Aspect Industrial Estate - Vegetation Management Plan

Mirvac Projects Pty Ltd

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

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Project Manager	Rebecca Ben-Haim
Prepared by	Rebecca Ben-Haim and Claire Wheeler
Reviewed by	Alastair Jones
Approved by	David Bonjer
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Template 2.8.1

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Abbreviations

Abbreviation	Description
BC Act	*Biodiversity Conservation Act 2016*
DA	Development Application
ELA	Eco Logical Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
MZ	Management Zone
NRAR	Natural Resources Access Regulator
NVR	Native Vegetation Retention
PCT	Plant Community Type
RFEF	River-flat Eucalypt-forest
VMP	Vegetation Management Plan
WM Act	*Water Management Act 2000* (NSW)
WoNS	Weed of National Significance

1. Introduction

This vegetation management plan (VMP) has been prepared by Eco Logical Australia Pty Ltd (ELA) on behalf of Mirvac Projects Pty Ltd (Mirvac) for the proposed Aspect Industrial Estate development at Mamre Road, Kemps Creek (Lots 54-58 DP 259135) (Figure 1). This site is located within the Penrith City Council Local Government Area (LGA).

1.1 Background

The site is to be redeveloped for offices, warehouses, carparks and associated infrastructure including access roads and stormwater infrastructure. The site will also contain landscaped areas and a conservation riparian corridor.

There are two mapped unnamed waterways within the Aspect Industrial Estate development area. The first order watercourse mapped within the south east and centre of the development area did not meet the definition of a watercourse (Figure 2). A defined channel was observed within the north western section of the development area, where the second order watercourse was mapped (Figure 2).

As part of the proposed Aspect Industrial Estate development, Mirvac wish to realign the validated second order watercourse through the construction of a swale. The civil designs and the typical riparian corridor cross section can be found in Appendix A.

This VMP has been prepared in accordance with the *Guidelines for Vegetation Management Plans on Waterfront Land* (Office of Water, 2012) and has been prepared in consideration of Penrith City Council's Development Control Plan 2014. This VMP has also been prepared based on current best practice and is consistent with the Natural Resources Access Regulator (NRAR) Guidelines, including provision of indicative costs for management actions.

1.2 Objectives of the Vegetation Management Plan

The overall objectives of the VMP are to establish native species cover and density along the realigned riparian corridor by revegetation works. The initial maintenance period will run for five years or until the objectives and performance criteria outlined in this VMP are met. The objectives for the VMP are summarised in Table 1.

Table 1: VMP Objectives

Objectives	Approach
Reinstate native vegetation along the realigned watercourse and maintain ecological health (species composition and structure) within 5 years.	• Rehabilitate and revegetate riparian corridor using appropriate native species • Maintenance weed control • Control of priority and environmental weeds and prevent new outbreaks • Assist in the natural regeneration of species across the VMP area • Addition of logs and artificial hollows
Stabilise bed and bank along 800 m of realigned creek.	• Sandstone boulders or blocks used to protect the outside of the channel meander in the north west area of the site • 'Soft engineering' approach with a focus on planting locally native species

1.3 Key Terms

For the purpose of this VMP, the following terminology has been adopted:

- Subject site: Lots 54 – 58 DP 259135
- Development area: The proportion of the study area to be developed, specifically the proposed lots and roads. This area is outside the scope of the VMP area.
- VMP area: The proportion of the study area to be rehabilitated and conserved by this VMP specifically.

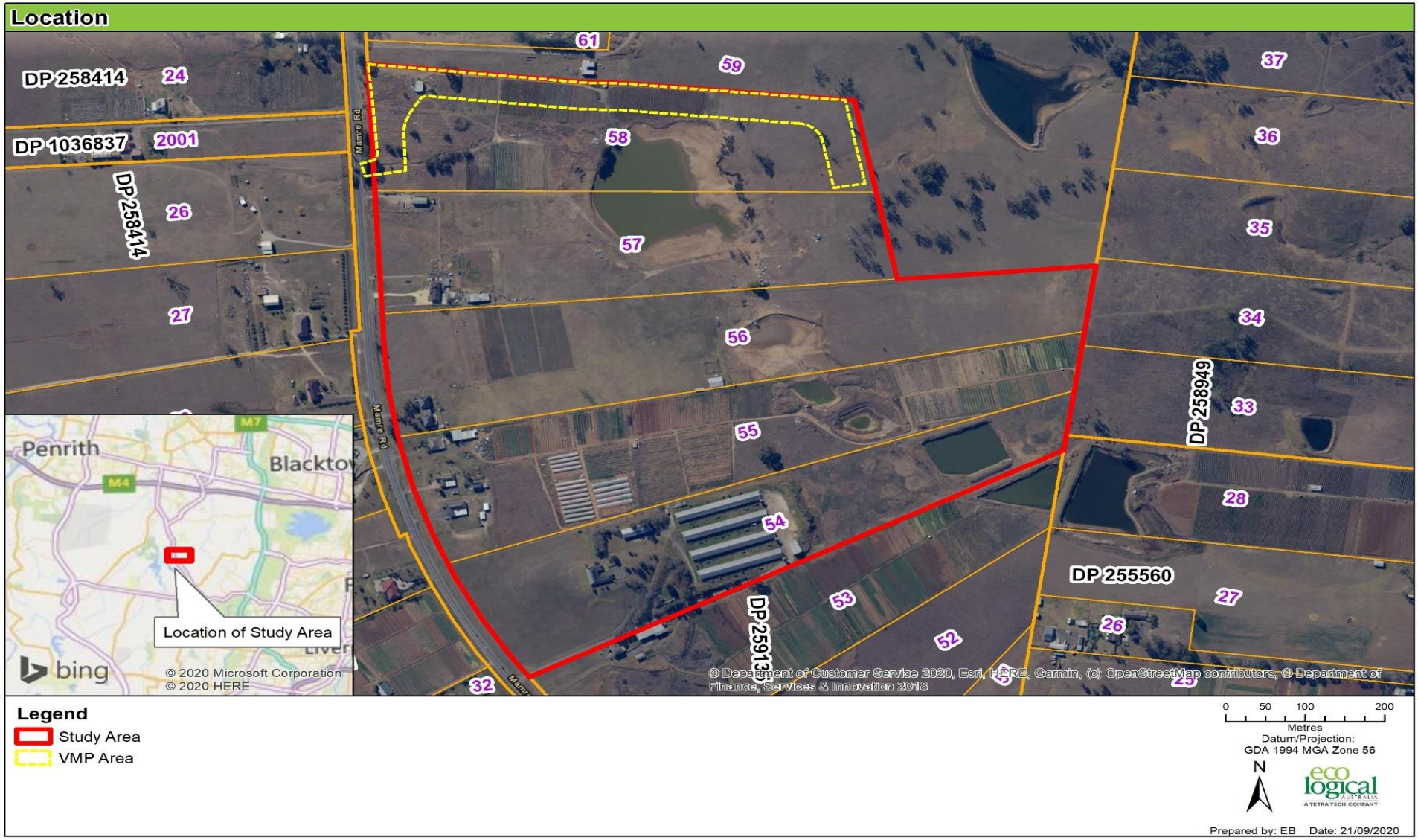

Figure 1: Location of development and VMP areas

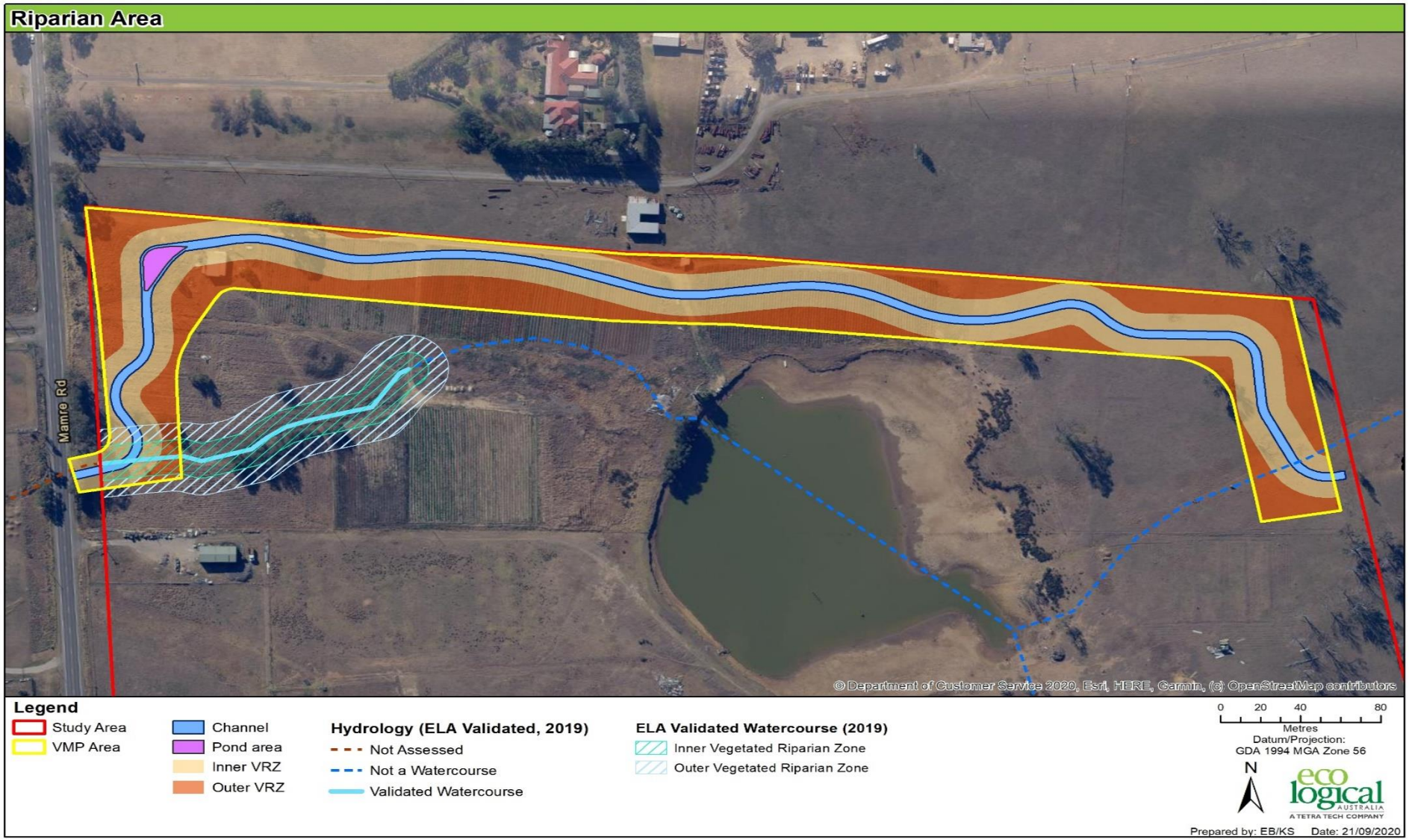

Figure 2: Validated watercourses within the VMP area

2. Description of the Environment

2.1 Location

The study area is located within the Penrith City Council LGA. It is bound by Mamre Road to the west and rural land to the east, north and south. The site is currently zoned IN1 (General Industrial), E2 (Environmental Conservation) with a small part zoned as SP2 (Infrastructure) in accordance with the *State Environmental Planning Policy (Western Sydney Employment Area) 2009* (WSA SEPP).

2.2 Soils and Topography

The topography of the study area gently slopes to the west to South Creek. The VMP area is located on both the Blacktown and South Creek residual soil landscapes. The Blacktown soil landscape is characterised by undulating slopes on soils derived from Wianamatta Group shales. The South Creek soil landscape is characterised by floodplains, valley flats and drainage depressions, which are usually flat with incised channels.

2.3 Drainage and Hydrology

There are two mapped unnamed waterways within the Aspect Industrial Estate development area, which are tributaries of South Creek. Within the development area there are also six farm dams, most of which have limited adjoining riparian and / or fringing vegetation and poor aquatic habitat values.

The first order watercourse mapped within the south east and centre of the development area had no indicative features of a waterway. A defined channel was observed along the mapped second order watercourse within the north western section of the development area (Figure 2). The defined watercourse started downstream of the sixth dam, starting at a patch of *Phragmites australis* (Common Reed) and flowing through the site in a westerly direction towards Mamre Road.

Downstream of the area of *P. australis*, the channel passed through an area of dense *Cenchrus clandestinus* (Kikuyu Grass) and scattered *Casuarina glauca* (Swamp She-oak) trees at the top of the creek bank. Roughly 20 m upstream of the Lot 58 boundary fence, the channel widens to approximately 2.5 m and there was a small amount of standing water in the creek line. There was a break in the riparian vegetation in this section of the watercourse, with no *C. glauca* present at the top of bank. However, there was more instream vegetation including the native species *Persicaria decipiens* (Slender Knot weed), *Alternanthera* sp. and the exotic species *Rumex crispus* (Curled Dock).

At the western extent of Lot 58, the creek flows under Mamre Road through three box culverts, each approximately 0.8 m high and 1.5 m wide. Each culvert has a brick wingwall extending out to the northern and southern end. This area also appeared to collect roadside drainage from the north and south of Lot 58 along Mamre Road.

Further information can be found in the Aspect Industrial Estate Riparian Assessment (ELA, 2020).

2.4 Vegetation Communities

2.4.1 River-Flat Eucalypt Forest

The remnant native vegetation community *PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion* was present along the validated second order watercourse in poor condition. PCT 835 is listed as *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* Endangered Ecological Community (EEC) under the BC Act 2016. River-flat Eucalypt Forest on site consisted of a canopy dominated by *C. glauca,* an absent midstorey and an understorey comprised of predominately exotic species including *Plantago lanceolata* (Plantain), *Senecio madagascariensis* (Fireweed)*, Paspalum dilatatum* (Common paspalum) and *Cirsium vulgare* (Spear thistle).

2.4.2 Cleared/Exotic

The cleared land within the VMP area was dominated by exotic species including *P.lanceolata*, *S. madagascariensis, P. dilatatum* and *C. vulgare.*

2.5 Flora Species

A total of 17 flora species were identified within the VMP area during the site inspection, of which one was a native species and 16 were exotic species (Appendix B).

No threatened flora species were recorded within the VMP area during the field inspection**.**

2.6 Priority Weeds

Sixteen exotic species were recorded in the VMP area. One of these is a listed priority weed in the Greater Sydney region under the *Biosecurity Act 2015* and one of these is listed as a Weed of National Significance (WoNS). WoNS and priority weeds including their required duties under the *Biosecurity Act 2015* are shown in Table 2.

Appropriate control measures for priority and environmental weeds are provided in Appendix D.

Table 2: Priority weed species recorded in the study area

Scientific Name	Common Name	WoNS	Priority Level	Priority Weed Objective
Senecio madagascariensis	Fireweed	Yes	State	Asset Protection

3. Management Zones

The VMP area of approximately 3.34 ha, will be entirely managed. The management works for this VMP are focused on weed control and revegetation. The VMP area consists of four management zones as identified below and in Figure 3.

- Zone 1: Low Flow Channel with Aquatic Macrophytes – Weed Control and Aquatic Macrophyte Revegetation
- Zone 2: High Flow Channel with Low Density Plantings
- Zone 3: Embankment with High Density Plantings
- Zone 4: Pond Area with Aquatic Macrophytes

3.1 Management Overview

An assessment of the native resilience and weed densities was conducted during field surveys. The vegetation within the VMP area is in poor condition. Weed densities are high in the ground layer and no mid-storey or canopy exists.

Weeds within the landscaped area adjacent to the VMP area will require maintenance to prevent the continued incursion of weeds into the VMP area. This will best be achieved by regular mowing or ongoing weed control along the interface of the VMP area and the landscape area.

3.2 Management Zones

For the management zones, specific weed control measures and revegetation methods are detailed in Appendix D. Monitoring will be conducted across all zones and will be used to adaptively manage the type and intensity of follow-up treatments.

3.2.1 Management zone 1 (MZ1) – Low Flow Channel with Aquatic Macrophytes - Weed Control and Aquatic Macrophyte Revegetation

3.2.1.1 General Description

This management zone encompasses 1.18 ha of exotic grassland. After the construction of the channel, this zone will be revegetated with native aquatic macrophyte species, creating a low flow channel with a minimum width of 3.75 m.

The low flow channel may be used as a detention basin for sediment during the construction works onsite and be converted into a channel after construction works are finished. All accumulated sediment would need to be removed prior to revegetation. No jute matting is to be installed as this will impact on the filtration of the channel.

Once the low flow channel is constructed, approximately 80% of this zone is expected to require revegetation to reinstate native sedge and rush species. Species selection and placement will be dependent on the final design of the channel. Sedges and rushes will be planted into areas prone to prolonged inundation.

The key management priorities and required management actions are:

- Tubestock planting across the majority of the zone.
- Control of exotic grasses and other exotic species.
- Monitor native vegetation and weed densities.

3.2.2 Management Zone 2 (MZ2) – High Flow Channel with Low Density Plantings - Weed Control and River-flat Eucalypt-forest Revegetation

3.2.2.1 General description

This management zone encompasses 0.39 ha of exotic grassland. After the construction of the channel, this zone will be predominantly revegetated with ground cover and mid-storey species consistent with the vegetation community River-flat Eucalypt-forest to compensate for the impact to this community during development. The majority of this zone is expected to require revegetation to reinstate the River-flat Eucalypt-forest vegetation community.

The key management priorities and required management actions are:

- Tubestock planting across entire zone.
- Control of exotic grasses and other exotic species.
- Monitor native vegetation and weed densities.

3.2.3 Management Zone 3 (MZ3) – Embankment with High Density Plantings - Weed Control and River-flat Eucalypt-forest Revegetation

3.2.3.1 General description

This management zone encompasses 1.74 ha of exotic grassland. After the construction of the channel, this zone will be entirely revegetated with species consistent with the vegetation community River-flat Eucalypt-forest to compensate for the impact to this community during development. The entirety of this zone is expected to require revegetation to reinstate the River-flat Eucalypt-forest vegetation community, including canopy species.

The key management priorities and required management actions are:

- Tubestock planting across entire zone.
- Control of exotic grasses and other exotic species
- Monitor native vegetation and weed densities

3.2.4 Management Zone 4 (MZ4) – Pond Area with Aquatic Macrophytes

3.2.4.1 General description

This zone currently encompasses 0.03 ha of exotic grassland. After construction of the pond area, this zone will be revegetated with native emergent macrophytes.

The construction of the pond will allow for treatment of stormwater quality before it leaves the site.

The key management priorities and required management actions are:

- Tubestock planting across the majority of the zone.
- Control of noxious aquatic species.
- Monitor sediment accumulation within the pond.

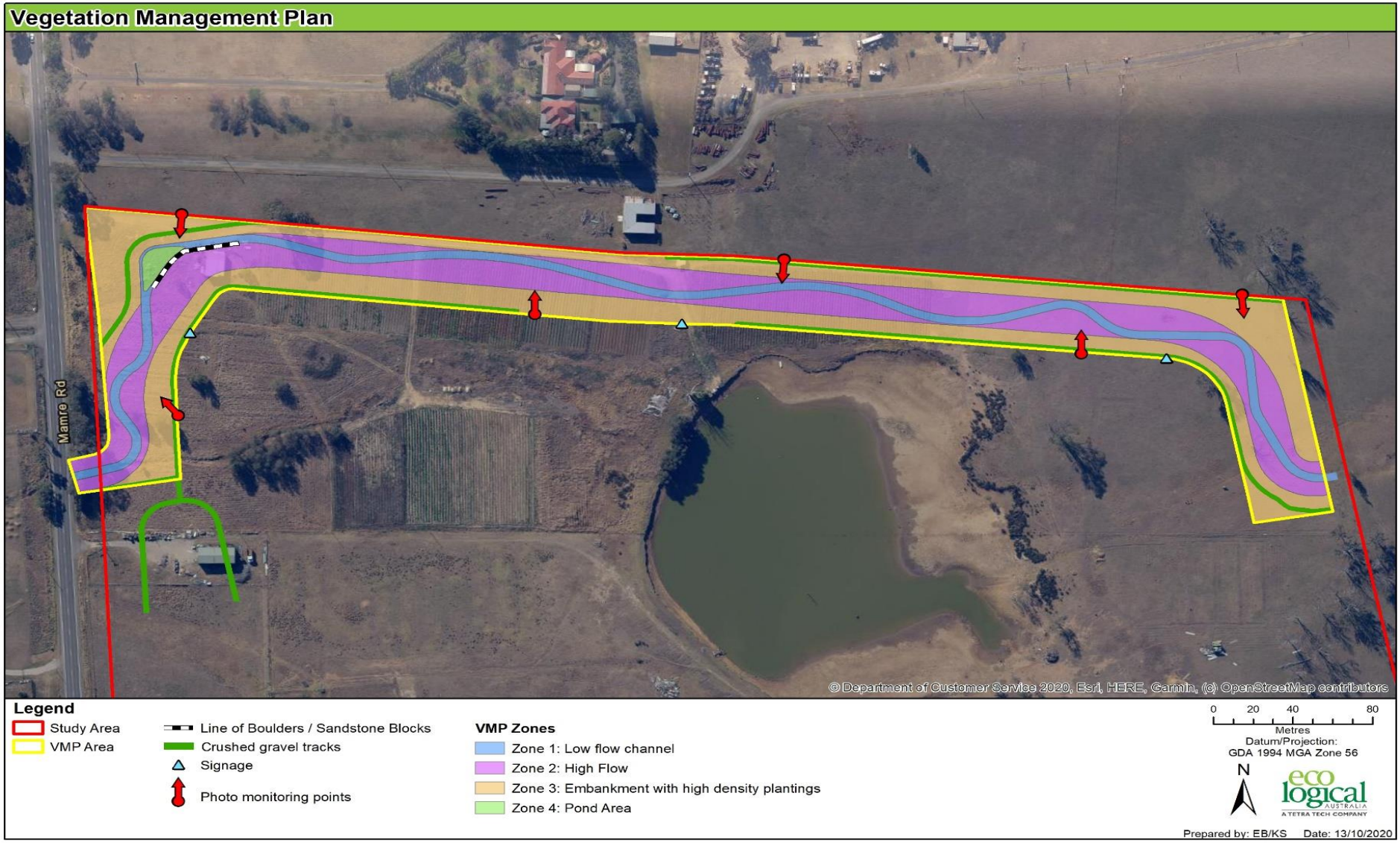

Figure 3: VMP Management Zones

4. Construction and Management Works

Preliminary works relating to the VMP are to occur either before or whilst development is occurring onsite. All works are assumed to be undertaken by the developer or the civil construction company.

4.1 Earthworks and Construction of the Riparian Channel

During construction activities, all timber from native trees within the development area should be retained onsite, with mulch stockpiled for use within the VMP area, all viable seed and genetic material to be collected and all timber cut into logs to be utilised as habitat for native fauna.

4.2 Fencing and Interpretive Signage

After completion of the construction of the riparian corridor, fencing must be installed to prevent encroachment of civil machinery and compaction of soil during the revegetation period. Temporary construction fencing should consist of star pickets with highly visible plastic mesh or similar. Temporary fencing must not be placed outside of the clearing limits.

Temporary informational signage must be installed around the site as needed to convey the works that are being undertaken and the final strategy for the site. The exact information and location of these signs will be determined during implementation works. At a minimum this signage should identify, at all access points to the site and that the riparian area is being managed for conservation purposes. Further signage may include permanent signs describing the natural values of the site and surrounding area.

Permanent fencing should be installed around the northern boundary of the VMP area to delineate the site boundary. It is recommended that a permanent rural-style fence is erected around the remainder of the VMP area to delineate the conservation area.

4.3 Installation of Fauna Habitat in the VMP Area

It is recommended that an ecologist undertakes a pre-clearance survey within the proposed development area as per the Flora and Fauna Management Plan (ELA, 2021) to supervise the felling of the 12 hollow-bearing trees proposed to be removed to ensure the protection of native fauna. It is recommended that the removed hollows are relocated to the VMP area for on-ground fauna habitat. Where the removed hollows can't be successfully relocated, nest boxes are to be installed at a ratio of three nest boxes for every one hollow removed.

4.4 Vegetation management works

The total VMP area is 3.34 ha and encompasses the area shown in Figure 1. Maintenance weed control and revegetation are to be carried out by a bush regeneration contractor.

4.4.1 Primary and Secondary Weed Control

Depending on the timeframe between the construction of the channel and revegetation works, primary weed removal may be required, prior to revegetation. Secondary and maintenance weed control will be required following revegetation. During these weed control activities, care must be taken to avoid natural regeneration of native species.

4.4.2 Maintenance

Following secondary weed removal and revegetation, all areas will require ongoing maintenance to control weed regrowth from the soil seed bank. Maintenance work is to be undertaken by qualified bush regeneration contractor(s).

Maintenance will be undertaken on a regular basis in the peak growing seasons (spring and summer), with less frequent visits in cooler periods (autumn and winter). Maintenance work will include herbicide spot spraying of emergent weed species. Herbicides must be suitable for use adjacent to a waterway (e.g. Glyphosate Bi-Active).

4.4.3 Revegetation

Revegetation should be undertaken with tube stock at the densities in Table 3. Revegetation should use appropriate native aquatic macrophyte and River-flat Eucalypt-forest species within the VMP area including trees, shrubs and groundcover species as identified in Appendix C and to the specifications included in Appendix D. The recommended species are in accordance with the draft Mamre Road Precinct Development Control Plan 2020, which requires all vegetation works to include endemic tree species and shrubs. It is noted that some species listed in Appendix C have been outlined within the draft Wildlife Management Assessment Report (Avisure, 2020) as undesirable. If this Report is finalised and adopted, changes to the recommended species list may be required to minimise wildlife hazard risk to the Western Sydney Aerotropolis.

All management zones will require revegetation at different densities over the zone. Aquatic macrophytes will be planted in Management Zones 1, 2 and 4, where areas are likely to be regularly inundated. Species from all strata will be planted within Management Zone 3 to increase densities and prevent the incursion of exotic species. Canopy species will be planted in Management Zone 3 where canopy species are currently not present.

Management Zones 3 and 4 will require the installation of jute matting following construction of the channel and prior to revegetation to help stabilise the banks of the channel.

Table 3: Planting guidelines for Management Zones

Management Zone	Revegetation Area (m^2)	Mulch / Jute Matting	Planting Densities				Total Planting Numbers
			Trees (1/15 m^2)	Shrubs (1/5 m^2)	Herbs/ Scramblers (1/ m^2)	Grasses/Sedges /Rushes (5/ m^2)	
MZ1	3,120	-	0	0	0	15,600	15,600
MZ2	9,440			1,888	18,800	47,200	67,968
MZ3	17,400	Jute matting	1,160	3,480	17,400	87,000	109,040
MZ4	150					750	750
TOTALS	**30,110**	**-**	**1,160**	**5,368**	**36,280**	**150,550**	**193,358**

5. Monitoring and 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 because of vegetation management works. Monitoring works will require liaison with the land holders, the bush regeneration contractor and the approval agency.

The bush regeneration contractor will establish photo monitoring points and prepare reports to record the progress of their work and demonstrate compliance with the VMP. Photo monitoring points are identified in Figure 3**.** During the maintenance phase the land manager will complete the reports in consultation with the approval agency. Reports will include a brief work report and an annual audit and assessment of compliance with the performance criteria in Table 4. The requirements of monitoring and reporting are described in detail in the sections below.

5.1 Photo Monitoring Points

Photo monitoring points will be established across the VMP area to highlight changes in the vegetation through time. The initial photos must be taken prior to revegetation works commencing, with subsequent photos taken after major management actions are implemented (e.g. tubestock planting) and annually in Spring/Summer. To do this, the bush regeneration contractor needs to establish photo monitoring points as indicated in Figure 3**.** Installation of photo points should follow the below process:

- place two six-foot star pickets 10 m apart;
- record the location (eastings and northings) of the first star picket with a GPS;
- record the bearing to the second star picket;
- take a digital photo from the first star picket looking towards the second star picket, with the entire length of the second star picket visible in the photo to act as a reference point; and
- label each digital image with a unique reference number that indicates where the photo was taken (i.e. the photo monitoring point) and date it was taken (e.g. 01_180315 for a photo taken at photo monitoring point 1 on the 15th March 2018).

5.2 VMP Implementation Reporting

A brief report outlining work undertaken by the bush regeneration contractor will be prepared every six months during the revegetation and primary weed control phases, then yearly throughout the maintenance phase. These reports will be submitted to the land holders committee and Penrith City Council. Reports will include:

- the time period for which the report relates to;
- a summary of works carried out within the period, including the dates and times spent on site doing works;
- an approximation of the time spent on each task;
- a table totalling man hour for each task undertaken on site;
- the qualifications and experience of contractors;
- certification of seed and local provenance stock;
- methods of weed control undertaken, and chemicals used;

- numbers of local provenance tubestock planted or methods;
- photo monitoring results of each of the scheduled stages of the vegetation progress;
- a description of any problems encountered in implementing the works recommended in the VMP and how they were overcome;
- any observations made, including new plant species recorded (native and weed species), comments on rates of regeneration and any problems which impact on the implementation of the VMP; and
- the results of the implementation work, in relation to the relevant performance criteria.

5.3 Review of the Vegetation Management Plan

The implementation of this VMP will be reviewed at the end of each year following the completion of the annual monitoring report for the life of this VMP. A review of this VMP should evaluate the effectiveness of the current management strategy and consider appropriate recommendations to achieve the performance criteria for each zone.

5.4 Performance Criteria

The progress and compliance with the VMP will be monitored and reviewed annually. This process will involve the bush regeneration contractor and the land holders. As identified in Section 5.2, a report will be prepared commenting on the success of the performance criteria. The performance criteria listed in Table 4 are best practice and are not linked with any specific legislation. Planting guidelines are outlined in Table 3 and recommended species for each vegetation community provided in Appendix C. An adaptive management approach to this site is recommended since techniques may need to be changed or be modified to suit site conditions. This approach allows the contractor to develop and build on site knowledge whilst implementing this VMP. Monitoring will assist in refining VMP actions in subsequent years.

Table 4: Performance criteria

MZ	Year 1	Year 2	Year 3 – 4	Year 5
1	• Weed control of all weeds including priority and environmental weeds. Weed cover no greater than 15% across entire zone. • Revegetation of native species completed across the entire zone as per Table 3. 90% survival rate of all plantings at end of Year 1. • All rubbish removed.	• Treatment of new weed breakouts • Weed control of all weeds. Weed cover no greater than 10% across entire zone. • Survival of revegetation plantings maintained at 90%. Replacement plantings* with all strata to meet densities in Table 3, if required.	• Treatment of new weed breakouts • Weed control of all weeds. Weed cover no greater than 5% across entire zone. • Survival of revegetation plantings maintained at 90%. Replacement plantings with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover less than 5% across entire zone. • Survival of revegetation plantings maintained at 90%.
2	• Weed control of all weeds including priority and environmental weeds. Weed cover no greater than 10% across entire zone. • Revegetation of native species completed across the entire zone as per Table 3. 80% survival rate of all plantings at end of Year 1. • All rubbish removed	• Weed control of all weeds. Weed cover no greater than 5% across entire zone. • 90% survival rate of all plantings at end of Year 2. Replacement plantings* with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover no greater than 5% across entire zone. • 90% survival rate of all plantings at end of Year 4. Replacement plantings with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover less than 5% across entire zone. • 90% survival rate of all plantings at end of Year 5.
3	• Weed control of all weeds including priority and environmental weeds. Weed cover no greater than 30% across entire zone. • Revegetation of native species completed across the entire zone as per Table 3. 80% survival rate of all plantings at end of Year 1. • Jute matt installed across entire zone. • All rubbish removed	• Weed control of all weeds. Weed cover no greater than 20% across entire zone. • 90% survival rate of all plantings at end of Year 2. Replacement plantings* with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover no greater than 10% across entire zone. • 90% survival rate of all plantings at end of Year 4. Replacement plantings with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover less than 5% across entire zone. • 90% survival rate of all plantings at end of Year 5.

MZ	Year 1	Year 2	Year 3 – 4	Year 5
4	• Weed control of all weeds including priority and environmental weeds. Weed cover no greater than 30% across entire zone. • Revegetation of native species completed across the entire zone as per Table 3. 80% survival rate of all plantings at end of Year 1. • All rubbish removed	• Weed control of all weeds. Weed cover no greater than 20% across entire zone. • 90% survival rate of all plantings at end of Year 2. Replacement plantings* with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover no greater than 10% across entire zone. • 90% survival rate of all plantings at end of Year 4. Replacement plantings with all strata to meet densities in Table 3, if required.	• Weed control of all weeds. Weed cover less than 5% across entire zone. • 90% survival rate of all plantings at end of Year 5.

*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.

6. Implementation Schedule and Cost

The estimated cost of implementing this VMP over a five-year period is approximately **$1,070, 176** (ex GST) (Table 5). Costs may vary significantly over consecutive years of management according to the response to the weed control techniques. Rates and costs are based on estimates of current standard commercial rates and there is potential for variation across the sector. On-going maintenance costs (labour and materials) may also increase over time with inflation. Other assumptions that have been made regarding estimation of costs have been outlined below.

The VMP area is to be maintained in perpetuity , however a minimum standard for the implementation of the VMP for the first five years is provided below in Table **5**. This schedule is indicative but sets out the minimum number and timing of visits. This may be amended according to timing of when the VMP works start, however, the performance criteria must be met, and any changes should aim to meet these targets. It should be noted that specific activities must occur during the correct seasons, i.e. planting should only occur during the colder months when temperatures are mild as this will give plants a greater chance of survival.

Monitoring reports are required every six months and annually (see Section 5).

6.1 Weed control treatments

Bush regeneration contractors will implement this VMP, including the weed management treatments. These works have been estimated to cost **$2,000** for a team of four bush regenerators, including a supervisor, per day. The cost of bush regeneration works includes the costs of herbicide, vehicles and equipment which are required to implement the VMP.

6.2 Revegetation treatments

Bush regeneration contractors will implement this VMP, including the planting treatments. These costs have been budgeted at an estimated **$3.50 per tree and shrub** including planting, tree guards, water crystals and initial watering, and an estimated **$2.50 per grass, sedge and groundcover** including planting, water crystals and initial watering. Initially 193,358 plants will be required at an estimated cost of **$489,923**. An attrition rate of 10% has been assumed, with replacement estimated at a cost of **$48,992**.

6.3 Site Preparation

Site preparation works are necessary for the successful establishment of revegetation works in areas of low resilience. The extent of preparation will depend on the site condition.

Preparation works should be undertaken prior to revegetation. The area to be revegetated will undergo major disturbance prior to revegetation, hence will require major site preparation works (e.g. topsoil application) to make suitable for revegetation. The application of topsoil has not been costed as part of this VMP. Topsoil importation will be at the cost of the developer or civil construction company.

6.4 Planting

Revegetation should be conducted in the colder months (early spring or early autumn) to prevent shock to young saplings and reduce exposure to frost or drought conditions. 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 especially in difficult to access locations. All plants will be irrigated when installed to increase survival rates of revegetation. Depending on the weather, irrigation needs to be undertaken for at least 4 - 6 weeks following planting to aid establishment of the plants.

Tree guards will need to be installed on tubestock plantings in Management Zone 3 to protect tree and shrub seedlings from extreme weather (frosts and heat), herbivorous grazing and herbicide drift during maintenance. The requirement for tree guards will be determined by the bush regeneration contractor during the establishment phase. If used, bio-degradable tree guards are recommended to protect the seedlings, especially those in the more exposed restoration zones. Tree guards have been included in the costings.

Planting of tube-stock for trees and shrubs species and Hiko or Viro cells for grasses and other groundcover species are the preferred methods for revegetation works. Planting densities are provided in Table 3. Herbaceous species will be planted in clumps rather than scattered individuals. The recommended species planting list is available in Appendix C.

Table 5: Indicative implementation costs

Treatment	Preliminary	Establishment	Maintenance					TOTALS
			Year 1	Year 2	Year 3	Year 4	Year 5	
Revegetation								
Seed collection, cleaning, storage	$16,864							**$16,864**
Site Preparation		$8,425						**$8,425**
Jute Matting / Mulch		$116,100						**$489,923**
Tubestock, supply and install		$489,923						**$398,240**
Replacement tubestock, supply and install			$24,496	$24,496				**$48,992**
Irrigation		$37,638						**$37,638**
Weed control								
Preliminary / primary	$25,850							**$25,850**
Establishment / secondary		$113,975						**$113,975**
Maintenance			$33,280	$33,280	$33,280	$33,280	$33,280	**$166,400**
Associated costs								
Supervision of Earthworks		$16,610						**$9,530**
Monitoring & Reporting	$4,200	$4,200	$4,200	$4,200	$4,200	$4,200	$4,200	**$29,400**
TOTALS	**$46,914**	**$786,871**	**$61,976**	**$37,480**	**$37,480**	**$37,480**	**$37,480**	**$1,070,176**

Table 6: Implementation schedule

Treatment	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
Civil Works																				
Bulk earthworks and channel construction																				
Install fencing informational signage																				
Revegetation																				
Seed collection, cleaning, storage																				
Site preparation																				
Install jute matting within management zones one, three and four																				
Tubestock, supply and install																				
Replacement tubestock, supply and install																				
Irrigation																				
Weed control																				
Primary																				
Secondary																				
Maintenance																				
Other works																				
Monitoring and reporting																				

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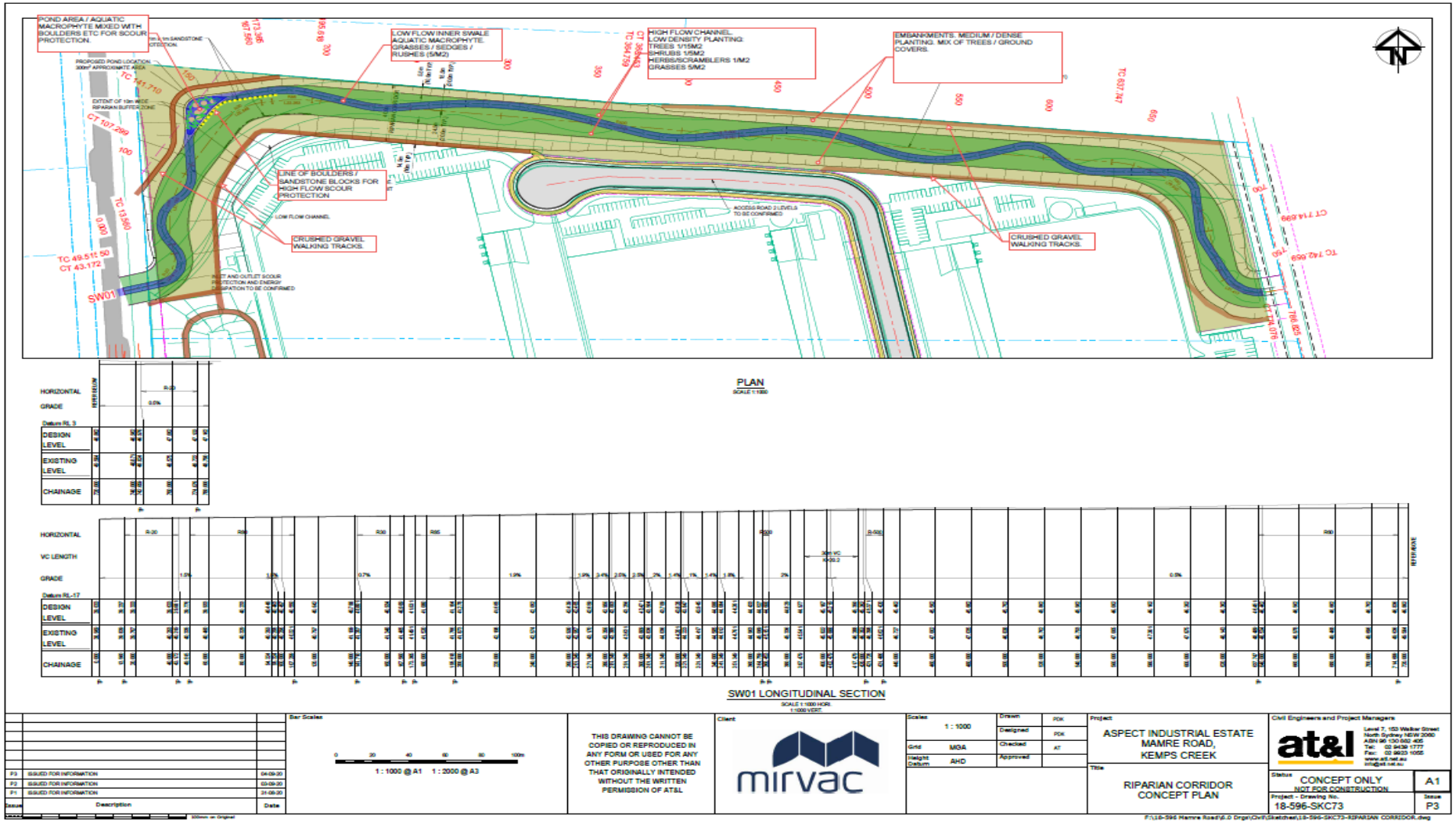
Appendix A Riparian Channel Civil Designs



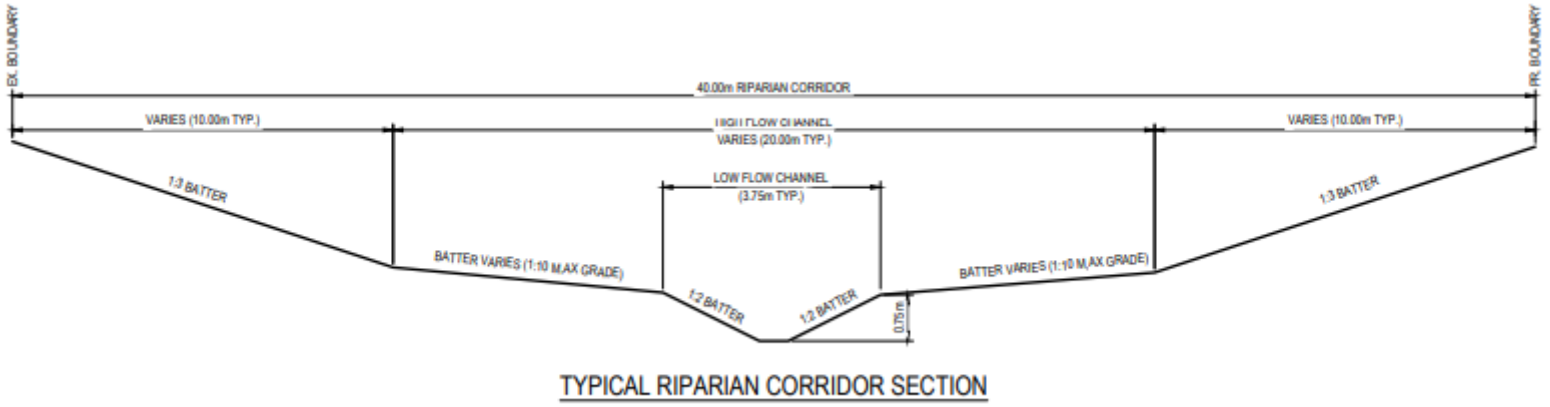


Figure 4: Typical Riparian Corridor Cross Section (AT&L 15 October 2020)

Appendix B Flora Species

Table 7: Flora species recorded in the VMP area

Scientific Name	Common Name	Exotic (*)	Priority Weed	WoNS
Araujia sericifera	Moth Vine	*	PW	
Bromus catharticus	-	*		
Casuarina glauca	Swamp Oak			
Cirsium vulgare	Spear-thistle	*	PW	
Chloris gayana	Rhodes Grass	*		
Cyperus gracilis	Slender Flat Sedge	*		
Hypochaeris glabra	Smooth Cat's Ear	*		
Lepidium bonariense	-	*		
Oxalis perennans	-	*		
Paspalum dilatatum	Dallas Grass	*	PW	
Pennisetum spp.	-	*		
Plantago lanceolata	Plantain	*		
Rumex crispus	Curly Dock	*		
Senecio madagascariensis	Fireweed	*	PW	WoNS
Solanum nigrum	Blackberry Nightshade	*		
Trifolium repens	White Clover	*		
Verbena bonariensis	Verbena	*		

Appendix C Recommended Planting List

Table 8: Recommended planting list

Life form	Scientific Name	Common Name	MZ1 – Low Flow Channel	MZ2 – Pond area	MZ3 – High Flow Channel	MZ4 - Embankment
Tree/Canopy Species	*Angophora floribunda*	Rough-barked Apple			X	X
	Angophora subvelutina	Broad-leaved Apple			X	X
	Casuarina cunninghamiana subsp. cunninghamiana	River Oak			X	X
	Casuarina glauca	Swamp Oak			X	X
	Eucalyptus amplifolia	Cabbage Gum			X	X
	Eucalyptus moluccana	Grey Box			X	X
	Eucalyptus tereticornis	Forest Red Gum			X	X
Shrub Species	*Acacia floribunda*	White Sally			X	X
	Acacia parramattensis	Parramatta Wattle			X	X
	Breynia oblongifolia	Coffee Bush			X	X
	Bursaria spinosa	Blackthorn			X	X
	Melaleuca decora	-			X	X
	Melaleuca styphelioides	Prickly-leaved Tea Tree			X	X
	Ozothamnus diosmifolius	Rice Flower			X	X
	Trema aspera	Native Peach			X	X
Sedges, Rushes, Reeds and Grasses	*Carex appressa*	Tall Sedge	X	X	X	X
	Cyperus gracilis	Slender Flat sedge	X	X	X	X
	Dichelachne micrantha	Shorthair Plumegrass			X	X

Life form	Scientific Name	Common Name	MZ1 – Low Flow Channel	MZ2 – Pond area	MZ3 – High Flow Channel	MZ4 - Embankment
	Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass			X	X
	Echinopogon ovatus	Forest Hedgehog Grass			X	X
	Eleocharis sphacelata	Tall Spike-rush	X	X	X	X
	Entolasia marginata	Bordered Panic			X	X
	Entolasia stricta	Wiry Panic			X	X
	Gahnia clarkei	Tall Saw-sedge	X	X	X	X
	Imperata cylindrica var. major	Blady Grass	X		X	X
	Isolepis inundata	Swamp Club-sedge	X	X	X	X
	Juncus kraussii subsp. australiensis	Sea Rush	X	X	X	X
	Juncus usitatus	Common Rush	X	X	X	X
	Lomandra filiformis	-			X	X
	Lomandra longifolia	Spiny-head Mat-rush			X	X
	Lomandra multiflora subsp. multiflora	-			X	X
	Microlaena stipoides var. stipoides	Weeping Meadow Grass			X	X
	Oplismenus imbecillis	Basket Grass			X	X
	Paspalidium distans	-			X	X
	Schoenoplectus mucronatus	Club Sedge	X	X	X	X
	Schoenoplectus validus	River Club-sedge	X	X	X	X
	Themeda australis	Kangaroo Grass			X	X
Groundcover Species (~0-	*Centella asiatica*	Indian Pennywort			X	X
	Cheilanthes sieberi subsp. sieberi	Poison Rock Fern			X	X
	Commelina cyanea	Creeping Christian			X	X

Life form	Scientific Name	Common Name	MZ1 – Low Flow Channel	MZ2 – Pond area	MZ3 – High Flow Channel	MZ4 - Embankment
1.5 m) & Vines/Scramblers	*Desmodium varians*	Slender Tick-trefoil			X	X
	Dichondra repens	Kidney Weed			X	X
	Geranium solanderi	Native Geranium			X	X
	Glycine clandestina	Twining Glycine			X	X
	Glycine microphylla	Small-leaf Glycine			X	X
	Glycine tabacina	-			X	X
	Hardenbergia violacea	Purple Coral Pea			X	X
	Plectranthus parviflorus	Cockspur Flower			X	X
	Solanum prinophyllum	Forest Nightshade			X	X

Appendix D Techniques and Specifications

Various weed control techniques are required to control weed infestations in natural areas. Weed infestations usually consists of a number of different weed species, densities and weed forms.

Weed control techniques are summarised below. These techniques are guidelines only. An adaptive weed management program should include a combination of different weed control techniques and involves consideration of monitoring and reporting outcomes and potential changes to the weed management program based on those result.

Depending on the area, density and priority, objectives of weed control may change. For example, it may be more cost-effective to contain zones with a high weed infestation but with a low risk of spreading into adjacent habitats or impacting on threatened species or communities, rather than attempting to eradicate all weeds. Alternatively, it is cost effective in the long-term to eradicate weeds in small infestations before they become larger and more widespread.

To effectively manage the issue of weed invasion an understanding of the types of vectors responsible is important. The movement of wind and water is often considered the greatest mode of weed dispersal into new habitats. Water is commonly responsible for the transport of weed propagules along the riparian corridors and contributes to weeds establishing downstream watercourses. However, there are many options for weed dispersal by vectors other than wind or water. A list of some of the potential weed vectors and examples of weeds species is shown the table below.

Table 9: Weed vectors table

Vector	Weed Examples	Description	Ecological Implications
Watercourse	Trad	Fleshy stems can be transported along watercourse	Widely dispersed into native and disturbed environments
Drain	Moth Vine	Light feathery capsules float on water	Widely distributed along creek lines and into downstream habitats
Wind	Pampas Grass	Very light seeds are windborne over long distances	Readily invades disturbed open habitats, particularly along road verges
Track	Cobblers Pegs	Burrs stick to animals and humans	Invades disturbed bushland along tracks and is carried into adjacent habitats
Birds	Privet, Blackberry, Lantana	Edible fruits are dispersed over large areas	Birds increase weed dispersal into new habitats
Mammals	Blackberry, Prickly Pear	Eat fruit or transport burrs on fur	Mammals spread seeds or burrs into new habitats
Humans	Cobblers Peg, African Lovegrass	Transport propagules on clothes and shoes	Humans spread seeds or burrs into new habitats

Hygiene protocols

A strict hygiene protocol must be implemented to control the spread of weed propagules between habitats and the accidental introduction of invasive species into sensitive areas. Best management practices recommend work from should target areas of high native resilience to areas then move towards high weed infestation. Weed propagules may be spread on the clothes or boots of humans or in the soil on vehicles. It is important that all vehicles, especially earth movement, are thoroughly washed down before moving to a new site. This also applies to humans. Clothes must be free of weed propagules before entering a new site.

Principles of weed control within natural areas

Weed control programmes within natural areas follow the principles of bush regeneration including the Bradley Method and other techniques to promote natural regeneration as described in Buchanan (2000). These are summarised below:

- Where available, refer to best practice guidelines for individual weed species which may need to be adapted to a natural setting and ecological outcome
- Ensure correct plant identification – many weed species are difficult to identify because they resemble native species or typically occur in a vegetative (i.e. non-flowering) form.
- Limit the creation of bare patches of soil and soil disturbance in general, since this will encourage weeds to establish and grow – do not create unnecessary tracks with vehicles or other machinery;
- As a first option for weed control, consider methods that do not use herbicide (e.g. hand pulling and crowning) and which create very little soil disturbance;
- When using herbicides, use the least toxic chemical whenever possible and always follow the instructions;
- When working on or near drainage lines, use an approved herbicide for this environment;
- Refer to Australian Pesticides and Veterinary Medicines Authority (APVMA) website (www.apvma.gov.au) for information on off-label permits;
- Apply herbicides when the plants are actively growing and prior to seed set to achieve the best results;
- Regularly monitor for new infestations; and
- Where woody weeds are providing habitat for native birds and animals, use the drill and fill technique to enable the same structure to remain in situ while the tree or shrub dies – this will enable the plant to provide shelter for a period of time, while giving the birds and animals a chance to move on of their own accord. Where this is not practical considering the size of an infestation consider a mosaic approach to control.

Integrated Weed Management

Integrated weed management may use a combination of any of the following techniques; mechanical, chemical, manual handling and biological methods. According to the Department of Primary Industries" (DPI) *Noxious and environmental weed control handbook* the best management practices considers a long-term perspective and does not rely solely on herbicide application (DPI 2010).

Weed control can be broken down into three main categories:

- **Primary Treatment:** the first weeding of the site.
- **Secondary Treatment:** the second weeding of the site which may be very intensive as all regrowing/germinating weeds should be removed before they seed and out-compete native plants.
- **Maintenance/Follow-up Treatment:** every re-weeding of the site after the secondary phase.

The first time an area is weeded (primary treatment) can be labour intensive and time consuming and depending on the target species and site conditions. It may take over several months to complete for one species (Buchanan 2009). In areas of high weed infestation and with no native resilience and/or native plants present, primary weeding may be accelerated as preparatory works for revegetation. However, in areas where native plants may occur, primary weeding should be undertaken at a pace that assists with the natural regeneration of the site.

Secondary treatment of an areas can take longer than primary treatment as new species can be present that more difficult to treat than the original weed (Buchanan 2009). Secondary treatment needs to be carefully timed to:

- Prevent weeds from setting seed;
- Suppress vegetative regrowth while plants are still small; and
- Allow native plants to recruit without being smothered or out-competed by weeds.

However, secondary treatment should allow enough time for the soil profile to recover following primary treatment and the establishment of weed growth from the soil seed bank.

Maintenance treatment refers to weed control that is carried out after the secondary treatment (Buchanan 2009). The goal of follow-up treatments is to remove weedy recruits so that native species can re-colonise the area; frequent visits are likely to be needed at first, although the amount of time and resources used should gradually decrease through time.

Chemical Weed Control – Herbicide Application

Herbicide Selection

Any herbicide used in weed management activities must be registered for use in the appropriate situation for the species being treated. It is the responsibility of the weed control operator to check that the herbicide intended for use is registered at the time of control. Where herbicide application is used, many hardy species may require re-treatment between six and twelve months after the initial treatment to ensure mortality of individual plants.

Spot Spray Application

Hand operated spray gun connected to a knap-sack or vehicle (e.g. truck, ATV, etc.) mounted herbicide storage tank is used to direct diluted herbicide spray to defined areas. When applied under correct conditions, individual plants or parts of plants may be treated using this method with minimal risk of overspray and non-target damage. Spot spraying is an effective and targeted way of treating weeds on a landscape level, though non-target damage is possible on an individual plant level. This can be mitigated in some situations through the use of selective herbicides.

This method is most suitable for low growing or juvenile grasses, herbs, and woody weeds that have copious, but compact, foliage. In most cases, spot spraying should be undertaken after new growth is produced but before flowering. Because the plant is left *in situ* after spraying, there is potential of seed to mature on the plant if spraying is left to late. In some cases the target plant may also take weeks or months to die off.

Boom Spray Application

A nozzle spray apparatus is connected to the rear of a vehicle-mounted herbicide storage tank to apply a diluted herbicide application. Where terrain is suitable for vehicle access, large areas are typically treated using this technique (e.g. open paddock situation). Boom spraying is a fast and economical way of treating large areas of weeds on a landscape scale. However, boom spraying does not allow the operator to avoid individual plants and so has a high potential for non-target damage. This can be mitigated in some situations through the use of selective herbicides. This method is most suitable for large areas of weed infestation without any native regeneration potential.

Figure 5: Boomless spray nozzle attached to a truck

Splatter Gun Application

Individually operated splatter or gas guns are connected to a 5L backpack which may be equipped with a canister of LPG. The handgun applicator is charged with a dose of herbicide and a splatter of low volume-high concentration herbicide solution is applied. The LPG forces the herbicide out of the pack up to several meters distance; however, instead of a fine spray mist, as in the case of spot spray application, the herbicide is applied in a large droplet form leaving a line of herbicide on the plant.

"Stripes" of herbicide are applied across large plants instead of coating all parts of the plant in a fine mist.

Splatter guns are very effective as the application of the herbicide is more directed and produces limited off target damage. This treatment provides a good alternative to spot-spraying where access is difficult or materials have to be carried in, as they use much less water. Splatter guns can also provide an alternative to mechanical removal or herbicide treatments requiring access to the stem of the plant (e.g. cut and paint, drill and frill, etc.) amongst dense, low growing woody weeds such as Bitou and Lantana. This treatment is not effective on vegetation with sparse foliage cover.

Cut and Paint

In the cut and paint treatment, the stem of the plant is cut all the way through and herbicide applied to the stump. The plant should be cut as close to the base as possible, below any branches and the cut should be horizontal. The remaining stump should not exceed 10mm in height. The tools required to make the cut may be a handsaw, secateurs or chainsaw. Any dirt on the stump needs to be removed and the herbicide needs to be directly applied within 30seconds to the stump using a dabber bottle. Some plant species re-sprout after this treatment and follow up work may be required to kill the plant effectively. A non-specific herbicide should be used for the cut and paint method.

The cut and paint method is suitable for the control of woody weeds, large herbaceous weeds and vines/climbers. When done with vines/climbers it is referred to as „skirting". This treatment is commonly used when the biomass is to be removed from the site following the primary weed control. It is most suitable for plants with a small diameter at the base and a single stem or trunk. Given that to be effective the herbicide has to be applied as soon as possible after cutting, this method is not effective where extensive cutting is required.

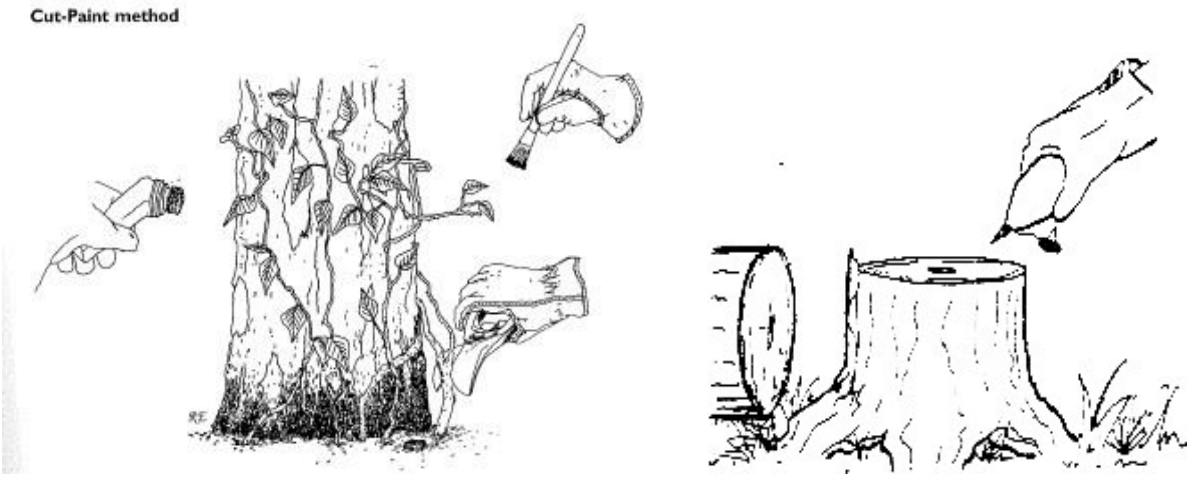


Figure 6: The cut and paint method (Muyt 2001, Sydney Weeds Committee 2013)

Drill and Fill

The drill and fill method involves drilling a hole into the base of a tree below any branches with a hand drill using a 9 or 10mm drill bit at an angle of 40-60^0. The hole should only penetrate through the sap wood and not through to the heart wood. The hole should then be filled immediately with the appropriate herbicide. An eye dropper or a squeeze bottle with a narrow nozzle can be used to fill the hole. If the plant re-sprouts follow up work will be required to kill the plant. A non-specific herbicide should be used for this treatment method.

The drill and fill method is suitable for woody weeds with a large diameter at ground height or for plants with multiple stems at the base. This control method is useful where dead trees are intended to be left standing as habitat trees and would be a suitable method for the eradication of large Camphor Laurels or Broad-leaved Privet trees, providing the dead trees do not present a hazard to the public at a later stage.

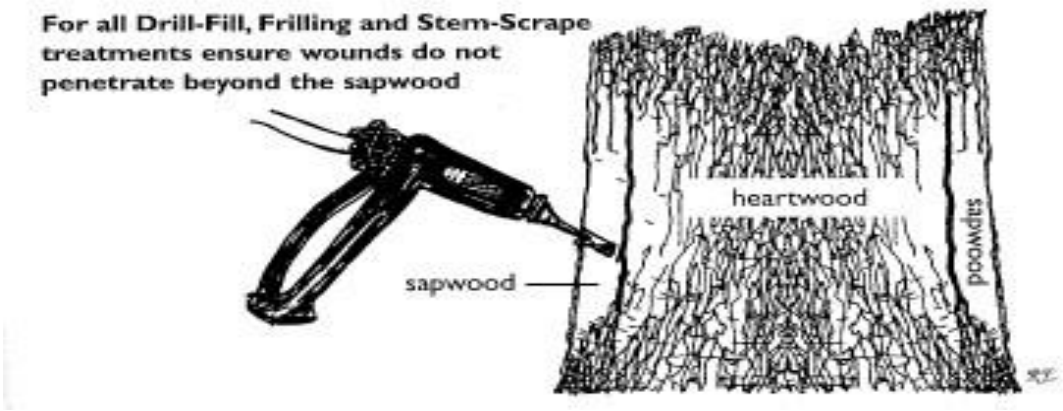
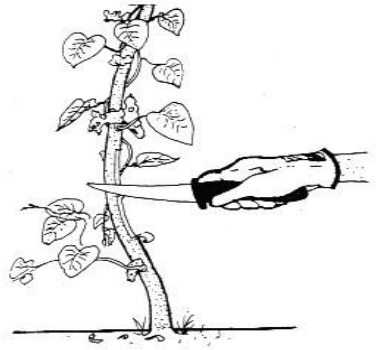


Figure 7: Drill and fill method for large woody trees (Muyt 2001)

Stem Scrape

The stem scrape method involves using a sharp knife to scrape back the top layer of bark from the vine 20-30cm long. An appropriately mixed herbicide needs to be applied immediately (within 30 seconds) using a dabber bottle. The root system of the plant should not be disturbed until the plant has died as this may reduce the effectiveness of the herbicide. Skirting method may be used in conjunction with stem scrape. This method is especially important to remove large infestations of vines within the canopy layer. Skirting involves cutting the vines within the canopy at chest height. This will allow an increase in the amount of light and resources to the canopy trees through the reduction of vine biomass



The stem scrape method is most useful when used to treat species that need greater herbicide coverage than can be provided by the cut and pain method (e.g. Green Cestrum, Ochna), or a species that has reproductive material (e.g. tubers) that must be poisoned as well (e.g. Madeira Vine). For the latter, this is especially important if it is not possible to collect the reproductive material. However, for most woody weeds and vines, this method is not necessary.

Figure 8: Stem scrape (Sydney Weeds Committee, 2013)

Manual and Mechanical Weed Control

This technique physically removes plants from the soil and depending on the weed species may require special conditions for disposal (e.g. some noxious weeds must not be transported off-site and must be disposed of by deep burial). Manual treatment effectively removes the entire plant using hand tools such as shovels or the use of heavy machinery. This technique is most productive when treating small area infestations and successfully removes the entire plant effectively preventing future seed set.

Certain parts of plants may also be targeted for removal to prevent flowering or seed set (i.e. post flowering but prior to mature seed being released from the fruit or seed head). Re-treatment may be required if mature plants have previously released viable seed into the soil which may germinate post soil disturbance.

To reduce the risk of localised increased fuel load no debris should stockpiled on site.

Hand Removal / manual methods

Hand removal of weeds involves pulling the plant as close to the base as possible and ensuring the entire tap root is pulled out of the soil. This usually results in soil disturbance and the soil should be replaced and compressed to prevent further weed invasion.

The successful hand removal of some other weeds may require the removal of the plant's roots, bulbs or tubers. This method includes digging and crowning with the use of a hand mattock, knife or trowel. Crowning involves using a knife to cut the roots around the crown of the plant.

The hand removal or pulling of weeds is suitable for many species of weeds as long as they have a shallow root system. This includes woody weeds, grasses and herbaceous species. It is useful for follow up work on woody weeds to control seedlings

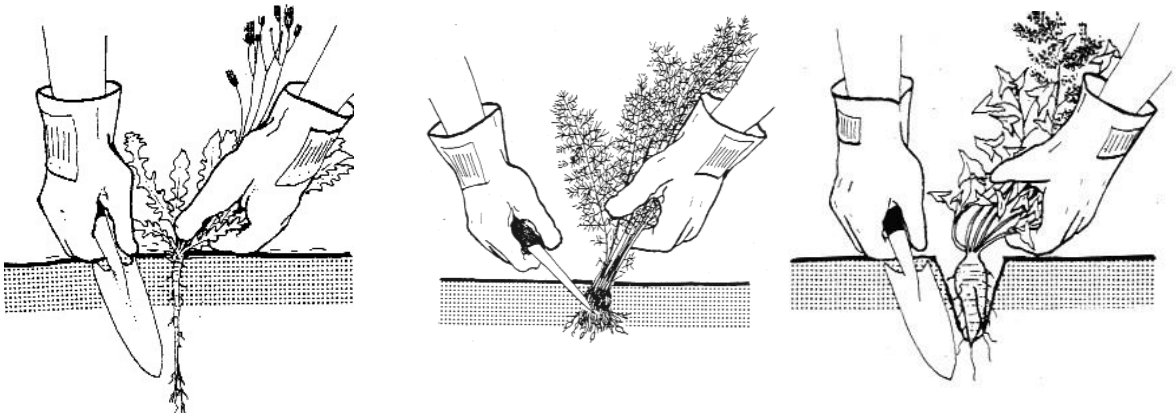


Figure 9: Hand pull (left), crown cut (middle) and rhizome / tuber trace (right) (Sydney Weeds Committee 2013)

Mechanical Removal

This technique physically removes or destroys individual plants via a process utilising large machinery or chainsaws. The use of large-scale machinery can be extremely successful for the localised eradication of dense infestations of woody weed species such as African Olive and Blackberry.

Weeds may be grubbed or raked out, and then removed from site or mulched *in situ*. Species such as African Olive will resprout and will require follow up treatment with herbicide.

Mechanical removal is most effective with areas of high weed density, especially with woody weeds where herbicide spray is not practical. Where machinery access is possible, this is preferred as it has the added benefit of being able to mulch the woody weeds *in situ*. However, in creek lines or other steep sites chainsaws can be used to cut down woody weeds. When using chainsaws in this way it is recommended that only the outer layer of woody weeds and the smaller woody weeds in the interior be completely cut down. This will provide access into the interior. The larger woody weeds in the interior of the area should be treated by drill and frill and left standing. This allows for access through the creek line for follow up treatments. It is recommended to leave woody debris *in situ* or spread out loosely. The creation of large piles of woody debris is not recommended as it can impede follow up.

Generally, work sites where this technique is used requires a maintenance component to monitor and control the potential reshooting root material, the germination of residual seed of the weed species and the colonisation of the site by other weed species. In some circumstances the control program requires follow up erosion, weed control, and revegetation programs to mitigate the risk of the aforementioned issues.

Figure 10: Tritter machine mulching African Olive

Slashing

Slashing involves removing some or all of the vegetative portion of a plant using mechanical blades. The use of machine drawn slashers or on a smaller scale individually operated brush cutters can prove extremely successful in reducing the seed load of key species.

The success of this technique is dependent on the timing of the slashing coinciding with the early flowering of the key species, in turn removing the flower heads prior to seed set. The timely use of slashing when combined with the use of herbicide application can provide an extremely cost effective and environmental favourable program of weed control. Slashing reduces the vegetative material of a plant, encourages new growth and removes dead thatch. All these factors make herbicide spraying after slashing more efficient, effective and economical. It should be noted that as slashing is indiscriminate it

can result in non-target damage. However, unlike herbicide which kills the entire plant slashing only removes the top portion and so can be used around native grasses especially with less risk. This can be further mitigated through setting of the slashing height and timing of the slashing to avoid native seed set.

Figure 11: Slashing Paspalum amongst native grasses

Biological Control

Biological control agents may be used for the management of some weed species. These control agents may have limited effectiveness due to their sensitivity to environmental conditions, and so the efficacy of this control technique depends on the ability of the control agent to establish self-perpetuating populations.

Biological control agents are generally best applied to high density weed infestations and the control agents (eg, Blackberry Rust) may need to be actively bred and reapplied regularly to counter natural mortality and periods of dormancy in target species.

Release of biological controls is particularly effective in treating weed populations in areas of high environmental sensitivity or to assist in the management of the identified weeds as part of a larger scale control program. These agents need to demonstrate high host specificity and pose little or no threat to other desirable plant species. If so, this is an ideal option for use in areas of threatened species or within sensitive habitats such as along water courses. The use of biological controls is strongly regulated to prevent the introduction of pests or diseases which impact on non-target species.

Herbicide Information

Herbicides

Herbicide application often forms an important component of an integrated weed management approach and can be the most appropriate method to control some weed species. Many herbicides are harmful not only to plants, but also fauna, particularly fish and amphibians.

Any herbicide used in weed management activities must be registered for use in the appropriate situation for the species being treated. These registration requirements are provided on the product label or an „Off-label Permit". Some species which are known to be difficult to control may be treated using combinations of herbicides registered for use in „Off-label Permits" which are issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA). It is the responsibility of the weed control operator to check that the herbicide intended for use is registered at the time of control.

The situation of control should be carefully considered to ensure correct herbicide usage. In all cases the application technique must be aligned to the registration requirements of the individual herbicides selected for the weed control program. Where a sensitive environment coincides with weed infestation only herbicides suitable for use in sensitive areas (as dictated by the product registration) should be used. For example, to target a weed infestation in close proximity to water courses such as a creek line, a product such as Roundup® Biactive® could be used as it is registered for use in this type of situation.

Residual herbicides can be present in the soil profile for several months post application to reduce the incidence of regrowth of the target weed species. A residual selective herbicide would not, however, be appropriate if plans for the area involved revegetation, particularly with species intolerant to the herbicide. This would pose a serious threat to rehabilitation maintenance works where the area was to be revegetated with species which are susceptible to herbicide impact. Application of a residual herbicide may reduce recruitment of these species, further compounding the maintenance issues. In this situation a non-residual herbicide would be recommended to reduce the impact on establishing vegetation.

Herbicides fall into two main categories with regard to their impact on particular plants

- Non-selective herbicides which will, at appropriate rates, kill all plants. Glyphosate is a non-selective herbicide.
- Selective herbicides which will target either grass (monocot) species or broad-leaf (dicot) species.

Herbicide use should occur during the active growing season for plants to encourage the chemical uptake into the plant. Where herbicide application is used, many hardy species may require retreatment between six and twelve months after the initial treatment to ensure mortality of individual plants. Off target damage is common with herbicide use and consideration should be given to the following factors to avoid this damage.

- Correct identification of target species
- Spray drift in high winds
- Environmental conditions at time of application

A number of selective herbicides have been approved for grasses and for broad-leaf species in the NSW Department of Primary Industries (DPI) *Noxious and environmental weed control handbook.*

These selective herbicides represent a range of environmental toxicities and the Material Safety Data Sheets (MSDS) should be referred to in each instance. For instance, Metsulfuron-methyl poses a low risk to the environment, while Triclopyr is considered to be relatively toxic and has the potential to pose

a moderate risk to the environment. Dimethylamine salt is in the same category as triclopyr, but is moderated by mixing it with metsulfuron-methyl.

Registration and records of any herbicide use must be kept in accordance with the NSW *Pesticide Regulation 2009*.

Herbicides impact on ecosystem

The correct training and appropriate application of herbicides must be followed at all times. There is a high risk of ecological impacts associated with use of herbicides. These risks include accidental death of plants due to spray-drift or due to incorrect handling technique or sensitive plants. There is also evidence that there are indirect impacts on microbats due to herbicide poisoning and reduced numbers of prey items for microbat species. Where possible consider alternative methods to herbicide use.

Staff Training

All weed control operators must be properly trained and hold required certification e.g. ChemCERT® and comply with requirements of the Pesticides Regulation 2009 (NSW) and Pesticides Act 1999 (NSW).

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1300 646 131
www.ecoaus.com.au