Edmondson Park STP Removal

Vegetation Management Plan

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Abbreviations

Abbreviation	Description
CPW	Cumberland Plain Woodland
DS	Direct Seeding
ELA	Eco Logical Australia
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*
NP&W Act	NSW National Parks and Wildlife Act 1974
OEH	Office of Environment and Heritage
RFEF	River Flat Eucalypt Forest
SSD	Sewage Sludge Disposal site
STP	Sewage Treatment Plant
TS	Tubestock
TSC Act	NSW *Threatened Species Conservation Act 1995*
VMP	Vegetation Management Plan

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1 Introduction

Ecological Australia Pty Ltd (ELA) was engaged by AVER and Urban Growth NSW (UGNSW) to prepare a vegetation management plan (VMP) to guide rehabilitation of vegetation following the removal of the infrastructure and possibly the ponds of the Edmondson Park Sewage Treatment Plant (STP) within the boundary of Edmondson Regional Park. The works will also involve the construction of an additional access road for access to the STP site. The site location is shown in **Figure 1**.

This VMP will address the revegetation with species from Shale Plains Woodland, a component of Cumberland Plain Woodland (CPW) which is listed as a Critically Endangered Ecological Community (CEEC) under both the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act); and Alluvial Woodland, a component of River Flat Eucalypt Forest (RFEF) which is listed as an Endangered Ecological Community (EEC) under the TSC ACT. These two vegetation communities border the remediation site (**Figure 2**).

A Remediation Action Plan for this site has been prepared by JBS&G detailing removal of the STP and associated infrastructure and ponds; and additional works to remediate the site prior to vegetation management works. Remediation of the site is to include STP removal, possible drainage of the oxidation ponds and the construction of one containment cell for the containment of waste from within the STP site and the broader Edmondson Park development area. This cell will be capped and then covered with topsoil for revegetation.

1.1 Background

The STP site was acquired by UGNSW from the Commonwealth Government in 2011 and the STP was subsequently shut down. Prior to this the STP serviced the Bardia Barracks heritage precinct, Ingleburn North Primary School, and several residential properties.

This site is to be passed to NPWS to be managed as part of the Edmondson Regional Park following remediation, vegetation establishment and a maintenance period.

1.2 Objectives

This VMP will address the rehabilitation and long term management of both CPW and RFEF following remediation works within the remediation site.

The VMP will provide a working guideline for the ongoing management of the vegetation within the remediation area and adjacent cleared vegetation impacted by remediation works. Weed control procedures are also recommended in adjacent retained vegetation within a buffer of at least 10m to assist long-term weed control within the remediation area and favour a better outcome.

The key objective of the Vegetation Rehabilitation and Native Landscape Management Plan (VRNLMP) for the proposed Edmondson Regional Park (OEH 2013) is to protect and enhance the ecological and conservation values of the Edmondson Regional Park site. The activities proposed in this plan support that outcome and have also been developed to be compatible with the requirements of the Edmondson Park Precinct Conservation Agreement between the State and the Commonwealth which requires the establishment of additional CPW within appropriate areas of the remediation site.

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1.3 Growth Centres SEPP

An estimated 0.05 ha of CPW will be impacted during the construction of the haul road between Campbelltown Road and the existing track which leads to the STP site. Under the Growth Centres SEPP, this impact on CPW will need to be offset. This VMP recommends that this offset be in the vicinity of 1:3 and so includes the revegetation and management of an additional of 0.16 ha of CPW outside the STP works boundary (included in Zone 4 in this VMP). This area is adjacent to existing CPW, and is outside the mapped Existing Native Vegetation (ENV) under the Growth Centres SEPP.

1.4 Management outline

The maintenance period for the vegetation rehabilitation within this site is a minimum of 5 years, or until the objectives and performance criteria outlined in this VMP are met.

The VMP will

- outline appropriate site preparation works prior to revegetation
- provide suitable species planting lists and densities
- outline an appropriate timeframe for works and monitoring, providing for a staged approach to the rehabilitation
- facilitate action plans and on-going maintenance.

1.5 Management considerations

Given the timeframe of the project, seed collection for the production of tube stock will need to be commenced as soon as feasible, however it is likely that at least some stock will need to be sourced from local plant suppliers. In addition, tubestock produced from locally collected seed may be used for supplementary planting as required to meet the performance criteria.

A scientific licence under section 132C of the National Parks and Wildlife Act is required to collect seeds from any protected native plant, a threatened species or part of an endangered population or an endangered ecological community. This licence is not required when the seed collection is from vegetation whose removal has already been assessed and approved under the relevant environmental assessment legislation. Special permission is required to collect seeds on privately owned land. A license application must be submitted to OEH.

Guidelines and specifications for both weed control and revegetation works are provided in **Appendix A.**

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.

The success of the works will be determined by meeting the performance criteria (**Section 4.3**). Contractors have the flexibility to implement different techniques to those specified here providing that performance criteria are met.

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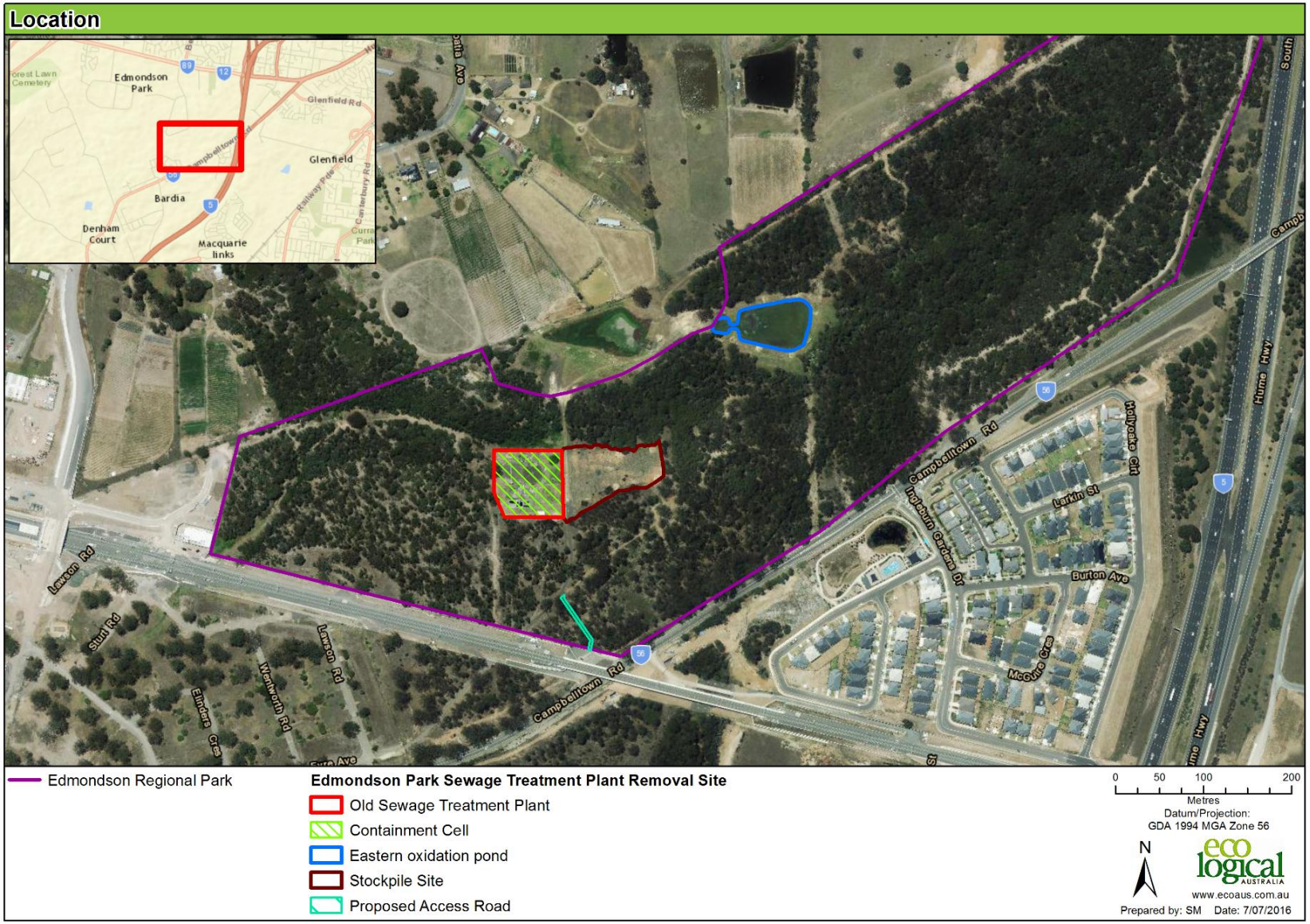

Figure 1 : Location of STP removal site

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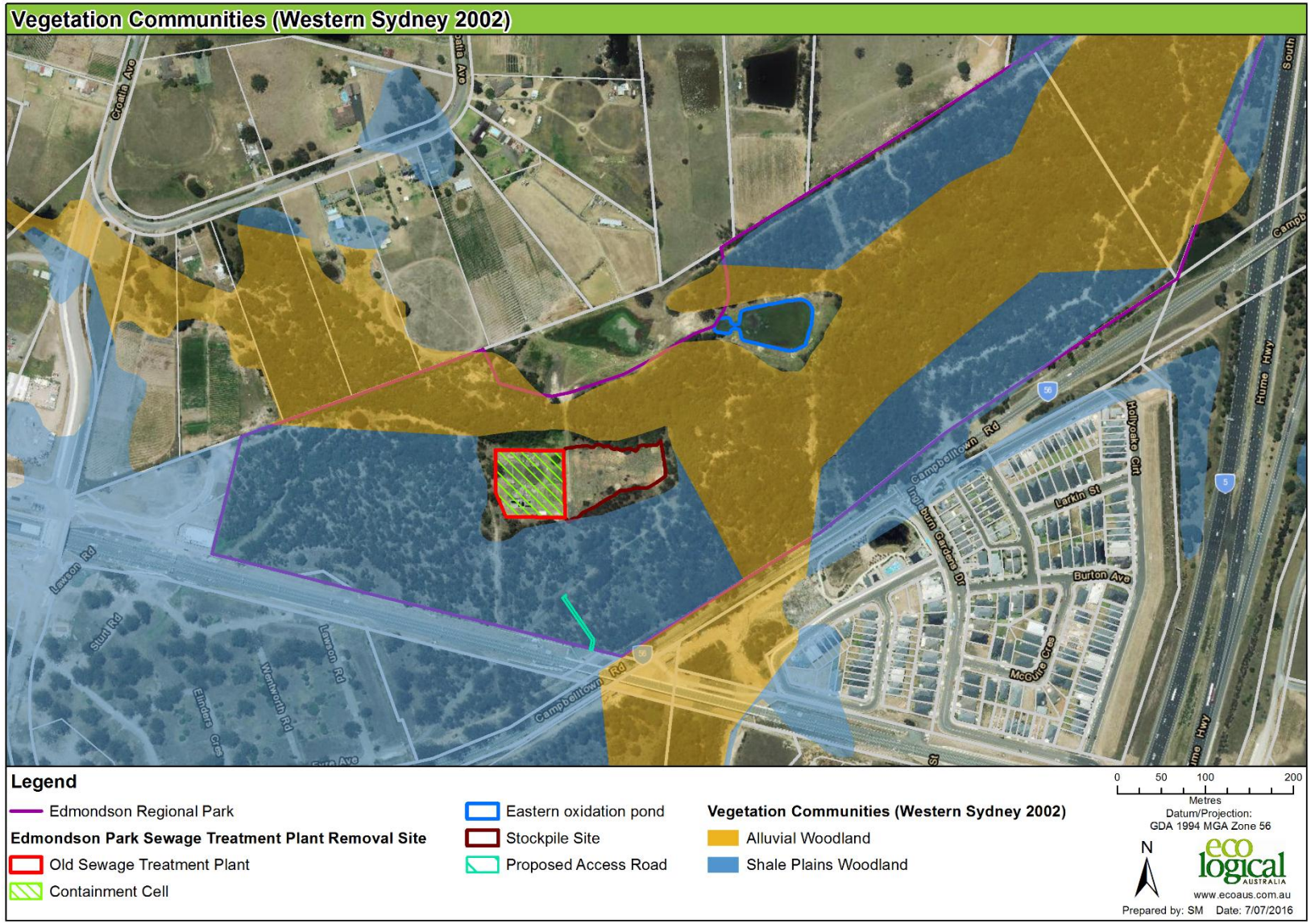

Figure 2: Vegetation communities surrounding the STP and oxidation ponds

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2 Site Description

2.1 Existing STP infrastructure

The areas which will be impacted by the STP removal and remediation include

- The area of existing infrastructure for the STP. The vegetation in this section is a mown grassland with one exotic tree in the north east corner and some woody weed infestations along the northern boundary (**Figure 3).** Vegetation to the north of this area is RFEF which is heavily infested by weeds, including some noxious species. The vegetation to the south and west is CPW in varying conditions with weed infestations highest along the western boundary.
- The sewage sludge disposal (SSD) area consisting of a mown grassland area to the east of the STP where sewage sludge was disposed during the STP operation period. This area has been remediated and is now an exotic grassland containing approximately six scattered *Acacia decurrens* saplings and one mature *Melaleuca styphelioides* on the northern boundary **(Figure 4).** CPW vegetation borders this section along the southern and south eastern edges and RFEF vegetation borders in the north. The condition of both these vegetation communities is moderate with weed densities high in the ground layer. Waste material has been stockpiled on this area during the removal of the STP infrastructure.
- The oxidation pond to the north-east of the STP with surrounding exotic grassland. The pond currently contains both exotic and native aquatic vegetation including one noxious weed species **(Figure 5).** RFEF borders the oxidation pond.

Note that the oxidation pond directly north of the SSD is not within the boundary of Edmondson Regional Park and is not covered by management actions within this VMP

In addition, the vegetation surrounding the STP area may suffer from indirect impacts due to the removal works, however there is a buffer of degraded grasslands around most areas of infrastructure. The CPW and RFEF bordering these areas are in moderate condition; however the groundlayer typically has a high weed density (**Figure 6** and **Figure 7**).

2.2 Exotic species

Both environmental and noxious weeds are present within the remediation site and adjacent areas. Weeds declared noxious within the Liverpool LGA were recorded during a field inspection in late August 2015 (**Table 1**). Control of these weeds prior to any revegetation works is required.

Dense infestations of the grassy weed *Eragrostis curvula* (African Lovegrass) exist in the woodland to the south of the SSD. Vegetation bordering the STP to the north and west carry a heavy weed load with woody weeds dominating in the north and grassy weeds to the west.

It is strongly recommended that the retained vegetation adjacent to the rehabilitation area also undergo weed control procedures within a buffer of at least 10m. Coordination of revegetation and maintenance works in the remediation areas with weed control works by NPWS in adjacent woodland will reduce maintenance costs and improve biodiversity outcomes.

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Table 1: Noxious weeds

Scientific name	Common name	Noxious weed class	Required management action
Alternanthera philoxeroides	Alligator Weed	3	CLASS 3 (Regionally Controlled Weed) – *The plant must be fully and continuously suppressed and destroyed* CLASS 4 (Locally Controlled Weeds) – *The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Asparagus asparagoides	Bridal Creeper	4	
Bryophyllum delagoense *Bryophyllum x houghtonii*	Mother-of-millions	4	
Cestrum parqui	Green Cestrum	3	
Lantana camara	Lantana	4	
Ligustrum sinense	Small-leaved privet	4	
Lycium ferocissimum	African Boxthorn	4	
Olea europaea subs. cuspidata	African Olive	4	
Rubus sp.	Blackberry	4	
Senecio madagascariensis	Fireweed	4	

Figure 3: STP infrastructure site

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Figure 4: SSD east of STP (Stockpile site)

Figure 5: Oxidation Pond

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Figure 6: Buffer vegetation north of the STP

Figure 7: Buffer vegetation north of SSD

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3 Management

The revegetation areas have been divided into six management zones based on the removal works required (e.g. containment cell construction), the condition and type of the adjoining native vegetation and weed species and densities. These management zones have been based on the assumption that all areas included in this VMP will be revegetated; however this has not been finalised and management of revegetation will require a flexible approach with revegetation works implemented in those areas disturbed by remediation works, and staged as appropriate.

The VMP will be implemented by a suitably qualified bush regeneration contractor (**Appendix A**).

Management zones are shown in **Figure 8**.

3.1 Revegetation

Revegetation will be required across most of the management zones. This will be carried out by broad-scale direct seeding and tubestock planting. Above the containment cell, native grasslands will be created with no native canopy or tall shrubs. These areas will also offer a passive recreational area for future park visitors. When revegetation is undertaken in areas not above containment cells, open woodlands will generally be created including native canopy, a mid-storey and ground cover species.

Table 2 provides a summary of management strategies for each zone with **Table 3** providing the recommended density for plantings. With reference to each recommended structural level to be revegetated, it is recommended that the minimum number of individual species included is

- 4 tree species
- 8 shrub species and
- 10 ground covers including grasses.

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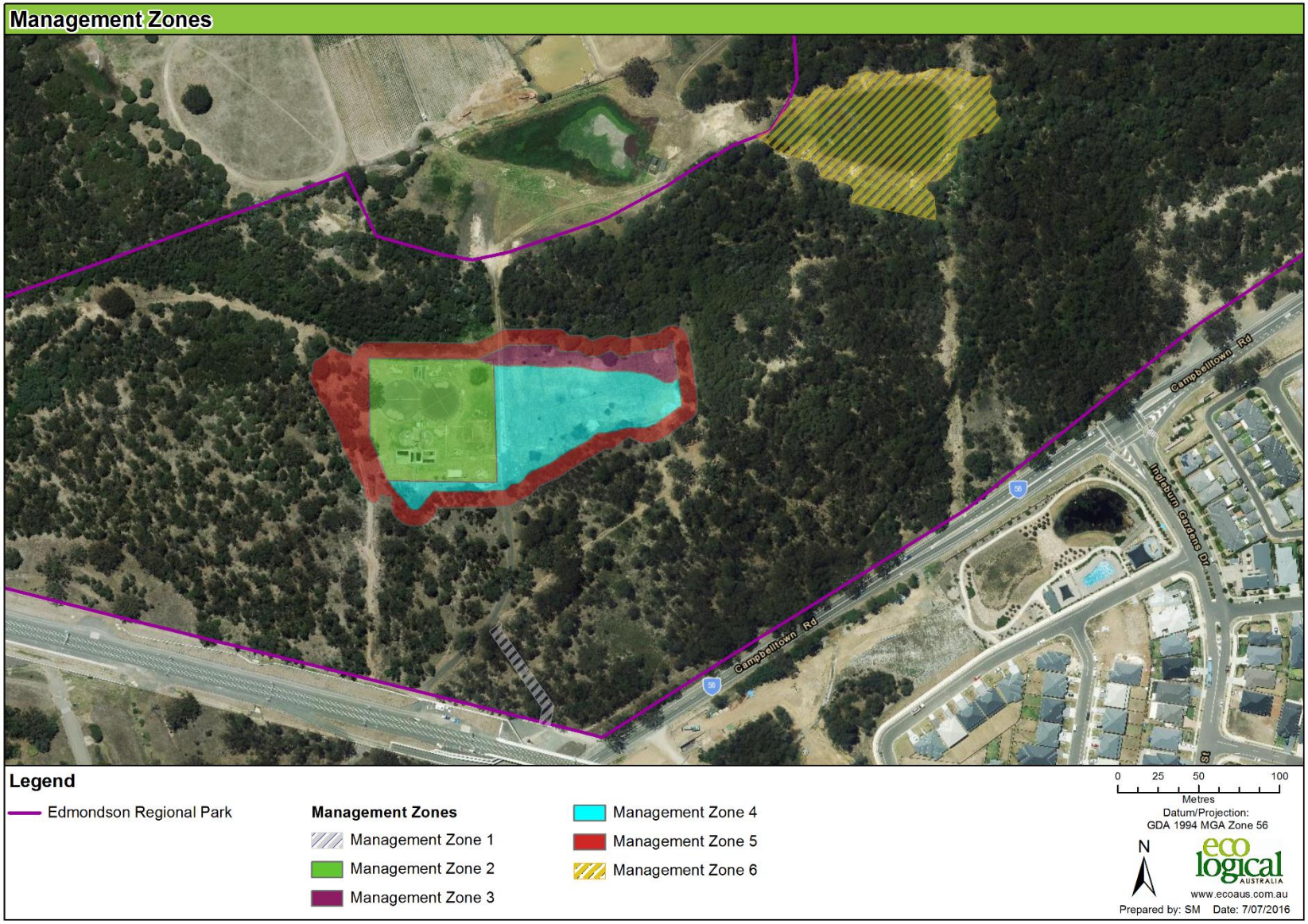

Figure 8: Management Zones

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3.2 Zone 1: Haul road edge

3.2.1 Zone description

Zone 1, an area of 0.05 ha, is the impact zone remaining following the establishment of a three metre wide temporary haul road joining Campbelltown Road with an existing road leading to the STP. The construction of this section of road is to avoid any mature trees representative of this vegetation community; however a number of juvenile eucalypts and shrub and groundcover vegetation will be removed or impacted. To manage indirect impacts, this zone includes an area approximately 2 to 3 m either side of the road which currently supports regenerating CPW with limited scattered trees.

3.2.2 Vegetation management

Revegetation of any disturbed soil adjacent to the new haul road linkage will be required following construction of the road.

Control of weeds, particularly grassy weeds, within this zone prior to significant vehicle movements will reduce the spread of weed seeds and propagules into the remediation areas. Additionally any weed species introduced during the STP remediation works within this zone will need to be controlled.

Weed Control

Weed control is to be undertaken within this zone immediately upon completion of the haul road linkage.

Site preparation

Topsoil removed from the haul road linkage path as part of road construction will be stockpiled separately and spread along the most disturbed areas of this zone as advised by the environmental manager.

Waste material and subsoil from the road construction must not be disposed within this zone.

Revegetation

Hand broadcasting of native grass seed is recommended for this zone. Some natural regeneration is expected from the topsoil native seed bank.

Maintenance

After seeding, this zone will need continual visual monitoring and re-watering as required to ensure survival.

Weed levels will need to be kept low across the zone to ensure plantings can establish without competition from weed species. Within this area, annual/perennial herbaceous weeds will be sprayed with a dicot specific herbicide as this will not affect the germination of native grass seeds. Maintenance of exotic grasses will need to be undertaken using a combination of hand removal, and careful spot spraying away from native grasses.

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3.3 Zone 2: CPW grasslands

3.3.1 Zone description

Zone 2, an area of 0.57 ha, includes the old sewage treatment plant site where a containment cell is proposed. This area currently contains exotic grassland and a limited number of small exotic trees.

Revegetation in Zone 2 will aim to produce a native grassland, with a diversity of grass and herb species from the vegetation community CPW.

Vegetation producing root structures which may threaten the integrity of the containment cell capping (e.g. trees and shrubs) is not to be used.

3.3.2 Vegetation management

The following systems are recommended to assist in delineating the boundary of the capped area to guide future revegetation works and to reduce the potential issue of tree roots growing into the capping material:

- posts secured into the ground
- locally sourced habitat logs from surrounding development areas.

Where the final outcome for any area within this zone is to be staged at a later date, the revegetation strategy in the short term is to include site preparation as below followed by seeding with a sterile cover crop to protect the area from erosion and weed infestation.

Site preparation

Where any containment cell is constructed, topsoil is to be installed to a minimum depth of 200mm. However any area which supports vehicle movements following final construction (e.g. access tracks) will require topsoil to a depth of 400mm to allow for ripping to a depth of 200mm prior to revegetation.

Revegetation

Revegetation will be undertaken using broad-scale direct seeding as specified in **Table 2** with species as listed in **Appendix B** to achieve the densities identified in **Table 3.**

Supplementary niche seeding may be required in this management zone two years after the initial direct seeding to improve cover and introduce additional species.

Maintenance

After seeding, this zone will need continual visual monitoring and re-watering as required to ensure survival.

Weed levels will need to be kept low across the zone to ensure plantings can establish without competition from weed species. Within this area, annual/perennial herbaceous weeds will be sprayed with a dicot specific herbicide as this will not affect the germination of native grass seeds. Maintenance of exotic grasses will need to be undertaken using a combination of hand removal, slashing/brush cutting prior to seed and careful spot spraying away from native grasses. Any temporary revegetation with sterile cover crops will also require weed management and control as described above.

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3.4 Zone 3: RFEF grassland/woodland

3.4.1 Zone description

The vegetation within this zone is currently exotic grassland and includes a limited number of small exotic and juvenile native trees. This zone has an area of 0.14 ha and borders the north east corner of the containment cell zone, and covers the northern portion of the SSD area (stockpile site).

The revegetation outcome for this zone will depend on the final desired vegetation structure and the impact of construction works. This VMP includes the below recommended actions for revegetation to a woodland structure across the whole zone; however this strategy may be applied to just those sections where a RFEF woodland is the final desired outcome, the alternative structure being a grassland.

Vegetation adjoining this management zone is RFEF which is in moderate condition with significant density of groundcover weeds. Revegetation within this zone will aim to extend the adjoining woodland and provide species diversity in accordance with the listing for this community. Alternatively herbs and grasses from this community will be installed to extend the community within the groundcover.

Revegetation in Zone 3 is to be undertaken following completion of construction works within the STP and SDD areas.

This zone may be impacted by the remediation works resulting in soil compaction.

3.4.2 Vegetation management

Weed Control

Where vegetation has not been removed during construction work, boom spraying of the grassland will be required to remove the exotic grass groundcover. This must be repeated six weeks after the initial treatment.

Spot spraying is to be undertaken along the boundary of this zone for weed control, avoiding natural regeneration of native species.

Site preparation
In areas for revegetation the following site preparation is required:

- Ripping to a depth of 200mm
- Where tubestock planting occurs mulching to a depth of 100mm will be installed, and where direct seeding is carried out, mulch will be applied as a light cover providing only 70% cover at 10mm depth.

Revegetation

Revegetation will be undertaken as specified in **Table 2** with species as listed in **Appendix B** to achieve the densities identified in **Table 3**. These tables provide alternative strategies to direct revegetation works for the outcome of either a grassland structure or a woodland structure.

Maintenance

Once installed, plants will need continual visual monitoring and re-watering as required to ensure survival.

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Weed levels will need to be kept low across the zone to ensure plantings can establish without competition from weed species. Maintenance weeding is to be undertaken by either brush cutting prior to seed set, spot spraying or hand weeding.

3.5 Zone 4: CPW grassland / woodland

3.5.1 Zone description

The vegetation within this zone is currently exotic grassland and borders a containment cell zone. Revegetation of the south west section of this zone is recommended as an offset for the vegetation removal for the Haul road extension.

Vegetation adjoining this management zone is regenerating CPW which is in moderate condition with a heavy infestation of *Eragrostis curvula*. Revegetation within this zone will aim to extend the adjoining woodland and provide species diversity in accordance with the listing for this community. Alternatively the SDS section of this zone will be revegetated to a CPW grassland structure; however it is recommended that at least 1,500 m^2 is revegetated to achieve a woodland structure to satisfy offset requirements.

This zone may be impacted by construction works resulting in soil compaction.

3.5.2 Vegetation management

Weed Control

Where vegetation has not been removed during construction work, boom spraying of the grassland will be required to remove the exotic grass groundcover. This must be repeated six weeks after the initial treatment.

Weed control along the boundary of this zone is to be undertaken by slashing *Eragrostis curvula*, followed by spot spraying of regrowth. During spot spraying care must be taken to avoid natural regeneration of native species.

Site preparation

In areas for revegetation the following site preparation is required:

- Ripping to a depth of 200mm
- Where tubestock planting occurs mulching to a depth of 100mm will be installed, and where direct seeding is carried out, mulch will be applied as a light cover providing only 70% cover at 10mm depth

Revegetation

Revegetation will be undertaken using both tubestock planting and direct seeding as specified in **Table 2** with species as listed in **Appendix B** to achieve the densities identified in **Table 3.** These tables provide alternative strategies to direct revegetation works for the outcome of either a grassland structure or a woodland structure.

Maintenance

Once installed, plants will need continual visual monitoring and re-watering as required to ensure survival.

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Weed levels will need to be kept low across the zone to ensure plantings can establish without competition from weed species. Maintenance weeding is to be undertaken by either brush cutting prior to seed set, spot spraying or hand weeding.

3.6 Zone 5: Buffer zone

3.6.1 Zone description

Management Zone 5 is a buffer zone where weed control works will limit the transfer of weeds from adjacent areas to the remediated areas, providing a greater probability of achieving the desired outcome.

This zone incorporates both CPW and RFEF in moderate condition with resilience observed in all strata.

Weed density is high in sections of this zone, with a number of noxious weeds recorded.

Weed Control

Weed control is the primary management action prescribed for this zone. Control is to be carried out by spot spraying with non-selective herbicide, cut and paste control and hand control. Methods will be determined by the weed type targeted.

Primary weed control is to be completed prior to any revegetation works, with secondary and maintenance works to be carried out in unison with works in Zones 1 to 4.

Figure 9 Noxious weed within the buffer zone

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3.7 Zone 6: RFEF Woodland

3.7.1 Zone description

Zone 6, an area of 0.83 ha, covers the north east oxidation pond and surrounding embankments. The final land-use of this zone has not been finalised; however if the oxidation pond is to be filled, this VMP provides a revegetation strategy which will aim to produce a native woodland.

The current vegetation immediately surrounding the oxidation pond is dominated by exotic grasses and weed species, with vegetation further away RFEF in moderate condition. Regenerating native species are encroaching into the exotic dominated area.

3.7.2 Vegetation management

Weed Control

Where vegetation has not been removed during construction work, boom spraying of the grassland will be required to remove the exotic grass groundcover. This must be repeated six weeks after the initial treatment.

Spot spraying is to be undertaken along the boundary of this zone for weed control, avoiding natural regeneration of native species.

Site preparation

In the oxidation pond remediation portion, topsoil is to be installed to a depth of 200mm over this area. However any area which supports vehicle movements following final construction (e.g. access tracks) will require topsoil to a depth of 400mm to allow for ripping to a depth of 200mm prior to revegetation

In areas of tubestock revegetation (i.e. outside of the remediated pond section), the following site preparation is required:

- Ripping to a depth of 200mm.
- Mulching to a depth of 100mm

Revegetation

Revegetation will be undertaken using both broad-scale direct seeding and tubestock as specified in **Table 2** with species as listed in **Appendix B** to achieve the densities identified in **Table 3**.

Maintenance

After seeding and planting, the areas will need continual visual monitoring and re-watering as required to ensure survival.

Weed levels will need to be kept low across the zone to ensure plantings can establish without competition from weed species. Herbicide application will be restricted in these areas in order not to harm germinating native dicot shrubs and canopy species. Accordingly maintenance weed control will be undertaken largely by hand removal until native species are well established.

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Table 2: Management strategies

Zone	Description	Vegetation community	Estimated Area (m^2)	Management strategy	Direct seeding (m^2)	Tubestock planting (m^2)
1	Haul road edge	CPW	700	Direct seeding	700	
2	CPW grassland	CPW	5,700	Direct seeding	5,700	
3*	RFEF grassland	RFEF	1,400	Direct seeding	1,400	
	RFEF woodland	RFEF		Tubestock planting - 60% Direct seeding – 40%	560	840
4*	CPW grassland and woodland	CPW	6,000	Tubestock planting – 1400m^2 (offset) Direct seeding	4,600	1,400
	CPW woodland	CPW		Tubestock planting - 40% Direct seeding – 60%	3,600	2,400
5	Buffer zone	CPW & RFEF	6,800	Weed control		
6	RFEF woodland	RFEF	8,300	Tubestock planting - 40% Direct seeding – 60%	4970	3,330
Total			**28,900**			

* Alternative vegetation structures for zones 3 and 4

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Table 3: Revegetation densities

Zone	Description	Revegetation Area (m^2)	Total plant number/ seed equivalent requirements				
			Tree	Shrub	Herbs / Scramblers	Sedges / Grass	*Total*
1	Haul road edge	700			1/m^2	3/m^2	*2,800*
2	CPW grassland	5,700			1/m^2	3/m^2	*22,800*
3*	RFEF grassland	1,400			1/m^2	4/ m^2	*7,000*
	RFEF woodland	1,400	1/25m^2	1/6m^2	1/m^2	3/m^2	*5,890*
4*	CPW grassland	6,000			1/m^2	3/m^2	*24,000*
	CPW woodland	6,000	1/25m^2	1/6m^2	1/m^2	3/m^2	*25,240*
5	Buffer zone	6,800	-	-	-	-	-
6	RFEF woodland	8,300	1/25m^2	1/6m^2	1/m^2	3/m^2	*34,900*
Total		**29,200**					

*Alternative vegetation structures for zones 3 and 4

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4 Monitoring and Reporting

Monitoring of the subject site is required for a minimum of 5 years after each revegetation stage or until the objectives of the VMP are achieved. The monitoring program will identify and confirm successive vegetation changes in the landscape that reflect the aims of the VMP. The annual monitoring results should also be used to assist in the management of the site, using an adaptive management framework.

Regular monitoring and annual report is required as part of the VMP process. This will assist in the early detection of key issues such as failure to thrive. The monitoring will consist of annual photo monitoring and assessment of the weed densities, foliage cover and planting success rate; and half yearly progress reports. Monitoring should be undertaken by either an Environmental Consultant or Ecologist. Photo monitoring points should be established prior to revegetation works.

4.1 Photo monitoring

Photo monitoring points will be established across the site to provide a visual reference of changes in the vegetation through time. This will be undertaken prior to the commencement of planting works and at the beginning of each summer season. The bush regeneration contractor will:

- set up one photo monitoring point in each zone
- mark the photo point with a six foot star picket and record location using GPS. For Zone 2 and 3 where star pickets are not appropriate, place an appropriate marker (eg stone cairn)
- take a digital photo of each photo point with the star picket or marker visible in the photo to act as a reference point
- organise the digital photos logically with each image labelled with a unique reference number indicating the location of the photo point and the date the photo is taken.

4.2 Reporting

The bush regeneration contractor will monitor the vegetation for changes over time. The objective of the monitoring and reporting program is to record changes to the vegetation as a result of vegetation management works. Monitoring works will require liaison with a NPWS (OEH) representative.

The bush regeneration contractor will establish photo monitoring points as above and prepare regular reports to describe the progress of their work and demonstrate compliance with the VMP. Reports will include a brief 6-monthly work report and an annual audit and assessment of compliance with the performance criteria in **Section 4.3**.

4.3 Performance criteria

The progress and compliance with the VMP will be monitored and reviewed annually. This process will involve the contractor(s), UGNSW and then NPWS following handover. This information will be integrated into the monitoring reports. If required, reporting will be followed by a site visit to discuss.

Performance criteria are detailed in **Table 4**.

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Table 4: Performance criteria (coordinated with construction staging)

Treatment Zones	Year 1	Year 2	Year 3	Year 4	Year 5
All zones	• Commencement of all tasks outlined in the VMP or evidence of planning for their implementation. • A demonstrated increase in native cover and diversity and a demonstrated decrease in exotic cover and diversity by the end of Year 5.				
Zones 1 and 2	Exotic groundcover no greater than 20%.		Exotic groundcover no greater than 10%.	Exotic groundcover no greater than 5%.	
	Native vegetation groundcover no less than 20% of each zone	Native vegetation groundcover no less than 40% of each zone	Native vegetation groundcover no less than 60% of each zone	Native vegetation groundcover no less than 70% of each zone	Native vegetation groundcover no less than 80% of each zone
Zones 3 and 4 (Zone 6 if oxidation pond remediated)	Exotic groundcover no greater than 10%.		Exotic groundcover no greater than 5%.		
	Native vegetation groundcover no less than 20% of each zone	Native vegetation groundcover no less than 40% of each zone	Native vegetation groundcover no less than 60% of each zone	Native vegetation groundcover no less than 70% of each zone	Native vegetation groundcover no less than 80% of each zone
	A minimum of 85% survival rate of all revegetation. 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 must be from the community being emulated and of local provenance				
Zone 5	Native vegetation groundcover no less than 10% of zone	Native vegetation groundcover no less than 20% of zone	Native vegetation groundcover no less than 40% of zone	Native vegetation groundcover no less than 60% of zone.	
	Exotic groundcover no greater than 40%.	Exotic groundcover no greater than 30%.	Exotic groundcover no greater than 20%.	Exotic groundcover no greater than 10%.	
	95% of all adult woody weeds to be controlled No individual woody weeds allowed to set seed and all seeding individuals removed No establishment of new noxious or woody species				

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5 Implementation schedule

A schedule to direct the implementation of this VMP is provided below in **Table 5**. These works are to be staged along with construction works

Table 5: Implementation schedule

Treatment Zones	Year 1	Year 2	Years 3	Years 4 and 5
Zone 1	Primary control of all weeds	Maintenance weed control		
	Direct seeding			
	Monitoring and reporting biannually		Monitoring and reporting annually	
Zone 2	Primary weed control	Maintenance weed control		
	Direct seeding with irrigation			
	Monitoring and reporting biannually		Monitoring and reporting annually	
Zones 3 and 4	Primary weed control	Maintenance weed control		
	Direct seeding with irrigation	Tubestock planting if required	Replacement planting to achieve performance criteria	
	Monitoring and reporting biannually		Monitoring and reporting annually	
Zone 5	Primary control of all weeds	Secondary control of all weeds	Secondary control of all weeds	Maintenance weed control
	Monitoring and reporting biannually		Monitoring and reporting annually	
Zone 6 (if oxidation pond remediated)	Primary control of all weeds	Maintenance weed control		
	Direct seeding in area of pond remediation			
	Tubestock planting in areas with low resilience	Replacement planting to achieve performance criteria		
	Monitoring and reporting biannually		Monitoring and reporting annually	

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Appendix A 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 OEH (2013). 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.

Exotic grasses

Exotic grasses, such as *Eragrostis curvula* (African Lovegrass), *Paspalum dilatatum* (Paspalum) and *Pennisetum clandestinum* (Kikuyu 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.

Annual / perennial herbaceous weeds

Where individual plants are found, and where intermixed with native groundcovers they will be hand pulled or slashed prior to flowering. Where large swaths of these species occur or where intermixed only with native grasses they will be sprayed using a 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.

Woody weeds

Woody weeds onsite in particular *Lantana camara* (Lantana), *Lycium ferocissimum (Afircan Boxthorn)* and *Olea europaea* subsp. *cuspidata.* (African Olive) 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.

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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, 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.

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

Revegetation has the aims of re-establishing the original native vegetation community at the site, creating habitat for flora and fauna and reducing erosion.

For broad-scale direct seeding, works will be undertaken using the local provenance native seed mix as per the groundcover and shrub species identified in **Appendix B** to achieve the required densities. Direct seeding is to be implemented by either broadcast followed by a 70% mulch cover, or hydro-mulching. Broadcasting is suitable for an area of this size and will produce a more random and therefore more natural placement of individuals. Direct seeding is to be implemented soon after weed free topsoil is instated.

Following seeding the site 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.

Tubestock revegetation will be undertaken using tubestock of hiko cells 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.

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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.

Tree guards may 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.

Plants should be installed in spring or autumn months, to take advantage of suitable weather conditions for planting. 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.

Provenance plant / seed supply

Any plantings or native seed to be utilised should consist of suitable provenance stock. Current research suggests that seed sourcing should concentrate less on 'local' collection and more on capturing high quality and genetically diverse seed in order to maximise the adaptive potential of restoration efforts to current and future environmental change. Florabank's collection guidelines reflect this emerging understanding and advise that, while seed should be collected as locally as possible, the matching of environmental conditions at the planting site with those of the collection location is the most important consideration in establishing the collection range.

Recommended species have been provided in **Appendix B**.

Bush regeneration contractors

All vegetation management works in the establishment phase will be undertaken by suitably qualified and experienced bush regeneration contractors who are members of the Australian Association of Bush Regenerators or fulfil the membership criteria. In addition to this, team leaders should have, as a minimum, a Certificate III in Conservation & Land Management or equivalent. The contractor will need to carry out best practice bush regeneration techniques as described by Buchanan (2009). A flexible approach to this site is recommended since techniques may need to be changed or modified to suit site conditions. This approach is consistent with adaptive management and allows the contractor to develop and build on site knowledge whilst implementing this VMP. Monitoring will assist in the development of the VMP actions in subsequent years.

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Appendix B Revegetation species list

Type	Scientific name	Common name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6
			CPW	CPW	RFEF	CPW	RFEF
Tree Canopy Species (>10m)	*Angophora bakeri*	Narrow-leaved Apple				X	
	Angophora floribunda	Rough-barked Apple			X	X	X
	Angophora subvelutina	Broad-leaved Apple			X	X	X
	Casuarina glauca	Swamp Oak			X		X
	Corymbia maculata	Spotted Gum				X	
	Eucalyptus amplifolia	Cabbage Gum			X	X	X
	Eucalyptus crebra	Narrow-leaved ironbark				X	
	Eucalyptus eugenioides	Thin-leaved Stringybark				X	
	Eucalyptus moluccana	Grey Box			X	X	X
	Eucalyptus tereticornis	Forest Red Gum			X	X	X
Small Trees / Tall shrub Species	*Acacia falcata*						
	Acacia floribunda	White Sally			X	X	X
	Acacia parramattensis	Parramatta wattle			X	X	X
	Acacia implexa	Lightwood				X	
	Breynia oblongifolia	Coffee bush			X		X
	Bursaria spinosa	Blackthorn			X	X	X
	Daviesia ulicifolia	Gorse bitter pea				X	
	Dillwynia sieberi	-				X	

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Type	Scientific name	Common name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6
			CPW	CPW	RFEF	CPW	RFEF
	Dodonaea viscosa subsp. cuneata	Wedge-leaf Hop-bush				X	
	Indigofera australis	Australian Indigo				X	
	Melaleuca styphelioides	Prickly-leaved Tea Tree			X		X
	Ozothamnus diosmifolius	White Dogwood			X		X
	Pultenaea microphylla	-				X	
Sedges, Rushes, Reeds & Grasses	*Aristida ramosa*	Purple Wiregrass	X	X		X	
	Aristida vagans	Threeawn Speargrass	X	X		X	
	Bothriochloa decipiens	Redleg Grass	X	X		X	
	Bothriochloa macra	Red Grass	X	X		X	
	Chloris divaricata	Slender Chloris	X	X		X	
	Chloris truncata	Windmill Grass	X	X		X	
	Chloris ventricosa	Plump windmill brass	X	X		X	
	Carex appressa	Tall Sedge		X	X		X
	Carex inversa	-				X	
	Cymbopogon refractus	Barbed-wire Grass	X	X	X	X	X
	Cyperus gracilis	Slender Flat-sedge		X		X	
	Dichelachne micrantha	Shorthair Plumegrass	X	X	X	X	X
	Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass	X	X	X	X	X
	Echinopogon ovatus	Forest Hedgehog Grass	X	X	X	X	X
	Entolasia marginata	Bordered panic		X	X		X

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Type	Scientific name	Common name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6
			CPW	CPW	RFEF	CPW	RFEF
	Eriochloa pseudoacrotricha	Early Spring Grass				X	
	Imperata cylindrica	Blady Grass		X	X		X
	Juncus usitatus	Common Rush				X	
	Lomandra filiformis	-		X	X	X	X
	Lomandra longifolia	Spiny-head Mat-rush		X	X		X
	Lomandra multiflora subsp. multiflora	-			X	X	X
	Microlaena stipoides var. stipoides	Weeping Meadow Grass	X	X	X	X	X
	Oplismenus aemulus	Australian Basket Grass		X	X		X
	Poa labillardieri var. labillardieri	Tussock Grass	X			X	
	Rytidosperma caespitosum	Ringed Wallaby Grass	X	X		X	
	Rytidosperma racemosa var. racemosa	-	X	X		X	
	Themeda triandra	Kangaroo Grass	X	X	X	X	X
Groundcover Species & Vines/Scramblers	*Brunoniella australis*	Blue Trumpet		X		X	
	Centella asiatica	Indian Pennywort		X	X	X	X
	Clematis glycinoides	Old Man's Beard		X	X	X	X
	Commelina cyanea	Creeping Christian		X	X	X	X
	Desmodium varians	Slender Tick-trefoil		X		X	
	Dianella longifolia	Blueberry Lily		X		X	

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Type	Scientific name	Common name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 6
			CPW	CPW	RFEF	CPW	RFEF
	Dichondra repens	Kidney Weed		X	X	X	X
	Geranium solanderi	Native Geranium		X	X	X	X
	Glycine clandestina	Twining Glycine		X		X	
	Glycine microphylla	Small-leaf glycine		X		X	
	Goodenia hederacea subsp. *Hederacea*	Ivy Goodenia		X		X	
	Hardenbergia violacea	Purple Coral Pea		X	X	X	X
	Phyllanthus virgatus	-		X		X	
	Pratia purpurascens	Whiteroot		X	X	X	X
	Plectranthus parviflorus	Cockspur flower		X	X	X	X
	Veronica plebeia	Creeping Speedwell		X	X	X	X
	Wahlenbergia gracilis	Sprawling Bluebell		X	X	X	X

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