and weed species and hold required certification AQFIII in 'Prepare and Apply Chemicals' and comply with requirements of the Pesticides Regulation 2009 (NSW) and Pesticides Act 1999 (NSW).

An Environmental Representative (ER) should be appointed to the project to oversee planning, implementation and sign off of works within this BMP. The ER is to have a minimum of ten years' experience in the project management of ecological restoration sites, with significant experience in Western Sydney ecological communities.

1.5 Personnel preparing this BMP

The qualifications of the ELA project team involved in the preparation of this BMP are identified below:

Table 2: Project team qualifications

Name	Role	Qualifications
Dr Steven Ward	Project Director	Ph.D., University of Western Sydney, 2002 Honours, University of Wollongong, 1999 BSc (Botany / Zoology), University of Western Australia, 1987 Accredited Biobanking and major projects assessor
Andrew Whitford	Technical Review	Master of Applied Science (Environmental Science), University of Sydney. Diploma of Conservation and Land Management, Ryde TAFE. Bachelor of Arts (Communications), Emerson College, Boston. +10 years in the restoration ecology industry
David Brennan	Project Manager Preparation of BMP	Masters of Wildlife Management (Habitat), Macquarie University – Graduate School of the Environment, 2009 BSc (Biology), 2006 TAFE Cert III of Conservation and Land Management, Ryde TAFE 10 years in the restoration ecology industry

2 Description of the environment

2.1 Location

The Western Sydney Parklands (WSP) is a 27 km corridor stretching from Quakers Hills to Leppington in western Sydney (WSP 2011). Bungarribee South is within WSP in the new suburb of Bungarribee which is part of the City of Blacktown Local Government Area (LGA). The Bungarribee Precinct covers an area approximately 216 ha.

The BMP site consists of Lot 11, to be created by the subdivision of Lot 1 DP1103025. The BMP area covers 16.5 hectares and is located in the most southern portion of the Bungarribee precinct and is bound by major roads Great Western Highway to the south, Doonside road to the east and Eastern Creek flows along the western boundary (**Figure 1**).

2.2 Management history

The study area occurs within a highly urbanised setting surrounded by extensive areas of established urban development. The site is assumed to have been used previously for a variety of semi-rural activities including livestock grazing.

2.3 Drainage and hydrology

Two major creek systems feature within the landscape and occasionally flood the surrounding plains. Eastern Creek is a major creek which flows a south – north direction. Bungarribee Creek converge with Eastern Creek in the north. An intermittent tributary flows from the south-east of the study area to the north-west. Native vegetation persists along the creek banks. Moist depressions are scattered at lower elevations within the floodplain which are fed by the unnamed tributary and Eastern Creek during high water flow events (i.e. located north-east of the study area).

2.4 Geology / landscape

Two main soil landscapes exist within the study area. South Creek soil landscape is confined to the alluvial flat encompassing Eastern Creek and Bungarribee Creek. The soil landscape occurs on floodplains and valley flats on the Cumberland Plains (Bannerman and Hazelton 1990). The dominant soils are brown sandy loam to sandy clay loam with low fertility and high erodibility. Waterlogging and frequent flooding is often experienced within the South Creek soil landscape (Bannerman and Hazelton 1990). The Blacktown soil landscape occurs at higher elevations and includes the south-eastern corner of the study area. Dominant soils include brownish black loam to clay loam with low to moderate fertility (Bannerman and Hazelton 1990). Both soil landscapes are associated with the Wianamatta Group shales and Hawkesbury Sandstone geology. Blacktown soil landscape is often underlain by the Wianamatta group – Ashfield Shales.

2.5 Native flora

No threatened flora species were identified onsite. A full list of all flora observed onsite by ELA in 2015 is included as **Appendix A**.

2.6 Native fauna

11 species of native birds and amphibian were observed onsite by ELA in 2015 from opportunistic surveys and Anabat survey (for microbats), as identified in **Appendix B**.

2.7 Vegetation communities

The vegetation outside of the exotic pasture areas has been identified as belonging to two native vegetation communities (ELA 2015), as shown in **Figure 2**:

- *River Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (RFEF)
- Shale Plains Woodland a sub-community of *Cumberland Plain Woodland in the Sydney Basin Bioregion* (CPW)

2.7.1 River Flat Eucalypt Forest (RFEF)

RFEF is an Endangered Ecological Community (EEC) under the Threatened Species Act 1995 (TSC Act).

The patch onsite is located along Eastern Creek, in the western edge of the site. The RFEF onsite represents a relatively young stand of replanted RFEF, with the upper stratum supporting young *Eucalyptus amplifolia* (Cabbage Gum) and the mid-storey dominated by various Acacia species including *Acacia parramattensis* (Parramatta Wattle) and *Acacia decurrens* (Black Wattle). *Casuarina glauca* (Swamp Oak) was also recorded within the northern biometric plot in this community. Remnant RFEF occurred beyond the western boundary of the site.

The understorey was dominated by a mixture of native and exotic ground cover species. Dominant species included weed pasture grasses *Cynodon dactylon* (Couch), *Briza subaristata*, *Axonopus fissifolius* (Narrow-leafed Carpet Grass). Some native grasses remained, including *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass) and *Themeda triandra* (Kangaroo Grass).

2.7.2 Cumberland Plain Woodland

CPW is listed as critically endangered under the TSC Act and a Critically Endangered Ecological Community (CEEC) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). CPW is present onsite in a range of conditions.

Vegetation in poor condition at the site is present as scattered *Eucalyptus moluccana* with a primarily exotic understorey. Native grass species, particularly of *Macrolaena stipoides* appear to increase directly beneath the trees but these are only small patches in a largely exotic landscape. Small patches of *Aristida vagans* are also present.

The moderate (medium) condition stand of CPW occurs in the south of the site. This stands support both mature and juvenile *Eucalyptus moluccana*, a sparse shrub layer and the ground layer dominated is by native species.

The most commonly recorded groundcover species in areas of CPW include *Axonopus fissifolius* (Narrow-leafed Carpet Grass), *Briza subaristata*, *Aristida vagans*, *Microlaena stipoides* (Weeping Grass), *Lomandra* spp., *Themeda triandra*, *Setaria parviflora* and *Paspalum dilatatum* (Paspalum).

The CPW in the east of the site forms part of a larger patch of CPW that is in good condition and is dominated by native species in all strata. The canopy is dominated by *Eucalyptus tereticornis* and *Eucalyptus amplifolia* with *Angophora floribunda* scattered throughout. *Bursaria spinosa* is common in the understorey as is *Melaleuca decora* and *Daviesia ulicifolia* (Gorse Bitter Pea). Commonly recorded groundcover species include *Aristida vagans*, *Microlaena stipoides* and *Themeda triandra*.

2.7.3 Other vegetation

Due to the sites previous management history the majority of the site is comprised of exotic pasture, dominated by *Cynodon dactylon*, *Briza subaristata*, *Axonopus fissifolius, Setaria gracilis*. These areas are largely contained within the construction footprint.

2.8 Weeds

The BAR (ELA 2015) identified a total of 28 weeds onsite. Of these five species are currently listed as noxious within the Blacktown LGA, with 3 species also identified as Weeds on National Significance (WoNS) as shown in **Table 3**.

Table 3: Noxious weed list

Scientific name	Common name	Class	WoNS
Asparagus asparagoides	Bridal Creeper	4	Yes
Hypericum perforatum	St John Wort	4	-
Ligustrum sinense	Narrow-leaf Privet	4	-
Opuntia stricta	Common Prickly Pear	4	Yes
Senecio madagascariensis	Fireweed	4	Yes

Figure 1: Location map

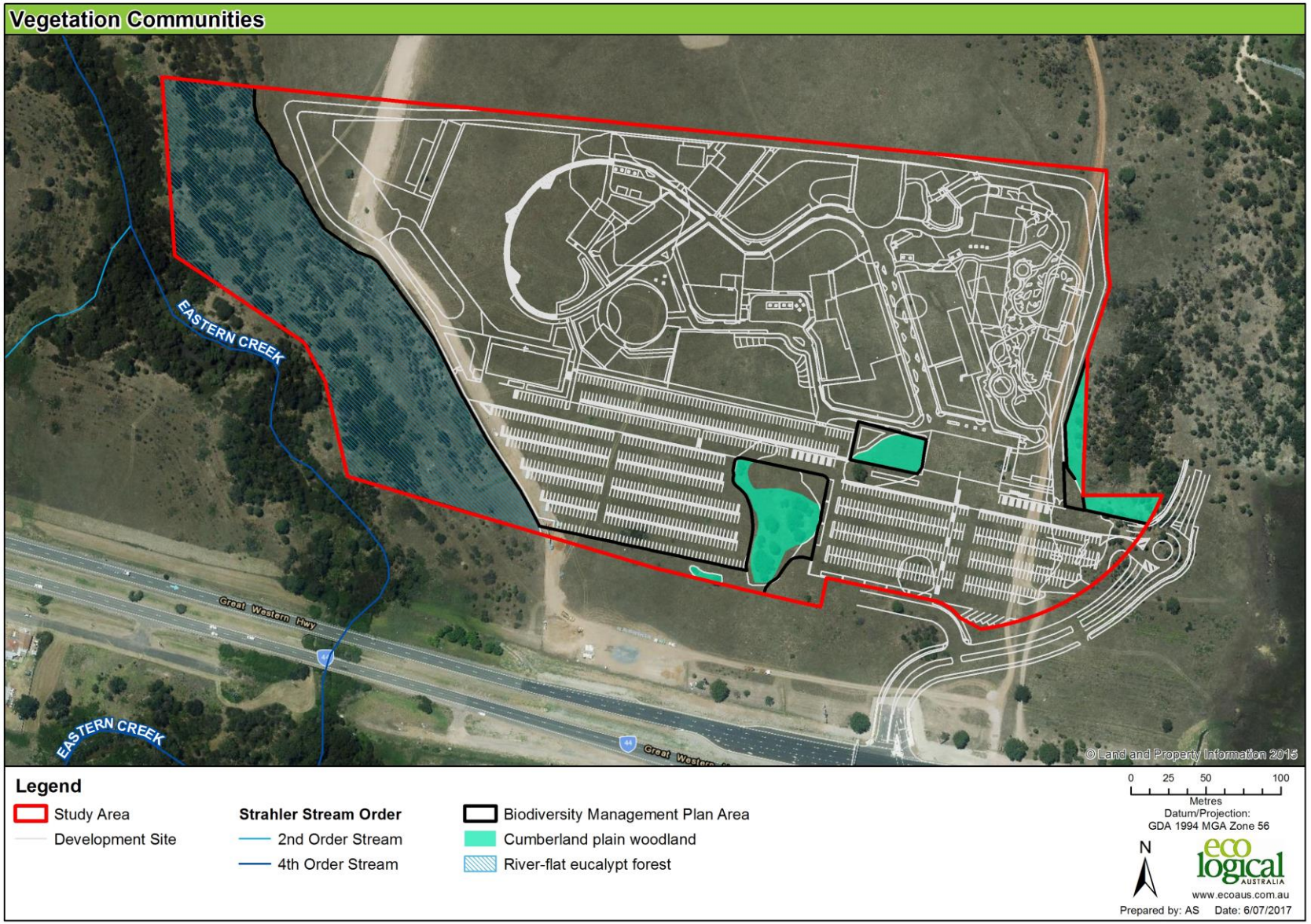

Figure 2: Vegetation communities

3 Biodiversity mitigation actions

The following actions are to be undertaken by the developer or civil construction company in order to minimise or mitigate any harm to native fauna or flora.

The works period has been divided into three periods as identified below:

Table 4: BMP timeframes

BMP phase	Construction phase	Expected duration
Preliminary period	pre - construction period	6 months
Establishment period	construction phase	18 months
Maintenance period	post construction phase / during Zoo operation	On-going, BMP covers the first 5 years

3.1 Preliminary works

Prior to the commencement of construction works the following actions will be required:

3.1.1 Fencing and signage

Prior to the commencement of works, the construction contractor shall be responsible for the installation of fencing to ensure construction activities do not impact onto BMP areas, including CPW to be retained and revegetated near the car park. The construction contractor will need to liaise with the ER and vegetation rehabilitation team to ensure proper laying of the fencing and ensure that vegetation rehabilitation can still access these areas.

Construction fencing is to be to clearly identify the boundary between construction activities and vegetation management works. The aim of this is to prevent unnecessary damage to native vegetation in the BMP area from construction activities and excludes all construction machinery, activities, materials and staff from the BMP areas.

Tree protection fencing or trunk protection measures will need to installed by a suitably qualified Arborist (Cert 5) around all trees to be retained within the construction footprint. A suitably qualified ecologist or Arborist (Cert 5) should be present on site during any excavation works within the BMP area to ensure extant native vegetation including tree roots are not disturbed by machine operators.

3.1.2 Sediment and erosion control

Prior to the commencement of earthworks, the construction contractor shall be responsible for the installation and maintenance of suitable sediment and runoff control measures in accordance with the latest version of the *Managing Urban Stormwater: Soils and Construction Guidelines* to prevent runoff entering adjacent bushland areas and watercourses.

Other considerations include:

- Construction adjacent to drainage lines should be completed during dry periods
- Storage areas should be located away from the drainage lines to minimise risk of pollution and adverse impact to aquatic ecosystems. Prevention of runoff and wastewater from the zoo entering

the adjacent watercourse through the implementation of a constructed wetlands and harvesting pond in the west of the site
- Wash down machinery before entering the site to limit weed spread.
- Potential chemical pollutants (e.g. fuels, oils, lubricants, paints etc.) would be stored in appropriate containers within bunded areas within construction compounds to minimise the risk of the pollution of aquatic environments

3.1.3 Tree felling / native vegetation clearance and habitat re-use

A qualified ecologist or suitably experienced wildlife carer (minimum 3 years) should be present on site during the removal of the hollow-bearing trees in the eastern part of the site to provide advice to machine operators, to salvage and relocate native fauna if native fauna are encountered and/or injured during tree felling.

All native timber should be retained onsite, with mulch stockpiled for use within conservation areas, all viable seed collected and all timber ≥200mm cut into logs to be utilised as habitat for native fauna. Material <200mm diameter may be mulched. Wherever possible all easily translocated native flora will be translocated from the construction footprint into the BMP areas.

Prior to tree felling being undertaken, 17 nest boxes of a range of styles and types targeting birds and bats are to be installed at a minimum height of 3m and a maximum of 5m, except as specified by the ER, are to be installed on mature trees to be retained, within the RFEF remnant, to replace the tree hollows which may potentially be lost. The use of artificial hollows cut into trees (where trees of suitable size and health are present that would allow this as an option), may be utilised as an alternative to the installation of nestboxes.

These should be assessed from the ground during monitoring reports. Any nest boxes lost or damaged to the point where they are no longer usable by native fauna during the period of the BMP should be replaced.

3.2 Establishment works

The establishment period is to occur during building works, estimated to take between 16 months, an allowance of 18 months has been provided in case of project delays. During construction works the following actions will be required

3.2.1 Contractor education and hygiene protocols

All contractor staff are to be aware of sensitivity of the threatened ecological communities (CPW, RFEF) to be retained and revegetated.

Other considerations include:

- Soil containing seeds from exotic grass species should be removed from the site as soon as practicable and / or stored appropriately to prevent their spread
- Contractors must be aware of potential for Aboriginal artefacts to be uncovered. If uncovered, work in the immediate area must stop immediately and suspected Aboriginal objects, reported to appropriate parties

3.2.2 Other measures

Other measures include:

- All neighbouring areas, will require weed control

- All exposed areas, neighbouring the BMP areas will require direct seeding with native provenance grass seeds or sterile grasses
- If construction lighting is required at night they should face away from vegetative areas to protect microbats

3.3 Maintenance period

Following the completion of the construction works, the following works will be required:

- After the completion of construction activities, the temporary high vis construction fencing material is to be replaced with long term exclusion fencing to prevent people walking over these planting areas. At minimum, this should consist of three strand wire, not barbed, and must be maintained in perpetuity.
- Signage should be erected on fencing and maintained during construction and operation periods to identify the area as a conservation zone. The design of long term signage will require approval of the Secretary and prepared in consultation with RMS, Council and the Western Sydney Parklands Trust (Condition C46)
- Ongoing weed control should be undertaken along the length of the works to reduce the impacts of edge effects on adjacent vegetation, including all landscaping areas and sediment basins
- Prevention of runoff and wastewater from the zoo entering the adjacent watercourse through the implementation of a constructed wetlands and harvesting pond in the west of the site.

4 Vegetation management works

All vegetation management works are to be undertaken by bush regeneration contractors.

As identified in **Figure 3**, three vegetation management zones have been identified based upon works required:

- Zone 1: CPW – revegetate
- Zone 2: CPW – regenerate
- Zone 3: RFEF – weed control

Further description of the zones and works required are provided below.

4.1 Zone 1: CPW - revegetate

Zone 1, an area of 0.32 ha comprises the three areas to be revegetated to CPW. These areas are mostly covered by exotic grasses, but are adjacent to remnant CPW (Zone 2) and will be planted out in order to provide a buffer to Zone 2 areas. These areas will require 100% revegetation.

Site preparation

All weeds will require control, in particular exotic grasses and groundcovers. A minimum of two herbicide foliar sprays will be required, further information is provided in **Appendix D**.

Following successful weed control, the area will be mulched to a minimum depth of 100mm with native eucalyptus mulch, expected to be generated onsite.

Revegetation

Revegetation will be undertaken in the establishment phase using tubestock using CPW species as identified in **Appendix C** to achieve the densities identified in **Table 5**. Further description of revegetation requirements is provided below.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.2 Zone 2: CPW - regenerate

Zone 2, an area of 0.46 ha comprises the four stands of remnant CPW to be retained and regenerated. These areas are in moderate to good condition, with few woody or vine weeds. The remnant vegetation includes scattered remnant canopy trees and native groundcovers, few native shrubs are present. Therefore, supplementary revegetation will be required in addition to the expected native regeneration.

Site preparation / weed control

These areas will require weed control, which should be undertaken in manner that does not impact on the native groundcovers and allow for natural regeneration and revegetation, further information is provided in **Appendix D**.

Revegetation

Revegetation will be undertaken in the establishment phase using tubestock using CPW species as identified in **Appendix C** to achieve the densities identified in **Table 5**. Further description of revegetation requirements is provided below.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.3 Zone 3: RFEF – weed control

Zone 3, an area of 2.65 ha comprises the large patch of RFEF in the west of the site. Overall the vegetation within this area is in moderate to good condition, however it consists mainly of young planted / re-growing canopy species and groundcover species. No revegetation is required in this area.

Weed control

These areas will require weed control, which should be undertaken in manner that does not impact on the native groundcovers and allow for natural regeneration and revegetation, further information is provided in **Appendix D**.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.4 Revegetation requirements

Revegetation has the twin aims of both re-establishing the original native vegetation community at the site and providing habitat for flora and fauna.

Any plantings should consist of local provenance CPW stock, a CPW planting species list has been provided in **Appendix C**. Planting should seek to ensure a diversity of species are utilised. As such, any one species of groundcover, being a herb, grass, sedge, or scrambler, should be no more than 5 percent than total number of groundcover plants.

Further description of revegetation method is provided in **Appendix D**.

A summary of the revegetation densities is shown in **Table 5** below.

Table 5: Revegetation requirements

Zone	Description	Reveg Area (m²)	Total plant number requirements				
			Trees	Shrubs	Herbs / Scramblers	Sedge / Grass	*Total*
1	CPW - revegetate	3,200	1/100m²	1/20m²	1.1/m²	3/m²	*13,312*
2	CPW - regenerate	4,600	1/250m²	1/20m²	1/2m²	1/m²	*7,148*
3	RFEF - regenerate	-					-
Totals		**7,800**	***50***	***390***	***5,820***	***14,200***	***20,460***

The Sydney Zoo Planting Strategy 2016, prepared by Geoff Duggan has been superseded by this BMP. The planting strategy has several species, including *Ranunculus lappaceus, Rhodanthe anthemoides, Scaevola albida* which although native are not from the CPW community which should not be installed into BMP areas. *Acacia pubescens* is a threatened species and if it is to be planted, would require consultation and approval from NSW Office of Environment and Heritage (OEH).

4.5 Pest control

A rabbit control program for the site should be implemented based on identification and fumigation of rabbit warrens. This is to be undertaken in consultation with the Local Land Services (LLS). The site is to be constantly monitored for evidence of rabbit activity. Any damage by rabbits, primarily due to grazing young plants, will require rectification.

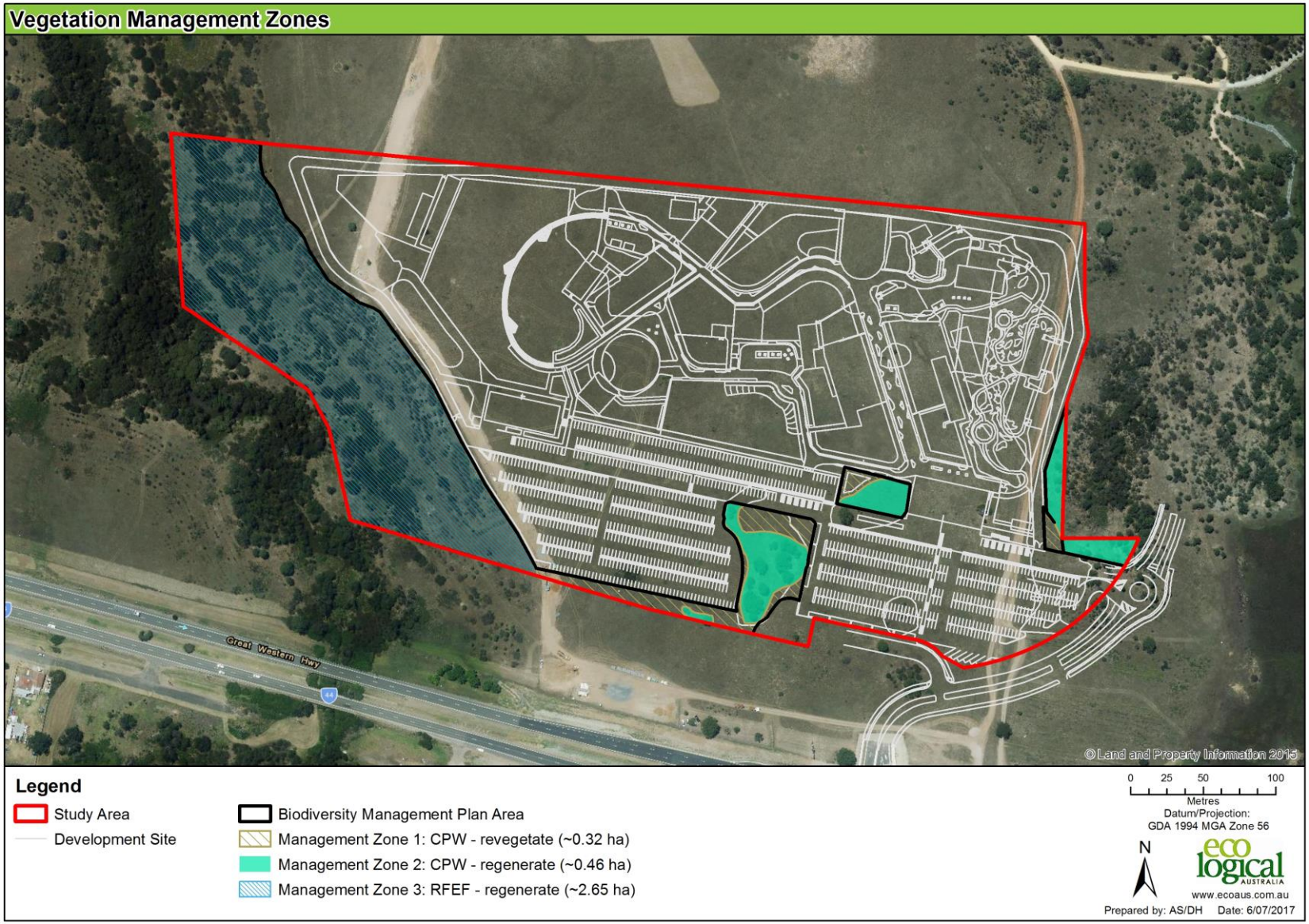

Figure 3: Vegetation management zones

5 Work schedule and performance criteria

5.1 Work schedule

The BMP area is to be managed in perpetuity. The project has been broken into timeframes as identified in **Table 4**.

A work schedule has been provided in **Table 6** . The key to the table is provided below.

Key	Construction activities	
	Vegetation management works	

Seed collection, should commence in the preliminary phase to allow sufficient time (minimum of 6 months) for species to be grown on. The establishment phase has been assumed to be a period of 18 months, but may be longer or shorter depending on the timing of the works and achievement of performance criteria.

5.2 Performance criteria

The performance criteria required for the site have been split into preliminary and establishment period **Table 7** and maintenance period **Table 8**.

If monitoring indicates that the BMP tasks are not resulting in achievement of the performance criteria, the task program may require revision in consultation with the ER, Blacktown City Council, Western Sydney Parklands and all other relevant authorities.

5.3 Adaptive management

As this is a long term project that will be implemented over a number of years, an adaptive management approach will be implemented that enables the successful contractor to learn from and respond to successful and unsuccessful techniques used on the site. In its simplest form this may include the substitution of species identified in the planting table for advanced direct seeding techniques in place of manual planting techniques.

In addition, at the request of Blacktown Council, an alternative approach that could be utilised in areas that have a long history of disturbance (ie. the CPW zone 1 revegetation area), is scalping away topsoil (and weed seeds in the ground) using a 4:1 bucket on a skid-steer loader or a grader to remove the top 40mm of soil, and direct seeding native species. With this approach care would need to be taken to either ensure that scraping is not too deep, or if subsoil is exposed that additional suitable topsoil is brought in.

The success of the works will be determined by meeting the performance criteria identified. Contractors have the flexibility to implement different techniques to those specified here providing that performance criteria are met. Any major departures from the BMP or changes to performance criteria must be approved in writing by the ER, Blacktown City Council, Western Sydney Parklands and all other relevant authorities.

Table 6: Work schedule

Zone	Treatment	Prelimin.		Establishment						Maintenance																			
										Year 1				Year 2				Year 3				Year 4				Year 5			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
All areas	Install high vis construction fencing																												
	Install long term fencing and signage																												
	Install sed. Fence/ erosion control measures																												
	Vegetation clearance and habitat relocation																												
	Install 17 nest boxes																												
	Weed control in neighbouring areas*																												
	Seed collection																												
	Monitoring and reporting																												
Zone 1: CPW – revege.	Site preparation - weed control																												
	Site preparation - mulching																												
	Revegetation																												
	Irrigation																												
	Maintenance																												
Zone 2: CPW – regen.	Site preparation - weed control																												
	Revegetation																												
	Irrigation																												
	Maintenance																												
Zone 3: RFEF –	Weed control																												

Zone	Treatment	Prelimin.		Establishment						Maintenance																			
										Year 1				Year 2				Year 3				Year 4				Year 5			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
weed control.																													

**neighbouring areas to include landscaped areas, construction footprint and detention basins*

Table 7: Performance criteria - preliminary and establishment periods

Treatment Zones	Performance Criteria
All zones	All construction and sediment fencing installed Informational signage installed 17 nest boxes installed into RFEF area All tree felling and habitat retention completed under the supervision of an ecologist Pest control management plan prepared in consultation with LLS, horses and rabbits excluded from revegetation and rehabilitation areas
	Evidence submitted showing all seed and or plants required for revegetation has been collected or is being grown Installation of all plants not including replacement plants to be undertaken by end of the establishment period. To ensure species diversity, any one species of groundcover, being a herb, grass, sedge, or scrambler, should be no more than 5 percent than total number of groundcover plants A minimum of 85% survival rate of all vegetation strata planted in each zone (e.g. tree, shrub and groundcover) Any localised plant failure within planting areas are to be addressed with no area larger than 2 m x 2 metres without surviving plants at the end this period To reduce bushfire risk, ensure plantings do not overhang any buildings, tree canopies are discontinuous, and shrubs are not positioned within 2 m of buildings, and implement appropriate hazard reduction program in consultation with Western Sydney Parklands and Cumberland Zone Rural Fire Service where woodland vegetation is within or above threshold (being an appropriate time period between bushfires to maintain ecological integrity).

	All adult seeding noxious weed individuals to be controlled and no establishment of new noxious species All primary woody weed control undertaken

**Note that some actions will be required before construction works start (e.g. fencing, seed collection) as identified in Section 3*

Table 8: Performance criteria - Maintenance

Treatment Zones	Maintenance				
	Year 1	Year 2	Year 3	Year 4	Year 5
All zones	Commencement or completion of all tasks outlined in the BMP An increase in native cover and diversity and a decrease in exotic cover and diversity by the end of the maintenance period At the end of each year, a minimum of 85% survival rate of all vegetation strata planted in each zone (e.g. tree, shrub and groundcover) Any localised plant failure within planting areas are addressed with no area larger than 2 m x 2 metres without surviving plants at the end of each year; Maintenance replanting is to replace plants by the same species, or where that species is not available, with the same growth form (i.e. tree for tree etc.) and must not decrease species diversity. Any new species to be planted must be from the community being emulated and of local provenance; Monitoring and reporting undertaken in accordance with **Section 6**				
	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Complete eradication of noxious weeds from the site and no establishment of new noxious species
	Native vegetation cover no less than 30% of each zone	Native vegetation cover no less than 40% of each zone	Native vegetation cover no less than 50% of each zone	Native vegetation cover no less than 65% of each zone	Native vegetation cover no less than 80% of each zone.
	Exotic vegetation no more than 30% of each zone.	Exotic vegetation no more than 20% of each zone.	Exotic vegetation no more than 15% of each zone.	Exotic vegetation no more than 10% of each zone.	Exotic vegetation no more than 5% of each zone.

6 Monitoring, reporting and review

Monitoring and reporting are both extremely important. The environmental representative will monitor the vegetation for changes over time. Information gained through the monitoring and reporting process will identify works that have and have not been successful, and the reasons for their success or failure.

The aim of monitoring is to measure the effectiveness of the control actions being undertaken to achieve the desired outcome. It will identify non-conformance and provide the developer with the ability to implement corrective actions. Information derived from the results of monitoring will also be used in adaptive management (i.e. learning from past experience to inform future priorities and work plans). For example, as annual grass weeds are removed, herbaceous and perennial weeds may establish.

Finally, monitoring and reporting will help determine and quantify the costs related to weed management and the cost effectiveness of this management plan.

The ER will undertake monitoring and provide monitoring reports and assessments against the performance criteria, with the Bush Regeneration contactor to provide progress reports describing works undertaken.

6.1 Monitoring

Monitoring will be undertaken at the following intervals:

- At the beginning (baseline) and end of the establishment period
- Annually every year during the maintenance period until the completion of management works

Across the site, the following monitoring will be undertaken at each monitoring reporting period :

- Three (one per zone), full floristic vegetation quadrats, (20 m x 20 m)
- One, 30 minute diurnal bird survey site (undertaken within two hours of sunrise, temperature range, between 20ºC and 25ºC)
- One anabat recording site (Minimum two full nights, temperature to be between 25ºC and 25ºC)

The quadrats should measure cover abundance and species diversity of native and native and exotic species in the ground, mid-storey and canopy layers.

Photo monitoring points will be established at quadrat locations to provide a visual reference of changes in the vegetation. This will be undertaken at each monitoring reporting period. Photo monitoring is to include:

- set up 6 photos points across the site (two in each zone) and map the location of each point
- mark the photo point with a six foot star picket (with safety cap)
- take a digital photo of each photo monitoring point with the whole length of the star picket visible in the photo to act as a reference point; and
- organise the digital photos logically with each image labelled with a unique reference number indicating the location of the photo monitoring point and the date the photo is taken.

The monitoring reports will include an independent assessment of works against the performance criteria. A follow up site visit with relevant certifying authorities may be undertaken following the submission of the monitoring reports.

6.2 Progress reports

Progress reports are to be provided to the ER for inclusion within the monitoring reports. Progress reports are to be provided at each monitoring reporting period.

Reports will include:

- a summary of works carried out within the period
- an approximation of the time spent on each task
- mapping of areas worked presented in a GIS compatible format
- a detailed account of plant numbers and species, installed per area, including provenance information for all plantings as per Flora bank guidelines
- a description of any problems encountered in implementing the works recommended in the BMP and how they were overcome; and
- any observations made including new species, particularly threatened entities, comments on rates of regeneration and problems beyond the scope of the BMP which impact on the study area

Blacktown Council have requested that they be forwarded annual monitoring reports.

6.3 Management plan renewal / review

At the conclusion of the five years of maintenance, a new management plan will be required to update this plan. This should be prepared by a suitably qualified restoration ecologist. The site is to be managed in perpetuity and management plans should be renewed every five years.

7 Costs

The cost to implement vegetation management works detailed in this BMP is estimated at approximately **$228,250** (ex GST), broken down into per work period as shown in **Table 9**, including revegetation costs shown in **Table 10**.

These costs are based on the experience that ELA has had in regards to preparing and implementing vegetation management plans across Sydney. It should be noted that these costs may vary significantly over subsequent years of management in response to, and effectiveness of, the proposed management. These rates are also based upon costs in 2016, and on-going maintenance costs (labour and materials) may increase over time with inflation.

7.1 Biodiversity mitigation works

The costs for Biodiversity mitigation works, as the responsibility of the civil construction crew / developer have not been included in the costs provided.

7.2 Vegetation management works

7.2.1 Regeneration / weed control

Weed control and regeneration works have been calculated at $2,000 for a team of four bush regenerators per day. The cost of bush regeneration works includes travel and the costs of herbicide, vehicles and equipment which are required to implement the proposed works.

7.2.2 Seed collection

Budget for the collection of seed has been included as an estimate based upon numbers of plants required, however note that seed availability is limited by climate, time frames, site access, condition of vegetation etc and additional seed collection may be required.

7.2.3 Revegetation

Bush regeneration contractors will implement the revegetation treatments identified in this BMP. The majority of the site will be revegetated via tubestock. Tubestock costs have been budgeted at an estimated **$3.50** per tree and shrub including shrub guard, planting, water crystals, fertiliser and initial watering, and an estimated **$2.00** per grass, sedge and groundcover including planting, water crystals and initial watering.

A total of 20,460 CPW plants will be required to achieve the densities identified in the BMP. The total estimated cost of revegetation is approximately $64,925, including a 10% replacement rate, site prep, mulch and irrigation costs (**Table 10**). These proportions may change in the future depending on the site conditions.

Increases in regeneration from niche seeding and the translocation of plants and from within the development footprint may reduce the revegetation requirements. Some assumptions in relation to the success of niche seeding have been factored into these costs. The actual amount of revegetation required will need to be re-assessed at the end of the preliminary phase.

7.2.4 Monitoring and reporting

The ER and bush regeneration contractors will undertake the monitoring and reporting as identified in this BMP. All monitoring, mapping and reporting works have been calculated using the rate for a qualified and trained Restoration Ecologist at $160 / hr.

Table 9: Costs

Treatment	Preliminary	Establishment	Maintenance					Total
			Year 1	Year 2	Year 3	Year 4	Year 5	
Revegetation								
Seed collection, cleaning, storage	$3,037	$0	$0	$0	$0	$0	$0	$3,037
Site Preparation	$0	$3,900	$0	$0	$0	$0	$0	$3,900
Jute Matting / Mulch	$0	$6,400	$0	$0	$0	$0	$0	$6,400
Tubestock, supply and install	$0	$41,580	$0	$0	$0	$0	$0	$41,580
Replacement tubestock, supply and install	$0	$0	$2,079	$2,079	$0	$0	$0	$4,158
Irrigation	$0	$5,850	$0	$0	$0	$0	$0	$5,850
Weed control								
Establishment	$0	$27,675	$0	$0	$0	$0	$0	$27,675
Maintenance	$0	$0	$35,550	$23,700	$23,700	$23,700	$11,850	$118,500
Associated costs								
Monitoring & Reporting	$0	$6,431	$2,144	$2,144	$2,144	$2,144	$2,144	$17,150
Totals	**$3,037**	**$91,836**	**$39,772**	**$27,922**	**$25,844**	**$25,844**	**$13,994**	**$228,250**

Table 10: Revegetation costs

Zone	Description	Tubestock (m^2)	Plant Cost	10% Plant replacement cost	Site preparation	Mulch Cost	Seed Collection Cost	Irrigation Cost	**Total**
Zone 1	CPW revegetate	3,200	$26,912	$2,691	$1,600	$6,400	$1,954	$2,400	**$41,957**
Zone 2	CPW - regenerate	4,600	$14,668	$1,467	$2,300	$0	$1,083	$3,450	**$22,968**
Totals	**-**	**7,800**	***$41,580***	***$4,158***	***$3,900***	***$6,400***	***$3,037***	***$5,850***	**$64,925**

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Appendix A Native Flora List (ELA 2015)

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form
Acacia decurrens	Black Wattle	N			S
Acacia sp.2		N			S
Acacia falcata		N			S
Acacia parramattensis	Parramatta Wattle	N			T
Acacia parramattensis	shrub layer	N			S
Acacia sp.		N			S
Acacia ulicifolia	Prickly Moses	N			S
Anagallis arvensis	Scarlet Pimpernel	E			F
Angophora floribunda		N			T
Angophora sp.	seedling	N			T
Araujia sericifera	Moth Vine	E			L
Aristida ramosa	Purple Wiregrass	N			G
Aristida vagans	Threeawn Speargrass	N			G
Asparagus asparagoides	Bridal Creeper	E	Class 4	Y	V
Axonopus fissifolius	Narrow-leafed Carpet Grass	E			G
Bothriochloa macra		N			G
Briza subaristata		E			G
Bulbine bulbosa	Native Leek	N			F
Bursaria spinosa	Blackthorn	N			S
Casuarina glauca	Swamp Oak	N			T
Chloris gayana	Rhodes Grass	E			G
Cirsium vulgare	Spear Thistle	E			F
Conyza bonariensis	Flaxleaf Fleabane	E			F
Conyza sp.		E			F
Cymbopogon refractus	Barbed Wire Grass	N			G
Cynodon dactylon	Couch	E			G
Cyperus sp.		N			V
Daviesia ulicifolia	Gorse Bitter Pea	N			S
Dianella longifolia	Blueberry Lily	N			V
Dianella sp.		N			V
Dichondra repens	Kidney Weed	N			F
Digitaria sp.		N			G
Dillwynia sieberi		N			S
Einadia hastata	Berry Saltbush	N			F
Eragrostis curvula	African Lovegrass	E			G
Eucalyptus amplifolia	Cabbage Gum	N			T
Eucalyptus amplifolia	seedling	N			T
Eucalyptus moluccana	Grey Box	N			T
Eucalyptus tereticornis	Forest Red Gum	N			T

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form
Eucalyptus sp.	Juvenile stringybark	N			T
Galium aparine	Goosegrass	E			F
Glycine microphylla	Small-leaf glycine	N			L
Glycine sp.		N			L
Glycine tabacina		N			L
Goodenia hederacea	Forest Goodenia	N			F
Goodenia paniculata	Branched Goodenia	N			F
Gomphocarpus sp.		E			S
Hakea sericea	Needlebush	N			S
Hypericum perforatum	St. Johns Wort	E	Class 4		F
Hypochaeris radicata	Catsear	E			F
Juncus sp.		N			V
Ligustrum sinense	Small-leaved Privet	E	Class 4		S
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush	N			V
Lomandra longifolia		N			V
Lomandra multiflora		N			V
Lomandra sp.		N			V
Melaleuca styphelioides	Prickly-leaved Tea Tree	N			T
Microlaena stipoides	Weeping Grass	N			G
Opuntia stricta	Prickly Pear	E	Class 4	Y	F
Oxalis perennans		N			F
Panicum effusum	Hairy Panic	N			G
Paspalidium sp.		N			G
Paspalum dilatatum	Paspalum	E			G
Plantago lanceolata	Lamb's Tongues	E			F
Romulea sp.		E			G
Rytidosperma sp.		N			G
Senecio hispidulus	Hill Fireweed	N			F
Rumex sp.		E			F
Senecio madagascariensis	Fireweed	E	Class 4	Y	F
Senecio sp.		N			
Setaria parviflora		E			G
Sida rhombifolia	Paddy's Lucerne	E			F
Solanum nigrum	Black-berry Nightshade	E			F
Solanum sp.		E			F
Sporobolus creber	Western Rat-tail Grass	N			G
Sporobolus sp.		E			G
Themeda triandra	Kanagaroo Grass	N			G
Trifolium sp.		E			F
Verbena bonariensis	Purpletop	E			F
Verbena sp.		E			F

Appendix B Native Fauna (ELA 2015)

	Common Name	Scientific Name	Observation Type
AVES			
1	Common Myna	*Acridotheres tristis**	O
2	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	O
3	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O
4	Australian Raven	*Corvus coronoides*	O
5	Australian Magpie	*Cracticus tibicen*	O
6	White-faced Heron	*Egretta novaehollandiae*	O
7	Superb Fairy-wren	*Malurus cyaneus*	O
8	Noisy Miner	*Manorina melanocephala*	O
9	Golden Whistler	*Pachycephala pectoralis*	O, W
10	Willie Wagtail	*Rhipidura leucophrys*	O
AMPHIBIAN			
11	Common Eastern Froglet	*Crinia signifera*	W

O denotes observed, W denotes heard.

Appendix C CPW Planting List

Type	Scientific name	Common name	CPW
Tree canopy species (>10m)	*Angophora floribunda*	Rough-barked Apple	X
	Angophora subvelutina	Broad-leaved Apple	X
	Corymbia maculata	Spotted Gum	X
	Eucalyptus amplifolia	Cabbage Gum	X
	Eucalyptus crebra	Narrow-leaved ironbark	X
	Eucalyptus eugenioides	Thin-leaved Stringybark	X
	Eucalyptus moluccana	Grey Box	X
	Eucalyptus tereticornis	Forest Red Gum	X
Small trees / shrub species (1.5m-10m)	*Acacia decurrens*	Sydney green wattle	X
	Acacia implexa	Lightwood	X
	Acacia parramattensis	Parramatta wattle	X
	Daviesia ulicifolia	Gorse bitter pea	X
	Dillwynia sieberi	-	X
	Dodonaea viscosa subsp. cuneata	Wedge-leaf Hop-bush	X
	Indigofera australis	Australian Indigo	X
	Pultenaea microphylla	-	X
Sedges, Rushes, Reeds & Grasses	*Aristida ramosa*	Purple Wiregrass	X
	Aristida vagans	Threeawn Speargrass	X
	Bothriochloa decipiens	Red leg grass	X
	Bothriochloa macra	Red Grass	X
	Chloris truncata	Windmill Grass	X
	Chloris ventricosa	Plump windmill brass	X
	Carex inversa	-	X
	Cymbopogon refractus	Barbed-wire Grass	X
	Cyperus gracilis	Slender Flat-sedge	X
	Dichelachne micrantha	Shorthair Plumegrass	X
	Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass	X
	Echinopogon ovatus	Forest Hedgehog Grass	X

Type	Scientific name	Common name	CPW
	Eriochloa pseudoacrotricha	Early Spring Grass	X
	Lomandra filiformis	-	X
	Lomandra multiflora subsp. multiflora	-	X
	Microlaena stipoides var. stipoides	Weeping Meadow Grass	X
	Poa labillardieri var. labillardieri	Tussock Grass	X
	Rytidosperma caespitosum	Ringed Wallaby Grass	X
	Rytidosperma racemosa var. racemosa	-	X
	Themeda triandra	Kangaroo Grass	X
Groundcover Species (~0-1.5m) & Vines/Scramblers	*Brunoniella australis*	Blue Trumpet	X
	Centella asiatica	Indian Pennywort	X
	Clematis glycinoides	Old Man's Beard	X
	Commelina cyanea	Creeping Christian	X
	Desmodium varians	Slender Tick-trefoil	X
	Dianella longifolia	Blueberry Lily	X
	Dichondra repens	Kidney Weed	X
	Einadia nutans	Climbing Saltbush	X
	Geranium solanderi	Native Geranium	X
	Glycine clandestina	Twining Glycine	X
	Glycine microphylla	Small-leaf glycine	X
	Goodenia hederacea subsp. *Hederacea*	Ivy Goodenia	X
	Hardenbergia violacea	Purple Coral Pea	X
	Mentha satureioides	Creeping mint	X
	Phyllanthus virgatus	-	X
	Pratia purpurascens	Whiteroot	X
	Plectranthus parviflorus	Cockspur flower	X
	Veronica plebeia	Creeping Speedwell	X
	Wahlenbergia gracilis	Sprawling Bluebell	X

Appendix D Techniques and specifications

Weed control

Weed control involves a combination of mechanical, physical and chemical techniques to remove the weeds and prevent regrowth. Weed control will be undertaken in all management zones. A selection of the best suited weed control method within the site depends on a number of factors including:

- the species or combination of weeds being targeted
- the density of the weeds
- resources available (time, labour, equipment and finances)
- weather conditions of the day

Weed control techniques

Detail of specific weed control techniques to be used such as cut and paint, scrape and paint, herbicide spraying and hand weeding are given in Brodie (1999). The principles of bush regeneration and techniques to trigger natural regeneration are to be in accordance with the Bradley Method and other techniques described in Buchanan (2000). Management techniques for different types of weeds are provided below.

Annual grasses

Annual grasses, such as *Bromus catharticus* (Prairie Grass), should be hand removed or spot sprayed where isolated or in low concentrations. Larger patches of annual grasses may be slashed/brush cut in late spring to early summer, after flowering, but prior to seed set. For most species, slashing/brush cutting prior to late spring through to early summer will promote vigorous growth and should not occur. However, some annual grasses can grow and produce seed at any time of the year dependent on climatic conditions such as high rainfall and warm temperatures. Monitoring of annual species should be undertaken and if new growth occurs, the same treatment will be applied to the new growth to prevent seed production. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Perennial grasses

Perennial grasses, such as *Paspalum dilatatum* (Paspalum) and *Eragrostis curvula* (African Love Grass), will be hand removed where isolated or in low concentrations. Larger patches may be slashed prior to seed production in spring or summer (depending on the growth cycle of the species) and the regrowth spot-sprayed 2-3 weeks later when it is actively growing and approximately 10 cm in length. Monitoring of these species will occur and if new seed production occurs, the same treatment will be applied again as required. However, slashing will not reduce the presence of exotic grasses on its own and must always be combined with targeted removal to reduce densities and allow for native regeneration. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Woody weeds

If woody weeds invade the site, these will be controlled by the cut and paint or drill and fill method using a non-selective herbicide. The most appropriate method to be used depends on the size of the individual to be removed and will be determined by the bush regeneration contractor. Primary weed control should

use techniques that will not encourage flushes of secondary weed growth. All seedlings of woody weeds will be hand pulled or spot-sprayed with a non-selective herbicide.

Creepers and climbers

The control of creepers, including *Asparagus asparagoides* (Bridal Creeper) and *Araujia sericifera* (Moth Vine) varies depending on the species. For the most part, seedlings will be hand pulled, while mature plants can be controlled by the stem-scrape method or spot spraying using a non-selective herbicide. The precise method to be used will be determined by the bush regeneration contractor depending on the species, size and reproductive status of the individual. All vegetative material removed should be bagged, removed from site and disposed of appropriately.

Herbaceous weeds

Where individual plants of herbaceous weeds, including *Conyza bonariensis* (Flax-leaf Fleabane) and *Verbena bonariensis* (Purpletop), are found, they will be hand pulled prior to flowering. Where large swaths of these species occur they will be sprayed using a non-selective herbicide. If high densities of mature stands occur, weeds may be slashed first using a brush cutter and any subsequent regrowth sprayed. Regular monitoring of these species will be required to prevent seed production. *Cirsium vulgare* (Spear Thistle) will not be hand-pulled due to its thorns and instead will be spot sprayed using a non-selective herbicide. All vegetative material that is pulled out and has the potential to regrow if deposited on ground will be bagged and removed from site.

Management of weed waste

All weed propagules especially noxious weeds will be bagged and disposed of as directed by legislation at facility licensed to receive green waste. All weed waste without propagules will be composted on-site in small unobtrusive piles.

Herbicide use

The use of herbicide to control weeds should be carefully considered. Herbicide use should assess potential long-term impacts of the technique including whether the proposed works actually address the source of the weed infestation. However, herbicide application forms an important and useful component of an integrated weed management approach and can be the most appropriate method to control some weed species.

Herbicide use should occur during the active growing season for plants to encourage the chemical uptake into the plant. The selection of herbicides should also consider the type of weed and the location. Where non-selective herbicides are required for use, glyphosate is the most suitable. If herbicides are required to be used near waterways, a glyphosate-based herbicide formulated for use near waterways will be used (e.g. RoundUp© Biactive™).

Broad-leaf selective herbicide may be used as per the *Noxious and environmental weed control handbook* (DPI 2010). However, this type of herbicide is extremely toxic to aquatic life and must not be used in, or adjacent to, waterways. Registration and records must be kept in accordance with the NSW *Pesticide Regulation 2009*.

Revegetation

Planting of Hiko for trees and shrub species and Hiko or Viro cells for grasses and other groundcover species is the preferred method. Planting should be done via a low impact method such as hand digging

or hand auger. The holes dug for each plant should be at least 1.5x the width and 2x the depth of the rootball. Fertiliser should be added to each hole dug as per the label specifications. Water crystals or wetting agents should be added to each plant hole. This will increase the water holding capacity of the soil and reduce watering schedules. Initial irrigation of the plantings is essential to ensure that the soil forms around the rootball and no air pockets are left. This will be required unless sufficient rainfall (approx 10mm) occurs on the day of planting.

If hydro -seeding direct seeding is undertaken within landscaping areas onsite, it should be undertaken with local provenance native seed mix as per the groundcover species identified in Appendix C to achieve the required densities. An exotic cover crop can be used, however this must be sterile. Following hydro-seeding event/s ecoblanket will be irrigated regularly for a period of at least 6 months or until establishment of native seed, whichever is longer. Where irrigation is not able to be set up; the areas will be watered manually until grasses are thoroughly established.

Tree guards will need to be installed on each tree or shrub to protect seedlings from extreme weather (frosts and heat), herbivorous grazing and herbicide drift during maintenance. Bio-degradable tree guards are recommended to protect the seedlings. Following the revegetation works, irrigation needs to be undertaken for at least 8 weeks following planting to ensure the establishment of the plants. The level of irrigation will be determined by rainfall and temperature experienced at the planting site.

Mulch should be used where identified. The use of mulch is very important because it provides organic matter to the top soil, improves soil structure and aeration, water infiltration, nutrient availability, and is also useful in the suppression of weed growth (Buchanan 2009). Mulch should be sourced from within the local area. Mulch must be free of weed propagules and invasive woody species such as Coral Tree (Erythrina x sykesii). Mulching should not be undertaken within areas of high potential erosion. It is recommended jute matting is used in these areas prior to revegetation.

A temporary irrigation system should be installed to assist in the establishment of vegetation. Timing of the planting of these areas will need to take into consideration surrounding civil works and erosion/sediment control requirements, these areas will not be planted until earthworks have been completed. A maximum rate of attrition of 10% is to be tolerated, with any plant loss above this rate to be replaced at the contractor's expense

Seed collection

For the growth of the plants used in the revegetation works, seed must be collected from local provenance species. Herbaceous groundcovers, shrubs and trees should ideally be collected from within the local area from a similar aspect, soil, topography and microclimate. As per the recommendations of the Australian Network for Plant Conservation, native grasses typically have much larger dispersal mechanisms and are to be collected from within the Cumberland Plain of Western Sydney. Wetland species are also typically widely dispersed and may be collected from the Cumberland Plain component of the Hawkesbury Nepean Catchment. However, in all cases seed must be sourced from within a 20 km radius where available.

Record keeping of seed collection and planting locations is to follow the Flora Bank guidelines (Mortlock, 2000). A Section 132C licence under the NSW National Parks and Wildlife Act 1974 will be required to undertake seed collection works. The bush regeneration contractor is responsible for recording this information and providing it to the ER and relevant certifying authorities. If suppliers are used, confirmation will be required regarding seed origin.

Only wild native species are to be used. Plants are not to be substituted with horticultural varieties under any circumstance.

Hygiene protocols

To avoid introducing soil pathogens / diseases in particular *Phytophthora cinnamomi* (Root rot disease) onto site a hygiene protocol should be undertaken as per the guidelines developed by the Royal Botanic Gardens in '*Best Practice Management Guidelines for Phytophthora cinnamomi with the Sydney Metropolitan Catchment Management Authority'*.

For bush regenerators all tools and boots should be washed down and thoroughly cleaned of soil / mud using a solution of water and disinfectants prior to undertaking works onsite. All machinery should be thoroughly cleaned of all soil / mud / debris prior to working within the BMP area.

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Jake Burgess

Sydney Zoo

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Ref / Job No: 16HAR:5863

17 November 2016

Dear Jake,

Re: Sydney Zoo at Bungarribee South – Biodiversity Management Plan and CPW Management Plan

Development consent was granted by the Planning Assessment Commission of NSW as a delegate for the Minister for Planning on 8 September 2017. As required under conditions C15 and C16 respectively, Eco Logical Australia Pty Ltd (ELA) prepared an integrated Biodiversity Management Plan (BMP) and Cumberland Plain Woodland Management Plan (CPW MP) for Sydney Zoo at Bungarribee (16.5ha site).

In addition to the above, condition B13 required consultation with relevant public authorities prior to submission to the Secretary or the PCA for approval. Sydney Zoo provided a copy of the BMP / CPW MP (version 2 dated 27 July 2017) to agencies for their comment. Responses were received from Rural Fire Service (RFS), Roads and Maritime Service (RMS), Western Sydney Parklands Trust (WSPT), Office of Environment and Heritage (OE&H), Transport for NSW (TfNSW), and Blacktown Council.

This letter provides documentation of the consultation comments that were received, details of the change(s) made to the document, or (where appropriate) a response to comment(s) made in the table attached to this letter. The BMP / CPW MP report has also been amended to address these comments (now version 3).

This letter, along with the amended BMP / CPW MP report (version 3), is considered to address the need for consultation under condition B13, and management plans required under conditions C15 and C16.

If you have any questions about any aspect of this proposal, please do not hesitate to contact me on (**02) 8536 8652** or stevenw@ecoaus.com.au.

Yours sincerely,

Dr Steven Ward,

Senior Environmental Planner

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Agency	Comment	Response
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Western Sydney Parklands trust (WSPT)	1. The number of trees could be reduced with increase in herbaceous species, particularly in the regenerate areas. By my calculations, the current numbers would create a planting spacing of a tree stem every 7 metres which doesn't allow for much crown development. Maybe reduce tree numbers to a third - ~50 trees??	Agreed. The density of tree planting in Table 5 has been reduced from 1/50m2 to 1/100m2 and 1/250m2 for zones 1 and 2 respectively, and the density of planting herbs/scramblers has been increased to 1.1/m2 for zone 1. This change means that the total number of trees to be planted has thus decreased from 156 to 50 (a reduction of 106 plants), and the total number of herbs/scramblers to be planted has increased from 5,500 to 5,820 (an increase of 320 plants). The total number of CPW plants has thus increased from 20,246 to 20,460. Costings have also been updated, and have increased slightly.
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NSW GOVERNMENT | Planning & Environment

Contact: Chloe Dunlop
Phone: 02 8289 6667
Email: chloe.dunlop@planning.nsw.gov.au

Mr Jake Burgess
Managing Director
Sydney Zoo Pty Ltd
3 Wills Avenue
Waverley NSW 2041

Dear Mr Burgess

Subject: Biodiversity Management Plan – Condition C15
Sydney Zoo – SSD 7228

I refer to your request for the Secretary's approval of the Biodiversity Management Plan (dated October 2017) in accordance with Condition C15 of the development consent granted by the Planning Assessment Commission on 8 September 2017 (SSD 7228).

The Department of Planning and Environment has considered your request against the requirements of Condition C15 and Condition C16 and approves the Biodiversity Management Plan that incorporates the Cumberland Plain Woodland Management Plan.

Should you have any questions regarding the above, please contact Chloe Dunlop, on 02 8289 6667.

Yours sincerely,

C. Ritchie 29/11/17.

Chris Ritchie
Director
Industry Assessments
As the Secretary's Nominee

Jake Burgess

Sydney Zoo

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ABN 87 096 512 088
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Ref / Job No: 16HAR:5863

9 November 2017

Dear Jake,

Re: Sydney Zoo at Bungarribee South – Biodiversity Management Plan and CPW Management Plan

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Sydney Zoo – Bungarribee South

Biodiversity Management Plan and Cumberland Plain Woodland Management Plan

Prepared for
Sydney Zoo

October 2017

DOCUMENT TRACKING

Item	Detail
Project Name	Sydney Zoo Biodiversity Management Plan
Project Number	16HAR:5863
Project Manager	David Brennan 0429 322 508 Suite 2, Level 3, 668 Old Princes Hwy, Sutherland NSW 2232
Prepared by	David Brennan
Reviewed by	Andrew Whitford
Approved by	Steven Ward
Status	FINAL - Amended with agencies comments
Version Number	3
Last saved on	27 October 2017
Cover photo	CPW onsite, photo taken by Tammy Paartalu September 2015

This report should be cited as 'Eco Logical Australia 2017. *Sydney Zoo Biodiversity Management Plan and Cumberland Plain Woodland Management Plan*. Prepared for Sydney Zoo.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Jake Burgess, Sydney Zoo

Contents

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Abbreviations

Abbreviation	Description
BAR	Biodiversity Assessment Report
BMP	Biodiversity Management Plan
CEEC	Critically Endangered Ecological Community
CPW	Cumberland Plain Woodland
EEC	Endangered Ecological Community
ELA	Eco Logical Australia
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
ER	Environmental Representative
FFA	Flora and Fauna Assessment
LGA	Local Government Area
LLS	Local Land Services
OEH	NSW Office of Environment and Heritage
REFF	River Flat Eucalypt Forest
RFS	Rural Fire Service
TSC Act	NSW Threatened Species Act
WSP	Western Sydney Parklands

1 Introduction

1.1 Background

Eco Logical Australia (ELA) has been commissioned by Sydney Zoo to prepare management plans for the conservation areas associated with the construction and operation of a zoo (referred to hereafter as the Sydney Zoo) within the Bungarribee Precinct in Western Sydney Parklands.

The proposed development of the Sydney Zoo will include the development of a number of exhibits of native and exotic animals. Additional features of the project include a restaurant, car / bus parking, gift shop and internal roads.

During discussions with agencies as part of obtaining State Significant Development approval the Office of Environment and Heritage (OEH) raised concerns with regards to the viability of native vegetation to be retained within the site, in particular with regards to Cumberland Plain Woodland vegetation. This was addressed by Sydney Zoo proposing the preparation and implementation of an appropriate management plan. This was subsequently picked up in the conditions of consent for a Biodiversity Management Plan, and Cumberland Plain Woodland Plan of Management, as identified below. It is the view of the authors of this document that the native vegetation retained will be viable if the recommendations and management actions identified in this plan are adopted and followed.

Development Consent conditions, under Section 89E of the Environmental Planning and Assessment Act 1979, include:

Biodiversity Management Plan

> *C15. The Applicant shall prepare and implement a Biodiversity Management Plan for the Development to the satisfaction of the Secretary. The plan shall:*
>
> > *(a) be prepared by a qualified ecologist in consultation with the OEH, RFS, Council and Western Sydney Parklands Trust;*
> >
> > *(b) be approved by the Secretary prior to the commencement of any works on the site;*
> >
> > *(c) include measures to be taken to minimise impacts upon flora and fauna; and*
> >
> > *(d) include a Cumberland Plain Woodland Plan of Management (see Condition C16).*

Cumberland Plain Woodland Plan of Management

> *C16. The Applicant shall prepare and implement a Cumberland Plain Woodland Plan of Management for the Development to protect, manage and enhance the Cumberland Plain Woodland on the site and in the immediate surrounds. This plan will form part of the Biodiversity Management Plan in Condition C15 and shall:*
>
> > *(a) be prepared by a qualified ecologist in consultation with the OEH, RFS, RMS, TfNSW and Western Sydney Parklands Trust;*
> >
> > *(b) include detail of the plant species, management zones, vegetation monitoring, weed control measures, planting methodology and regeneration monitoring;*

(c) include detail of all Cumberland Plain Woodland areas on the site of the Development and detail how these areas shall be suitably fenced and environmental qualities recognised (e.g. signage); and

(d) shall be implemented as part of the landscaping works and shall be maintained by or on behalf of the Applicant in perpetuity of the Development.

This report combines the Biodiversity Management Plan (BMP), and the Cumberland Plain Woodland Management Plan (CPW-MP). The CPW-MP portion has been created based off guidelines *'Appendix R, Indicative CPW Management Plan Structure'*, which is largely based upon the vegetation management plan template prepared by Macquarie City Council (February 2012). As the BMP includes the management of River Flat Eucalypt Forest (RFEF) the terminology of BMP has been adopted throughout this documents to encapsulate all natural areas requiring management.

The document is presented in an integrated format. The lands to which the BMP applies are shown in **Figure 1** and **Figure 2**, and includes Cumberland Plain Woodland (CPW), RFEF, and some lands which currently have exotic grassland, but which will serve as buffers or connections for CPW to be retained. The CPW-MP of this document applies only to those lands outside of the RFEF areas.

ELA prepared the Biodiversity Assessment Report (BAR) in December 2015, which assessed and provided advice on the proposed impacts on Biodiversity of the proposed development, including identifying ways to minimise the construction impact, assessing offsetting requirements and identifying other ways to minimise the impact of the proposal on the biodiversity of the site / area. Previous ecological reports have been prepared for the Bungarribee precinct by ELA, including Flora and Fauna Assessment's (FFA) in 2015 and in 2014.

1.2 Objectives of the BMP

The overall aims of the BMP are to conserve the biodiversity values of the site, ensuring that all native vegetation, including CPW is maintained and improved and that measures are undertaken to minimise impacts upon flora and fauna. The objectives of this BMP include:

Table 1: BMP objectives

Objectives	Approach
Improve ecological health and integrity by revegetating with native species	Control woody weeds and noxious weeds Revegetate with native appropriate species Maintenance weed control
Maintain and enhance habitat values	Protect existing native vegetation Weed control Increase native plant cover

1.3 Key terms

For the purpose of this BMP the following terminology has been used:

- *Study area*, refers to the entire site as surveyed by the BAR (ELA 2015)
- *Biodiversity Management Plan or BMP area*, refers to all conservation areas within the site

- *Development site,* refers to the proposed construction footprint. This area is outside of the scope of the BMP.

1.4 Implementation of works

BMP works are to be implemented by experienced bush regeneration contractors with team leaders and trained staff having a minimum TAFE Certificate III in Conservation & Land Management, proven experience working in Western Sydney ecological communities and membership of the Association of Australian Bush Regenerators (or having the necessary prerequisite qualifications and experience for membership). Trained staff should make up a minimum of 30% of each team.

All personnel using herbicide for weed control must be appropriately trained in the identification of natives and weed species and hold required certification AQFIII in 'Prepare and Apply Chemicals' and comply with requirements of the Pesticides Regulation 2009 (NSW) and Pesticides Act 1999 (NSW).

An Environmental Representative (ER) should be appointed to the project to oversee planning, implementation and sign off of works within this BMP. The ER is to have a minimum of ten years' experience in the project management of ecological restoration sites, with significant experience in Western Sydney ecological communities.

1.5 Personnel preparing this BMP

The qualifications of the ELA project team involved in the preparation of this BMP are identified below:

Table 2: Project team qualifications

Name	Role	Qualifications
Dr Steven Ward	Project Director	Ph.D., University of Western Sydney, 2002 Honours, University of Wollongong, 1999 BSc (Botany / Zoology), University of Western Australia, 1987 Accredited Biobanking and major projects assessor
Andrew Whitford	Technical Review	Master of Applied Science (Environmental Science), University of Sydney. Diploma of Conservation and Land Management, Ryde TAFE. Bachelor of Arts (Communications), Emerson College, Boston. +10 years in the restoration ecology industry
David Brennan	Project Manager Preparation of BMP	Masters of Wildlife Management (Habitat), Macquarie University – Graduate School of the Environment, 2009 BSc (Biology), 2006 TAFE Cert III of Conservation and Land Management, Ryde TAFE 10 years in the restoration ecology industry

2 Description of the environment

2.1 Location

The Western Sydney Parklands (WSP) is a 27 km corridor stretching from Quakers Hills to Leppington in western Sydney (WSP 2011). Bungarribee South is within WSP in the new suburb of Bungarribee which is part of the City of Blacktown Local Government Area (LGA). The Bungarribee Precinct covers an area approximately 216 ha.

The BMP site consists of Lot 11, to be created by the subdivision of Lot 1 DP1103025. The BMP area covers 16.5 hectares and is located in the most southern portion of the Bungarribee precinct and is bound by major roads Great Western Highway to the south, Doonside road to the east and Eastern Creek flows along the western boundary (**Figure 1**).

2.2 Management history

The study area occurs within a highly urbanised setting surrounded by extensive areas of established urban development. The site is assumed to have been used previously for a variety of semi-rural activities including livestock grazing.

2.3 Drainage and hydrology

Two major creek systems feature within the landscape and occasionally flood the surrounding plains. Eastern Creek is a major creek which flows a south – north direction. Bungarribee Creek converge with Eastern Creek in the north. An intermittent tributary flows from the south-east of the study area to the north-west. Native vegetation persists along the creek banks. Moist depressions are scattered at lower elevations within the floodplain which are fed by the unnamed tributary and Eastern Creek during high water flow events (i.e. located north-east of the study area).

2.4 Geology / landscape

Two main soil landscapes exist within the study area. South Creek soil landscape is confined to the alluvial flat encompassing Eastern Creek and Bungarribee Creek. The soil landscape occurs on floodplains and valley flats on the Cumberland Plains (Bannerman and Hazelton 1990). The dominant soils are brown sandy loam to sandy clay loam with low fertility and high erodibility. Waterlogging and frequent flooding is often experienced within the South Creek soil landscape (Bannerman and Hazelton 1990). The Blacktown soil landscape occurs at higher elevations and includes the south-eastern corner of the study area. Dominant soils include brownish black loam to clay loam with low to moderate fertility (Bannerman and Hazelton 1990). Both soil landscapes are associated with the Wianamatta Group shales and Hawkesbury Sandstone geology. Blacktown soil landscape is often underlain by the Wianamatta group – Ashfield Shales.

2.5 Native flora

No threatened flora species were identified onsite. A full list of all flora observed onsite by ELA in 2015 is included as **Appendix A**.

2.6 Native fauna

11 species of native birds and amphibian were observed onsite by ELA in 2015 from opportunistic surveys and Anabat survey (for microbats), as identified in **Appendix B**.

2.7 Vegetation communities

The vegetation outside of the exotic pasture areas has been identified as belonging to two native vegetation communities (ELA 2015), as shown in **Figure 2**:

- *River Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (RFEF)
- Shale Plains Woodland a sub-community of *Cumberland Plain Woodland in the Sydney Basin Bioregion* (CPW)

2.7.1 River Flat Eucalypt Forest (RFEF)

RFEF is an Endangered Ecological Community (EEC) under the Threatened Species Act 1995 (TSC Act).

The patch onsite is located along Eastern Creek, in the western edge of the site. The RFEF onsite represents a relatively young stand of replanted RFEF, with the upper stratum supporting young *Eucalyptus amplifolia* (Cabbage Gum) and the mid-storey dominated by various Acacia species including *Acacia parramattensis* (Parramatta Wattle) and *Acacia decurrens* (Black Wattle). *Casuarina glauca* (Swamp Oak) was also recorded within the northern biometric plot in this community. Remnant RFEF occurred beyond the western boundary of the site.

The understorey was dominated by a mixture of native and exotic ground cover species. Dominant species included weed pasture grasses *Cynodon dactylon* (Couch), *Briza subaristata*, *Axonopus fissifolius* (Narrow-leafed Carpet Grass). Some native grasses remained, including *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass) and *Themeda triandra* (Kangaroo Grass).

2.7.2 Cumberland Plain Woodland

CPW is listed as critically endangered under the TSC Act and a Critically Endangered Ecological Community (CEEC) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). CPW is present onsite in a range of conditions.

Vegetation in poor condition at the site is present as scattered *Eucalyptus moluccana* with a primarily exotic understorey. Native grass species, particularly of *Macrolaena stipoides* appear to increase directly beneath the trees but these are only small patches in a largely exotic landscape. Small patches of *Aristida vagans* are also present.

The moderate (medium) condition stand of CPW occurs in the south of the site. This stands support both mature and juvenile *Eucalyptus moluccana*, a sparse shrub layer and the ground layer dominated is by native species.

The most commonly recorded groundcover species in areas of CPW include *Axonopus fissifolius* (Narrow-leafed Carpet Grass), *Briza subaristata*, *Aristida vagans*, *Microlaena stipoides* (Weeping Grass), *Lomandra* spp., *Themeda triandra*, *Setaria parviflora* and *Paspalum dilatatum* (Paspalum).

The CPW in the east of the site forms part of a larger patch of CPW that is in good condition and is dominated by native species in all strata. The canopy is dominated by *Eucalyptus tereticornis* and *Eucalyptus amplifolia* with *Angophora floribunda* scattered throughout. *Bursaria spinosa* is common in the understorey as is *Melaleuca decora* and *Daviesia ulicifolia* (Gorse Bitter Pea). Commonly recorded groundcover species include *Aristida vagans*, *Microlaena stipoides* and *Themeda triandra*.

2.7.3 Other vegetation

Due to the sites previous management history the majority of the site is comprised of exotic pasture, dominated by *Cynodon dactylon*, *Briza subaristata*, *Axonopus fissifolius*, *Setaria gracilis*. These areas are largely contained within the construction footprint.

2.8 Weeds

The BAR (ELA 2015) identified a total of 28 weeds onsite. Of these five species are currently listed as noxious within the Blacktown LGA, with 3 species also identified as Weeds on National Significance (WoNS) as shown in **Table 3**.

Table 3: Noxious weed list

Scientific name	Common name	Class	WoNS
Asparagus asparagoides	Bridal Creeper	4	Yes
Hypericum perforatum	St John Wort	4	-
Ligustrum sinense	Narrow-leaf Privet	4	-
Opuntia stricta	Common Prickly Pear	4	Yes
Senecio madagascariensis	Fireweed	4	Yes

Figure 1: Location map

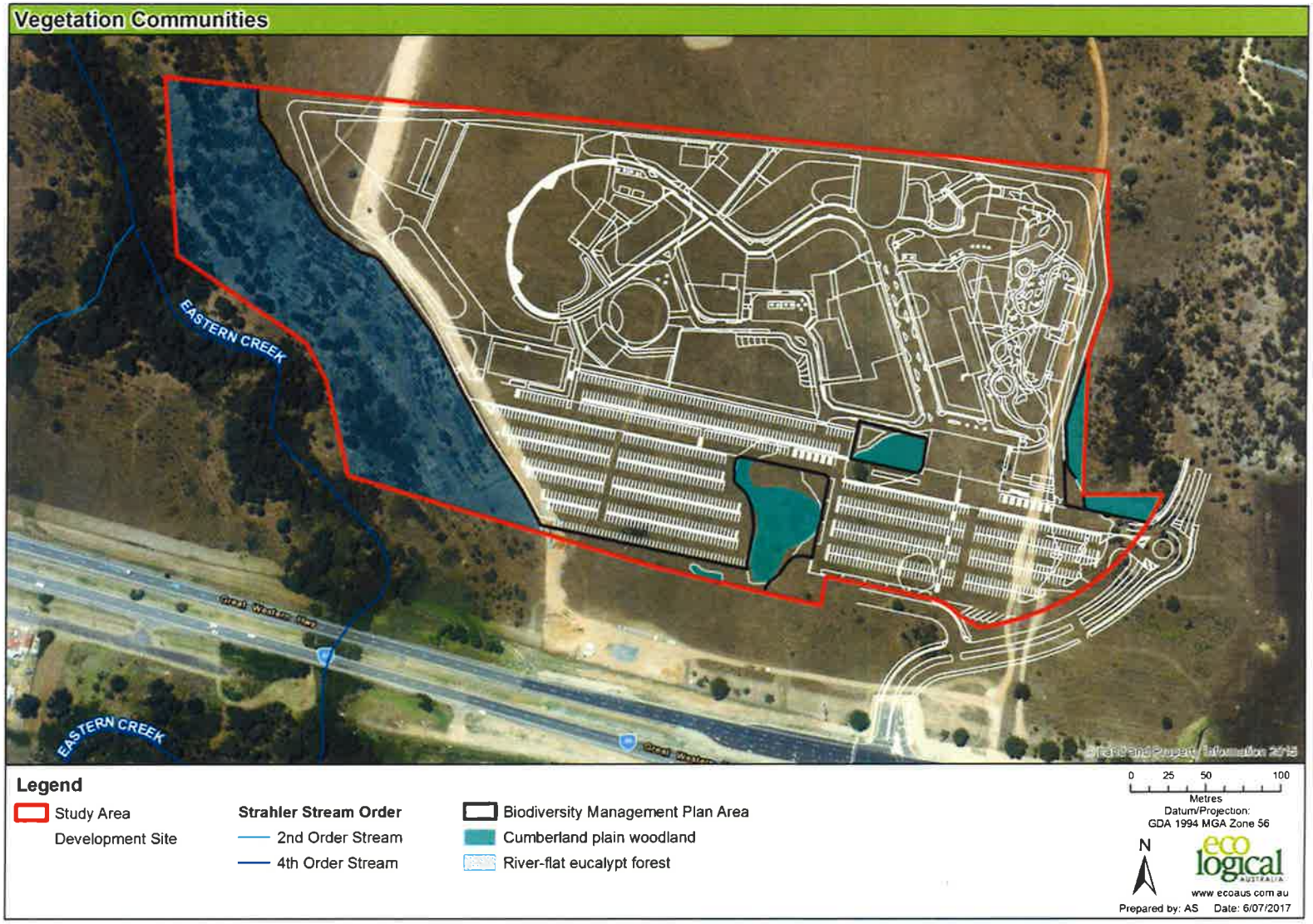

Figure 2: Vegetation communities

3 Biodiversity mitigation actions

The following actions are to be undertaken by the developer or civil construction company in order to minimise or mitigate any harm to native fauna or flora.

The works period has been divided into three periods as identified below:

Table 4: BMP timeframes

BMP phase	Construction phase	Expected duration
Preliminary period	pre - construction period	6 months
Establishment period	construction phase	18 months
Maintenance period	post construction phase / during Zoo operation	On-going, BMP covers the first 5 years

3.1 Preliminary works

Prior to the commencement of construction works the following actions will be required:

3.1.1 Fencing and signage

Prior to the commencement of works, the construction contractor shall be responsible for the installation of fencing to ensure construction activities do not impact onto BMP areas, including CPW to be retained and revegetated near the car park. The construction contractor will need to liaise with the ER and vegetation rehabilitation team to ensure proper laying of the fencing and ensure that vegetation rehabilitation can still access these areas.

Construction fencing is to be to clearly identify the boundary between construction activities and vegetation management works. The aim of this is to prevent unnecessary damage to native vegetation in the BMP area from construction activities and excludes all construction machinery, activities, materials and staff from the BMP areas.

Tree protection fencing or trunk protection measures will need to installed by a suitably qualified Arborist (Cert 5) around all trees to be retained within the construction footprint. A suitably qualified ecologist or Arborist (Cert 5) should be present on site during any excavation works within the BMP area to ensure extant native vegetation including tree roots are not disturbed by machine operators.

3.1.2 Sediment and erosion control

Prior to the commencement of earthworks, the construction contractor shall be responsible for the installation and maintenance of suitable sediment and runoff control measures in accordance with the latest version of the *Managing Urban Stormwater: Soils and Construction Guidelines* to prevent runoff entering adjacent bushland areas and watercourses.

Other considerations include:

- Construction adjacent to drainage lines should be completed during dry periods
- Storage areas should be located away from the drainage lines to minimise risk of pollution and adverse impact to aquatic ecosystems. Prevention of runoff and wastewater from the zoo entering

the adjacent watercourse through the implementation of a constructed wetlands and harvesting pond in the west of the site
- Wash down machinery before entering the site to limit weed spread.
- Potential chemical pollutants (e.g. fuels, oils, lubricants, paints etc.) would be stored in appropriate containers within bunded areas within construction compounds to minimise the risk of the pollution of aquatic environments

3.1.3 Tree felling / native vegetation clearance and habitat re-use

A qualified ecologist or suitably experienced wildlife carer (minimum 3 years) should be present on site during the removal of the hollow-bearing trees in the eastern part of the site to provide advice to machine operators, to salvage and relocate native fauna if native fauna are encountered and/or injured during tree felling.

All native timber should be retained onsite, with mulch stockpiled for use within conservation areas, all viable seed collected and all timber ≥200mm cut into logs to be utilised as habitat for native fauna. Material <200mm diameter may be mulched. Wherever possible all easily translocated native flora will be translocated from the construction footprint into the BMP areas.

Prior to tree felling being undertaken, 17 nest boxes of a range of styles and types targeting birds and bats are to be installed at a minimum height of 3m and a maximum of 5m, except as specified by the ER, are to be installed on mature trees to be retained, within the RFEF remnant, to replace the tree hollows which may potentially be lost. The use of artificial hollows cut into trees (where trees of suitable size and health are present that would allow this as an option), may be utilised as an alternative to the installation of nestboxes.

These should be assessed from the ground during monitoring reports. Any nest boxes lost or damaged to the point where they are no longer usable by native fauna during the period of the BMP should be replaced.

3.2 Establishment works

The establishment period is to occur during building works, estimated to take between 16 months, an allowance of 18 months has been provided in case of project delays. During construction works the following actions will be required

3.2.1 Contractor education and hygiene protocols

All contractor staff are to be aware of sensitivity of the threatened ecological communities (CPW, RFEF) to be retained and revegetated.

Other considerations include:

- Soil containing seeds from exotic grass species should be removed from the site as soon as practicable and / or stored appropriately to prevent their spread
- Contractors must be aware of potential for Aboriginal artefacts to be uncovered. If uncovered, work in the immediate area must stop immediately and suspected Aboriginal objects, reported to appropriate parties

3.2.2 Other measures

Other measures include:

- All neighbouring areas, will require weed control

- All exposed areas, neighbouring the BMP areas will require direct seeding with native provenance grass seeds or sterile grasses
- If construction lighting is required at night they should face away from vegetative areas to protect microbats

3.3 Maintenance period

Following the completion of the construction works, the following works will be required:

- After the completion of construction activities, the temporary high vis construction fencing material is to be replaced with long term exclusion fencing to prevent people walking over these planting areas. At minimum, this should consist of three strand wire, not barbed, and must be maintained in perpetuity.
- Signage should be erected on fencing and maintained during construction and operation periods to identify the area as a conservation zone. The design of long term signage will require approval of the Secretary and prepared in consultation with RMS, Council and the Western Sydney Parklands Trust (Condition C46)
- Ongoing weed control should be undertaken along the length of the works to reduce the impacts of edge effects on adjacent vegetation, including all landscaping areas and sediment basins
- Prevention of runoff and wastewater from the zoo entering the adjacent watercourse through the implementation of a constructed wetlands and harvesting pond in the west of the site.

4 Vegetation management works

All vegetation management works are to be undertaken by bush regeneration contractors.

As identified in **Figure 3**, three vegetation management zones have been identified based upon works required:

- Zone 1: CPW – revegetate
- Zone 2: CPW – regenerate
- Zone 3: RFEF – weed control

Further description of the zones and works required are provided below.

4.1 Zone 1: CPW - revegetate

Zone 1, an area of 0.32 ha comprises the three areas to be revegetated to CPW. These areas are mostly covered by exotic grasses, but are adjacent to remnant CPW (Zone 2) and will be planted out in order to provide a buffer to Zone 2 areas. These areas will require 100% revegetation.

Site preparation

All weeds will require control, in particular exotic grasses and groundcovers. A minimum of two herbicide foliar sprays will be required, further information is provided in **Appendix D**.

Following successful weed control, the area will be mulched to a minimum depth of 100mm with native eucalyptus mulch, expected to be generated onsite.

Revegetation

Revegetation will be undertaken in the establishment phase using tubestock using CPW species as identified in **Appendix C** to achieve the densities identified in **Table 5**. Further description of revegetation requirements is provided below.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.2 Zone 2: CPW - regenerate

Zone 2, an area of 0.46 ha comprises the four stands of remnant CPW to be retained and regenerated. These areas are in moderate to good condition, with few woody or vine weeds. The remnant vegetation includes scattered remnant canopy trees and native groundcovers, few native shrubs are present. Therefore, supplementary revegetation will be required in addition to the expected native regeneration.

Site preparation / weed control

These areas will require weed control, which should be undertaken in manner that does not impact on the native groundcovers and allow for natural regeneration and revegetation, further information is provided in **Appendix D**.

Revegetation

Revegetation will be undertaken in the establishment phase using tubestock using CPW species as identified in **Appendix C** to achieve the densities identified in **Table 5**. Further description of revegetation requirements is provided below.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.3 Zone 3: RFEF – weed control

Zone 3, an area of 2.65 ha comprises the large patch of RFEF in the west of the site. Overall the vegetation within this area is in moderate to good condition, however it consists mainly of young planted / re-growing canopy species and groundcover species. No revegetation is required in this area.

Weed control

These areas will require weed control, which should be undertaken in manner that does not impact on the native groundcovers and allow for natural regeneration and revegetation, further information is provided in **Appendix D**.

Maintenance

The zone will require ongoing maintenance to control weed regrowth from the soil seed bank for emerging and re-emerging weed species. Maintenance will be undertaken on a more regular basis in the peak growing seasons (spring and summer) than in cooler periods (autumn and winter).

4.4 Revegetation requirements

Revegetation has the twin aims of both re-establishing the original native vegetation community at the site and providing habitat for flora and fauna.

Any plantings should consist of local provenance CPW stock, a CPW planting species list has been provided in **Appendix C**. Planting should seek to ensure a diversity of species are utilised. As such, any one species of groundcover, being a herb, grass, sedge, or scrambler, should be no more than 5 percent than total number of groundcover plants.

Further description of revegetation method is provided in **Appendix D**.

A summary of the revegetation densities is shown in **Table 5** below.

Table 5: Revegetation requirements

Zone	Description	Reveg Area (m²)	Total plant number requirements				
			Trees	Shrubs	Herbs / Scramblers	Sedge / Grass	*Total*
1	CPW - revegetate	3,200	1/100m²	1/20m²	1.1/m²	3/m²	*13,312*
2	CPW - regenerate	4,600	1/250m²	1/20m²	1/2m²	1/m²	*7,148*
3	RFEF - regenerate	-					-
Totals		**7,800**	***50***	***390***	***5,820***	***14,200***	***20,460***

The Sydney Zoo Planting Strategy 2016, prepared by Geoff Duggan has been superseded by this BMP. The planting strategy has several species, including *Ranunculus lappaceus, Rhodanthe anthemoides, Scaevola albida* which although native are not from the CPW community which should not be installed into BMP areas. *Acacia pubescens* is a threatened species and if it is to be planted, would require consultation and approval from NSW Office of Environment and Heritage (OEH).

4.5 Pest control

A rabbit control program for the site should be implemented based on identification and fumigation of rabbit warrens. This is to be undertaken in consultation with the Local Land Services (LLS). The site is to be constantly monitored for evidence of rabbit activity. Any damage by rabbits, primarily due to grazing young plants, will require rectification.

Figure 3: Vegetation management zones

5 Work schedule and performance criteria

5.1 Work schedule

The BMP area is to be managed in perpetuity. The project has been broken into timeframes as identified in **Table 4**.

A work schedule has been provided in **Table 6** . The key to the table is provided below.

Key	Construction activities	
	Vegetation management works	

Seed collection, should commence in the preliminary phase to allow sufficient time (minimum of 6 months) for species to be grown on. The establishment phase has been assumed to be a period of 18 months, but may be longer or shorter depending on the timing of the works and achievement of performance criteria.

5.2 Performance criteria

The performance criteria required for the site have been split into preliminary and establishment period **Table 7** and maintenance period **Table 8**.

If monitoring indicates that the BMP tasks are not resulting in achievement of the performance criteria, the task program may require revision in consultation with the ER, Blacktown City Council, Western Sydney Parklands and all other relevant authorities.

5.3 Adaptive management

As this is a long term project that will be implemented over a number of years, an adaptive management approach will be implemented that enables the successful contractor to learn from and respond to successful and unsuccessful techniques used on the site. In its simplest form this may include the substitution of species identified in the planting table for advanced direct seeding techniques in place of manual planting techniques.

In addition, at the request of Blacktown Council, an alternative approach that could be utilised in areas that have a long history of disturbance (ie. the CPW zone 1 revegetation area), is scalping away topsoil (and weed seeds in the ground) using a 4:1 bucket on a skid-steer loader or a grader to remove the top 40mm of soil, and direct seeding native species. With this approach care would need to be taken to either ensure that scraping is not too deep, or if subsoil is exposed that additional suitable topsoil is brought in.

The success of the works will be determined by meeting the performance criteria identified. Contractors have the flexibility to implement different techniques to those specified here providing that performance criteria are met. Any major departures from the BMP or changes to performance criteria must be approved in writing by the ER, Blacktown City Council, Western Sydney Parklands and all other relevant authorities.

Table 6: Work schedule

Zone	Treatment	Prelimin.		Establishment						Maintenance																			
										Year 1				Year 2				Year 3				Year 4				Year 5			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
All areas	Install high vis construction fencing																												
	Install long term fencing and signage																												
	Install sed. Fence/ erosion control measures																												
	Vegetation clearance and habitat relocation																												
	Install 17 nest boxes																												
	Weed control in neighbouring areas*																												
	Seed collection																												
	Monitoring and reporting																												
Zone 1: CPW – revege.	Site preparation - weed control																												
	Site preparation - mulching																												
	Revegetation																												
	Irrigation																												
	Maintenance																												
Zone 2: CPW – regen.	Site preparation - weed control																												
	Revegetation																												
	Irrigation																												
	Maintenance																												
Zone 3: RFEF –	Weed control																												

Zone	Treatment	Prelimin.		Establishment						Maintenance																			
										Year 1				Year 2				Year 3				Year 4				Year 5			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
weed control.																													

**neighbouring areas to include landscaped areas, construction footprint and detention basins*

Table 7: Performance criteria - preliminary and establishment periods

Treatment Zones	Performance Criteria
All zones	All construction and sediment fencing installed Informational signage installed 17 nest boxes installed into RFEF area All tree felling and habitat retention completed under the supervision of an ecologist Pest control management plan prepared in consultation with LLS, horses and rabbits excluded from revegetation and rehabilitation areas
	Evidence submitted showing all seed and or plants required for revegetation has been collected or is being grown Installation of all plants not including replacement plants to be undertaken by end of the establishment period. To ensure species diversity, any one species of groundcover, being a herb, grass, sedge, or scrambler, should be no more than 5 percent than total number of groundcover plants A minimum of 85% survival rate of all vegetation strata planted in each zone (e.g. tree, shrub and groundcover) Any localised plant failure within planting areas are to be addressed with no area larger than 2 m x 2 metres without surviving plants at the end this period To reduce bushfire risk, ensure plantings do not overhang any buildings, tree canopies are discontinuous, and shrubs are not positioned within 2 m of buildings, and implement appropriate hazard reduction program in consultation with Western Sydney Parklands and Cumberland Zone Rural Fire Service where woodland vegetation is within or above threshold (being an appropriate time period between bushfires to maintain ecological integrity).

	All adult seeding noxious weed individuals to be controlled and no establishment of new noxious species All primary woody weed control undertaken

**Note that some actions will be required before construction works start (e.g. fencing, seed collection) as identified in Section 3*

Table 8: Performance criteria - Maintenance

Treatment Zones	Maintenance				
	Year 1	Year 2	Year 3	Year 4	Year 5
All zones	Commencement or completion of all tasks outlined in the BMP An increase in native cover and diversity and a decrease in exotic cover and diversity by the end of the maintenance period At the end of each year, a minimum of 85% survival rate of all vegetation strata planted in each zone (e.g. tree, shrub and groundcover) Any localised plant failure within planting areas are addressed with no area larger than 2 m x 2 metres without surviving plants at the end of each year; Maintenance replanting is to replace plants by the same species, or where that species is not available, with the same growth form (i.e. tree for tree etc.) and must not decrease species diversity. Any new species to be planted must be from the community being emulated and of local provenance; Monitoring and reporting undertaken in accordance with **Section 6**				
	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Noxious plants to be less than 2%, not allowed to set seed and no establishment of new noxious species	Complete eradication of noxious weeds from the site and no establishment of new noxious species
	Native vegetation cover no less than 30% of each zone	Native vegetation cover no less than 40% of each zone	Native vegetation cover no less than 50% of each zone	Native vegetation cover no less than 65% of each zone	Native vegetation cover no less than 80% of each zone.
	Exotic vegetation no more than 30% of each zone.	Exotic vegetation no more than 20% of each zone.	Exotic vegetation no more than 15% of each zone.	Exotic vegetation no more than 10% of each zone.	Exotic vegetation no more than 5% of each zone.

6 Monitoring, reporting and review

Monitoring and reporting are both extremely important. The environmental representative will monitor the vegetation for changes over time. Information gained through the monitoring and reporting process will identify works that have and have not been successful, and the reasons for their success or failure.

The aim of monitoring is to measure the effectiveness of the control actions being undertaken to achieve the desired outcome. It will identify non-conformance and provide the developer with the ability to implement corrective actions. Information derived from the results of monitoring will also be used in adaptive management (i.e. learning from past experience to inform future priorities and work plans). For example, as annual grass weeds are removed, herbaceous and perennial weeds may establish.

Finally, monitoring and reporting will help determine and quantify the costs related to weed management and the cost effectiveness of this management plan.

The ER will undertake monitoring and provide monitoring reports and assessments against the performance criteria, with the Bush Regeneration contactor to provide progress reports describing works undertaken.

6.1 Monitoring

Monitoring will be undertaken at the following intervals:

- At the beginning (baseline) and end of the establishment period
- Annually every year during the maintenance period until the completion of management works

Across the site, the following monitoring will be undertaken at each monitoring reporting period :

- Three (one per zone), full floristic vegetation quadrats, (20 m x 20 m)
- One, 30 minute diurnal bird survey site (undertaken within two hours of sunrise, temperature range, between 20°C and 25°C)
- One anabat recording site (Minimum two full nights, temperature to be between 25°C and 25°C)

The quadrats should measure cover abundance and species diversity of native and native and exotic species in the ground, mid-storey and canopy layers.

Photo monitoring points will be established at quadrat locations to provide a visual reference of changes in the vegetation. This will be undertaken at each monitoring reporting period. Photo monitoring is to include:

- set up 6 photos points across the site (two in each zone) and map the location of each point
- mark the photo point with a six foot star picket (with safety cap)
- take a digital photo of each photo monitoring point with the whole length of the star picket visible in the photo to act as a reference point; and
- organise the digital photos logically with each image labelled with a unique reference number indicating the location of the photo monitoring point and the date the photo is taken.

The monitoring reports will include an independent assessment of works against the performance criteria. A follow up site visit with relevant certifying authorities may be undertaken following the submission of the monitoring reports.

6.2 Progress reports

Progress reports are to be provided to the ER for inclusion within the monitoring reports. Progress reports are to be provided at each monitoring reporting period.

Reports will include:

- a summary of works carried out within the period
- an approximation of the time spent on each task
- mapping of areas worked presented in a GIS compatible format
- a detailed account of plant numbers and species, installed per area, including provenance information for all plantings as per Flora bank guidelines
- a description of any problems encountered in implementing the works recommended in the BMP and how they were overcome; and
- any observations made including new species, particularly threatened entities, comments on rates of regeneration and problems beyond the scope of the BMP which impact on the study area

Blacktown Council have requested that they be forwarded annual monitoring reports.

6.3 Management plan renewal / review

At the conclusion of the five years of maintenance, a new management plan will be required to update this plan. This should be prepared by a suitably qualified restoration ecologist. The site is to be managed in perpetuity and management plans should be renewed every five years.

7 Costs

The cost to implement vegetation management works detailed in this BMP is estimated at approximately **$228,250** (ex GST), broken down into per work period as shown in **Table 9**, including revegetation costs shown in **Table 10**.

These costs are based on the experience that ELA has had in regards to preparing and implementing vegetation management plans across Sydney. It should be noted that these costs may vary significantly over subsequent years of management in response to, and effectiveness of, the proposed management. These rates are also based upon costs in 2016, and on-going maintenance costs (labour and materials) may increase over time with inflation.

7.1 Biodiversity mitigation works

The costs for Biodiversity mitigation works, as the responsibility of the civil construction crew / developer have not been included in the costs provided.

7.2 Vegetation management works

7.2.1 Regeneration / weed control

Weed control and regeneration works have been calculated at $2,000 for a team of four bush regenerators per day. The cost of bush regeneration works includes travel and the costs of herbicide, vehicles and equipment which are required to implement the proposed works.

7.2.2 Seed collection

Budget for the collection of seed has been included as an estimate based upon numbers of plants required, however note that seed availability is limited by climate, time frames, site access, condition of vegetation etc and additional seed collection may be required.

7.2.3 Revegetation

Bush regeneration contractors will implement the revegetation treatments identified in this BMP. The majority of the site will be revegetated via tubestock. Tubestock costs have been budgeted at an estimated **$3.50** per tree and shrub including shrub guard, planting, water crystals, fertiliser and initial watering, and an estimated **$2.00** per grass, sedge and groundcover including planting, water crystals and initial watering.

A total of 20,460 CPW plants will be required to achieve the densities identified in the BMP. The total estimated cost of revegetation is approximately $64,925, including a 10% replacement rate, site prep, mulch and irrigation costs (**Table 10**). These proportions may change in the future depending on the site conditions.

Increases in regeneration from niche seeding and the translocation of plants and from within the development footprint may reduce the revegetation requirements. Some assumptions in relation to the success of niche seeding have been factored into these costs. The actual amount of revegetation required will need to be re-assessed at the end of the preliminary phase.

7.2.4 Monitoring and reporting

The ER and bush regeneration contractors will undertake the monitoring and reporting as identified in this BMP. All monitoring, mapping and reporting works have been calculated using the rate for a qualified and trained Restoration Ecologist at $160 / hr.

Table 9: Costs

Treatment	Preliminary	Establishment	Maintenance					Total
			Year 1	Year 2	Year 3	Year 4	Year 5	
Revegetation								
Seed collection, cleaning, storage	$3,037	$0	$0	$0	$0	$0	$0	$3,037
Site Preparation	$0	$3,900	$0	$0	$0	$0	$0	$3,900
Jute Matting / Mulch	$0	$6,400	$0	$0	$0	$0	$0	$6,400
Tubestock, supply and install	$0	$41,580	$0	$0	$0	$0	$0	$41,580
Replacement tubestock, supply and install	$0	$0	$2,079	$2,079	$0	$0	$0	$4,158
Irrigation	$0	$5,850	$0	$0	$0	$0	$0	$5,850
Weed control								
Establishment	$0	$27,675	$0	$0	$0	$0	$0	$27,675
Maintenance	$0	$0	$35,550	$23,700	$23,700	$23,700	$11,850	$118,500
Associated costs								
Monitoring & Reporting	$0	$6,431	$2,144	$2,144	$2,144	$2,144	$2,144	$17,150
Totals	**$3,037**	**$91,836**	**$39,772**	**$27,922**	**$25,844**	**$25,844**	**$13,994**	**$228,250**

Table 10: Revegetation costs

Zone	Description	Tubestock (m^2)	Plant Cost	10% Plant replacement cost	Site preparation	Mulch Cost	Seed Collection Cost	Irrigation Cost	**Total**
Zone 1	CPW revegetate	3,200	$26,912	$2,691	$1,600	$6,400	$1,954	$2,400	**$41,957**
Zone 2	CPW - regenerate	4,600	$14,668	$1,467	$2,300	$0	$1,083	$3,450	**$22,968**
Totals	**-**	**7,800**	***$41,580***	***$4,158***	***$3,900***	***$6,400***	***$3,037***	***$5,850***	**$64,925**

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Appendix A Native Flora List (ELA 2015)

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form
Acacia decurrens	Black Wattle	N			S
Acacia sp.2		N			S
Acacia falcata		N			S
Acacia parramattensis	Parramatta Wattle	N			T
Acacia parramattensis	shrub layer	N			S
Acacia sp.		N			S
Acacia ulicifolia	Prickly Moses	N			S
Anagallis arvensis	Scarlet Pimpernel	E			F
Angophora floribunda		N			T
Angophora sp.	seedling	N			T
Araujia sericifera	Moth Vine	E			L
Aristida ramosa	Purple Wiregrass	N			G
Aristida vagans	Threeawn Speargrass	N			G
Asparagus asparagoides	Bridal Creeper	E	Class 4	Y	V
Axonopus fissifolius	Narrow-leafed Carpet Grass	E			G
Bothriochloa macra		N			G
Briza subaristata		E			G
Bulbine bulbosa	Native Leek	N			F
Bursaria spinosa	Blackthorn	N			S
Casuarina glauca	Swamp Oak	N			T
Chloris gayana	Rhodes Grass	E			G
Cirsium vulgare	Spear Thistle	E			F
Conyza bonariensis	Flaxleaf Fleabane	E			F
Conyza sp.		E			F
Cymbopogon refractus	Barbed Wire Grass	N			G
Cynodon dactylon	Couch	E			G
Cyperus sp.		N			V
Daviesia ulicifolia	Gorse Bitter Pea	N			S
Dianella longifolia	Blueberry Lily	N			V
Dianella sp.		N			V
Dichondra repens	Kidney Weed	N			F
Digitaria sp.		N			G
Dillwynia sieberi		N			S
Einadia hastata	Berry Saltbush	N			F
Eragrostis curvula	African Lovegrass	E			G
Eucalyptus amplifolia	Cabbage Gum	N			T
Eucalyptus amplifolia	seedling	N			T
Eucalyptus moluccana	Grey Box	N			T
Eucalyptus tereticornis	Forest Red Gum	N			T

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form
Eucalyptus sp.	Juvenile stringybark	N			T
Galium aparine	Goosegrass	E			F
Glycine microphylla	Small-leaf glycine	N			L
Glycine sp.		N			L
Glycine tabacina		N			L
Goodenia hederacea	Forest Goodenia	N			F
Goodenia paniculata	Branched Goodenia	N			F
Gomphocarpus sp.		E			S
Hakea sericea	Needlebush	N			S
Hypericum perforatum	St. Johns Wort	E	Class 4		F
Hypochaeris radicata	Catsear	E			F
Juncus sp.		N			V
Ligustrum sinense	Small-leaved Privet	E	Class 4		S
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush	N			V
Lomandra longifolia		N			V
Lomandra multiflora		N			V
Lomandra sp.		N			V
Melaleuca styphelioides	Prickly-leaved Tea Tree	N			T
Microlaena stipoides	Weeping Grass	N			G
Opuntia stricta	Prickly Pear	E	Class 4	Y	F
Oxalis perennans		N			F
Panicum effusum	Hairy Panic	N			G
Paspalidium sp.		N			G
Paspalum dilatatum	Paspalum	E			G
Plantago lanceolata	Lamb's Tongues	E			F
Romulea sp.		E			G
Rytidosperma sp.		N			G
Senecio hispidulus	Hill Fireweed	N			F
Rumex sp.		E			F
Senecio madagascariensis	Fireweed	E	Class 4	Y	F
Senecio sp.		N			
Setaria parviflora		E			G
Sida rhombifolia	Paddy's Lucerne	E			F
Solanum nigrum	Black-berry Nightshade	E			F
Solanum sp.		E			F
Sporobolus creber	Western Rat-tail Grass	N			G
Sporobolus sp.		E			G
Themeda triandra	Kanagaroo Grass	N			G
Trifolium sp.		E			F
Verbena bonariensis	Purpletop	E			F
Verbena sp.		E			F

Appendix B Native Fauna (ELA 2015)

	Common Name	Scientific Name	Observation Type
AVES			
1	Common Myna	*Acridotheres tristis**	O
2	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	O
3	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O
4	Australian Raven	*Corvus coronoides*	O
5	Australian Magpie	*Cracticus tibicen*	O
6	White-faced Heron	*Egretta novaehollandiae*	O
7	Superb Fairy-wren	*Malurus cyaneus*	O
8	Noisy Miner	*Manorina melanocephala*	O
9	Golden Whistler	*Pachycephala pectoralis*	O, W
10	Willie Wagtail	*Rhipidura leucophrys*	O
AMPHIBIAN			
11	Common Eastern Froglet	*Crinia signifera*	W

O denotes observed, W denotes heard.

Appendix C CPW Planting List

Type	Scientific name	Common name	CPW
Tree canopy species (>10m)	*Angophora floribunda*	Rough-barked Apple	X
	Angophora subvelutina	Broad-leaved Apple	X
	Corymbia maculata	Spotted Gum	X
	Eucalyptus amplifolia	Cabbage Gum	X
	Eucalyptus crebra	Narrow-leaved ironbark	X
	Eucalyptus eugenioides	Thin-leaved Stringybark	X
	Eucalyptus moluccana	Grey Box	X
	Eucalyptus tereticornis	Forest Red Gum	X
Small trees / shrub species (1.5m-10m)	*Acacia decurrens*	Sydney green wattle	X
	Acacia implexa	Lightwood	X
	Acacia parramattensis	Parramatta wattle	X
	Daviesia ulicifolia	Gorse bitter pea	X
	Dillwynia sieberi	-	X
	Dodonaea viscosa subsp. cuneata	Wedge-leaf Hop-bush	X
	Indigofera australis	Australian Indigo	X
	Pultenaea microphylla	-	X
Sedges, Rushes, Reeds & Grasses	*Aristida ramosa*	Purple Wiregrass	X
	Aristida vagans	Threeawn Speargrass	X
	Bothriochloa decipiens	Red leg grass	X
	Bothriochloa macra	Red Grass	X
	Chloris truncata	Windmill Grass	X
	Chloris ventricosa	Plump windmill brass	X
	Carex inversa	-	X
	Cymbopogon refractus	Barbed-wire Grass	X
	Cyperus gracilis	Slender Flat-sedge	X
	Dichelachne micrantha	Shorthair Plumegrass	X
	Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass	X
	Echinopogon ovatus	Forest Hedgehog Grass	X

Type	Scientific name	Common name	CPW
	Eriochloa pseudoacrotricha	Early Spring Grass	X
	Lomandra filiformis	-	X
	Lomandra multiflora subsp. multiflora	-	X
	Microlaena stipoides var. stipoides	Weeping Meadow Grass	X
	Poa labillardieri var. labillardieri	Tussock Grass	X
	Rytidosperma caespitosum	Ringed Wallaby Grass	X
	Rytidosperma racemosa var. racemosa	-	X
	Themeda triandra	Kangaroo Grass	X
Groundcover Species (~0-1.5m) & Vines/Scramblers	*Brunoniella australis*	Blue Trumpet	X
	Centella asiatica	Indian Pennywort	X
	Clematis glycinoides	Old Man's Beard	X
	Commelina cyanea	Creeping Christian	X
	Desmodium varians	Slender Tick-trefoil	X
	Dianella longifolia	Blueberry Lily	X
	Dichondra repens	Kidney Weed	X
	Einadia nutans	Climbing Saltbush	X
	Geranium solanderi	Native Geranium	X
	Glycine clandestina	Twining Glycine	X
	Glycine microphylla	Small-leaf glycine	X
	Goodenia hederacea subsp. *Hederacea*	Ivy Goodenia	X
	Hardenbergia violacea	Purple Coral Pea	X
	Mentha satureioides	Creeping mint	X
	Phyllanthus virgatus	-	X
	Pratia purpurascens	Whiteroot	X
	Plectranthus parviflorus	Cockspur flower	X
	Veronica plebeia	Creeping Speedwell	X
	Wahlenbergia gracilis	Sprawling Bluebell	X

Appendix D Techniques and specifications

Weed control

Weed control involves a combination of mechanical, physical and chemical techniques to remove the weeds and prevent regrowth. Weed control will be undertaken in all management zones. A selection of the best suited weed control method within the site depends on a number of factors including:

- the species or combination of weeds being targeted
- the density of the weeds
- resources available (time, labour, equipment and finances)
- weather conditions of the day

Weed control techniques

Detail of specific weed control techniques to be used such as cut and paint, scrape and paint, herbicide spraying and hand weeding are given in Brodie (1999). The principles of bush regeneration and techniques to trigger natural regeneration are to be in accordance with the Bradley Method and other techniques described in Buchanan (2000). Management techniques for different types of weeds are provided below.

Annual grasses

Annual grasses, such as *Bromus catharticus* (Prairie Grass), should be hand removed or spot sprayed where isolated or in low concentrations. Larger patches of annual grasses may be slashed/brush cut in late spring to early summer, after flowering, but prior to seed set. For most species, slashing/brush cutting prior to late spring through to early summer will promote vigorous growth and should not occur. However, some annual grasses can grow and produce seed at any time of the year dependent on climatic conditions such as high rainfall and warm temperatures. Monitoring of annual species should be undertaken and if new growth occurs, the same treatment will be applied to the new growth to prevent seed production. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Perennial grasses

Perennial grasses, such as *Paspalum dilatatum* (Paspalum) and *Eragrostis curvula* (African Love Grass), will be hand removed where isolated or in low concentrations. Larger patches may be slashed prior to seed production in spring or summer (depending on the growth cycle of the species) and the regrowth spot-sprayed 2-3 weeks later when it is actively growing and approximately 10 cm in length. Monitoring of these species will occur and if new seed production occurs, the same treatment will be applied again as required. However, slashing will not reduce the presence of exotic grasses on its own and must always be combined with targeted removal to reduce densities and allow for native regeneration. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Woody weeds

If woody weeds invade the site, these will be controlled by the cut and paint or drill and fill method using a non-selective herbicide. The most appropriate method to be used depends on the size of the individual to be removed and will be determined by the bush regeneration contractor. Primary weed control should

use techniques that will not encourage flushes of secondary weed growth. All seedlings of woody weeds will be hand pulled or spot-sprayed with a non-selective herbicide.

Creepers and climbers

The control of creepers, including *Asparagus asparagoides* (Bridal Creeper) and *Araujia sericifera* (Moth Vine) varies depending on the species. For the most part, seedlings will be hand pulled, while mature plants can be controlled by the stem-scrape method or spot spraying using a non-selective herbicide. The precise method to be used will be determined by the bush regeneration contractor depending on the species, size and reproductive status of the individual. All vegetative material removed should be bagged, removed from site and disposed of appropriately.

Herbaceous weeds

Where individual plants of herbaceous weeds, including *Conyza bonariensis* (Flax-leaf Fleabane) and *Verbena bonariensis* (Purpletop), are found, they will be hand pulled prior to flowering. Where large swaths of these species occur they will be sprayed using a non-selective herbicide. If high densities of mature stands occur, weeds may be slashed first using a brush cutter and any subsequent regrowth sprayed. Regular monitoring of these species will be required to prevent seed production. *Cirsium vulgare* (Spear Thistle) will not be hand-pulled due to its thorns and instead will be spot sprayed using a non-selective herbicide. All vegetative material that is pulled out and has the potential to regrow if deposited on ground will be bagged and removed from site.

Management of weed waste

All weed propagules especially noxious weeds will be bagged and disposed of as directed by legislation at facility licensed to receive green waste. All weed waste without propagules will be composted on-site in small unobtrusive piles.

Herbicide use

The use of herbicide to control weeds should be carefully considered. Herbicide use should assess potential long-term impacts of the technique including whether the proposed works actually address the source of the weed infestation. However, herbicide application forms an important and useful component of an integrated weed management approach and can be the most appropriate method to control some weed species.

Herbicide use should occur during the active growing season for plants to encourage the chemical uptake into the plant. The selection of herbicides should also consider the type of weed and the location. Where non-selective herbicides are required for use, glyphosate is the most suitable. If herbicides are required to be used near waterways, a glyphosate-based herbicide formulated for use near waterways will be used (e.g. RoundUp© Biactive™).

Broad-leaf selective herbicide may be used as per the *Noxious and environmental weed control handbook* (DPI 2010). However, this type of herbicide is extremely toxic to aquatic life and must not be used in, or adjacent to, waterways. Registration and records must be kept in accordance with the NSW *Pesticide Regulation 2009*.

Revegetation

Planting of Hiko for trees and shrub species and Hiko or Viro cells for grasses and other groundcover species is the preferred method. Planting should be done via a low impact method such as hand digging

or hand auger. The holes dug for each plant should be at least 1.5x the width and 2x the depth of the rootball. Fertiliser should be added to each hole dug as per the label specifications. Water crystals or wetting agents should be added to each plant hole. This will increase the water holding capacity of the soil and reduce watering schedules. Initial irrigation of the plantings is essential to ensure that the soil forms around the rootball and no air pockets are left. This will be required unless sufficient rainfall (approx 10mm) occurs on the day of planting.

If hydro -seeding direct seeding is undertaken within landscaping areas onsite, it should be undertaken with local provenance native seed mix as per the groundcover species identified in Appendix C to achieve the required densities. An exotic cover crop can be used, however this must be sterile. Following hydro-seeding event/s ecoblanket will be irrigated regularly for a period of at least 6 months or until establishment of native seed, whichever is longer. Where irrigation is not able to be set up; the areas will be watered manually until grasses are thoroughly established.

Tree guards will need to be installed on each tree or shrub to protect seedlings from extreme weather (frosts and heat), herbivorous grazing and herbicide drift during maintenance. Bio-degradable tree guards are recommended to protect the seedlings. Following the revegetation works, irrigation needs to be undertaken for at least 8 weeks following planting to ensure the establishment of the plants. The level of irrigation will be determined by rainfall and temperature experienced at the planting site.

Mulch should be used where identified. The use of mulch is very important because it provides organic matter to the top soil, improves soil structure and aeration, water infiltration, nutrient availability, and is also useful in the suppression of weed growth (Buchanan 2009). Mulch should be sourced from within the local area. Mulch must be free of weed propagules and invasive woody species such as Coral Tree (Erythrina x sykesii). Mulching should not be undertaken within areas of high potential erosion. It is recommended jute matting is used in these areas prior to revegetation.

A temporary irrigation system should be installed to assist in the establishment of vegetation. Timing of the planting of these areas will need to take into consideration surrounding civil works and erosion/sediment control requirements, these areas will not be planted until earthworks have been completed. A maximum rate of attrition of 10% is to be tolerated, with any plant loss above this rate to be replaced at the contractor's expense

Seed collection

For the growth of the plants used in the revegetation works, seed must be collected from local provenance species. Herbaceous groundcovers, shrubs and trees should ideally be collected from within the local area from a similar aspect, soil, topography and microclimate. As per the recommendations of the Australian Network for Plant Conservation, native grasses typically have much larger dispersal mechanisms and are to be collected from within the Cumberland Plain of Western Sydney. Wetland species are also typically widely dispersed and may be collected from the Cumberland Plain component of the Hawkesbury Nepean Catchment. However, in all cases seed must be sourced from within a 20 km radius where available.

Record keeping of seed collection and planting locations is to follow the Flora Bank guidelines (Mortlock, 2000). A Section 132C licence under the NSW National Parks and Wildlife Act 1974 will be required to undertake seed collection works. The bush regeneration contractor is responsible for recording this information and providing it to the ER and relevant certifying authorities. If suppliers are used, confirmation will be required regarding seed origin.

Only wild native species are to be used. Plants are not to be substituted with horticultural varieties under any circumstance.

Hygiene protocols

To avoid introducing soil pathogens / diseases in particular *Phytophthora cinnamomi* (Root rot disease) onto site a hygiene protocol should be undertaken as per the guidelines developed by the Royal Botanic Gardens in '*Best Practice Management Guidelines for Phytophthora cinnamomi with the Sydney Metropolitan Catchment Management Authority*'.

For bush regenerators all tools and boots should be washed down and thoroughly cleaned of soil / mud using a solution of water and disinfectants prior to undertaking works onsite. All machinery should be thoroughly cleaned of all soil / mud / debris prior to working within the BMP area.

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