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Vegetation Management Plan for the Oakdale South Development Horsley Park

Prepared for Goodman, 13 January 2016

EXECUTIVE SUMMARY

State significant development application (SSDA 6917)

Goodman Property Services (Aust) Pty Ltd (Goodman) were granted a Staged Development Application consent for the Oakdale South Industrial Estate (Oakdale South), by the Department of Planning and Environment (the Department) on 26th October 2016. The development is State significant development (SSD 6917) pursuant to section 89C of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Oakdale South covers approximately 117 hectares (ha) of land which is predominantly zoned IN1 – General Industrial under the Western Sydney Employment Area (WSEA) SEPP but also includes land zoned E2 – Environmental Protection. Lands zoned as E2 are associated with remnant vegetation and riparian corridors of Ropes Creek and its tributaries.

The Stage 1 DA would result in the removal of 3.58 ha of native vegetation, the filling of two tributaries of Ropes Creek and the realignment of Drainage Line 1 to accommodate the proposed estate road layout.

Relevant to the site's remnant vegetation and riparian corridors, the Concept Proposal included:

- A Biodiversity Offset Strategy (BOS), prepared Cumberland Ecology (2015) in accordance with the Framework for Biodiversity Assessment (FBA) under the NSW Biodiversity Offsets Policy for Major Projects (administered by OEH), and
- A Vegetation Management Plan (VMP), prepared by Ecohort (2015) in accordance with the NSW Office of Water guidelines for controlled activities on waterfront land, specifically the "Guidelines for vegetation management plans on waterfront land" (July 2012)

Controlled activities carried out in, on or under waterfront land are regulated by the *Water Management Act 2000* (WM Act). However, it should be noted that under Part 4 Division 4.1 Section 89J of the EP&A Act, controlled activity approval is not required for SSD.

The VMP was submitted as part of the SSD 6917 documentation by Goodman to demonstrate how the construction impacts associated with filling two tributaries of Ropes Creek and the realignment of Drainage Line 1 would be managed.

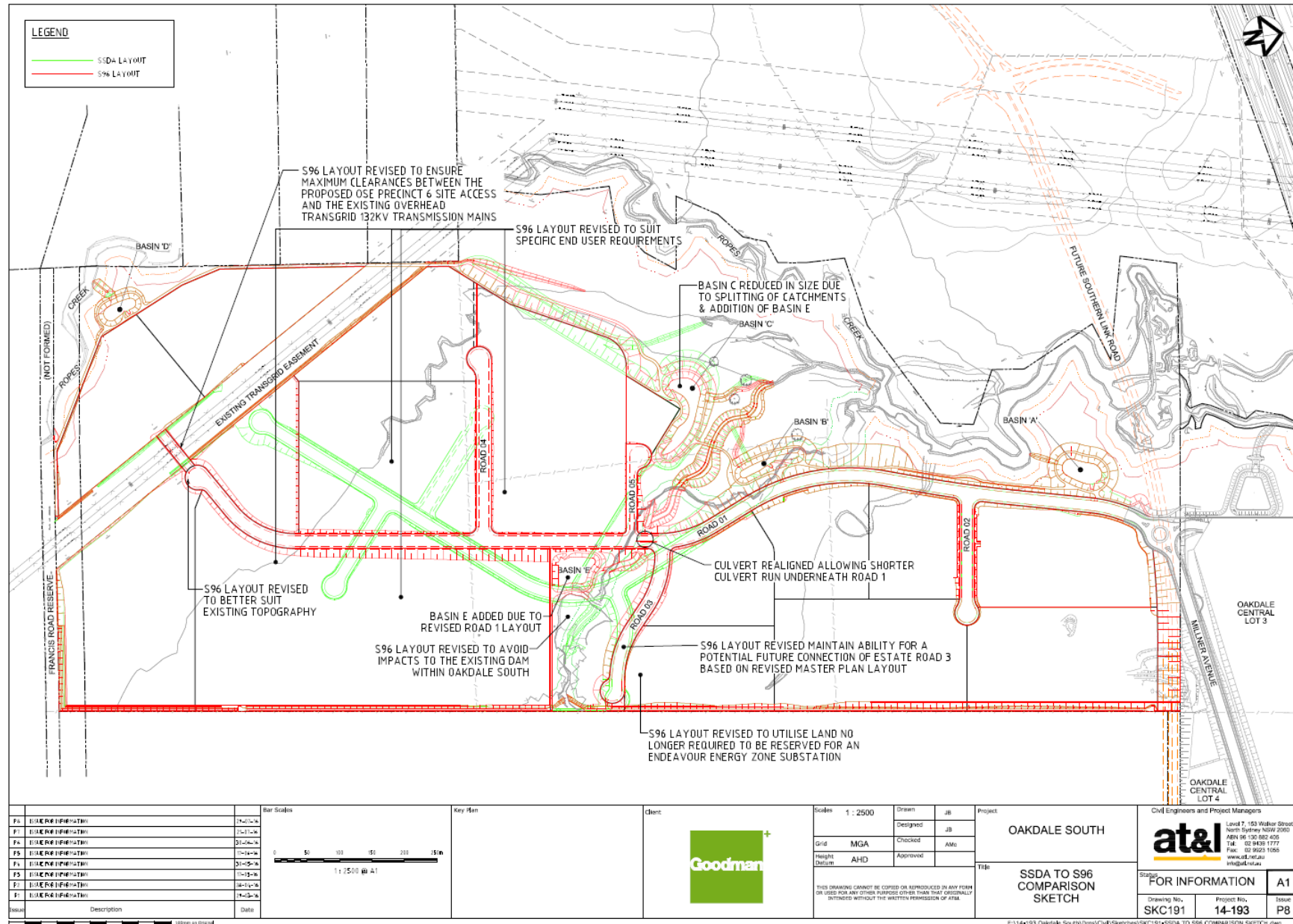
Section 96 modification

The approved SSD 6917 was designed to accommodate generic warehousing and distribution facilities, without knowledge of the specific needs of individual operators that may ultimately occupy the site. The three proposed operators, being Toyota, Sigma Pharmaceuticals and a confidential user, necessitated specific functional layout requirements for their individual sites and as a result a modification to the approved masterplan (Urbis 2016).

The proposed modification to the Oakdale South Stage 1 Development is to reflect the general layout changes made to the Oakdale South Concept Proposal and broadly entails: amendment of the subdivision layout; changes to road alignments and introduction of a new road; minor changes to earthworks design, including a reduction in the level of fill required to be imported to site; realignment of the creek to reflect the changes made to the Oakdale South Concept Proposal; and removing from the approval the construction and use of buildings in Precincts 4 and 5. It is intended that these will now be subject to separate development applications (Urbis 2016).

Figure A provides a comparison of the approved and proposed Oakdale South Concept Plan layout.

Figure B: Amended Oakdale South Masterplan layout comparison



F:\14\193 Oakdale South\Drawings\Civil\Sketches\SKC191-SSDA TO S96 COMPARISON SKETCH.dwg

Purpose of this VMP

This Vegetation Management Plan forms part of a Section 96 modification application to SSD 6917, which seeks approval for revisions to the approved Master Plan and Stage 1 Development in the southern portion of Oakdale South. The current VMP version (this document) has been amended to fulfil the Oakdale South Industrial Estate SSD 6917 consent condition E47 and respond to Section 96 modification application submissions, as follows:

E47: Prior to the issue of any Construction Certificate that includes creek realignment works, the Applicant shall submit a revised Vegetation Management Plan (VMP). The revised VMP shall:

- (a) Be submitted to the satisfaction of the Secretary;
- (b) Be prepared in consultation with the Office of Environment and Heritage (OEH);
- (c) Remove any geographic overlap with Figure 4.3 in the Biodiversity Offset Strategy prepared by Cumberland Ecology, dated 16 September 2015; and
- (d) Be consistent with the management measures and recommendations of the draft VMP prepared by Ecohort Pty Ltd, dated 31 August 2015.

The intent of this condition is to ensure the 5 year vegetation management measures proposed under the VMP are not included within the proposed biobank area to avoid precluding the creation of the proposed biobank site under Clause 11 of the *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*.

S96 submissions: VMP and Biodiversity Offset Area

- Following the meeting between the Department, OEH and Goodman (30/11/2016) a revised VMP will need to be provide reflecting the proposed modifications with respect to the current modification application
- Clarification should be provided for references to ‘ongoing management works’ in sections 2.5.3, 2.6.1, 2.6.6 and 3.4 of the VMP, nothing that OEH do not agree to any ongoing conservation management works within the proposed bio-banking site.

Clause 11(e) of the Biodiversity Banking Regulation excludes land from being designated as a biobank site if there is an existing conservation obligation for the purpose of complying with requirements imposed by or under any Act (including the requirements of any authority granted by a public authority under any Act).

By separating the geographic overlap of the VMP and the BioBank site, the Department was able to condition the implementation of the VMP without prejudicing the creation of the BioBank site under the BioBanking Regulation. The works would therefore not constitute an ‘existing obligation’ other than the 5 year vegetation management measures in the riparian corridor to which the VMP applies (refer Figure B), which would have otherwise been required by the consent in order to be consistent with the application of the Office of Water Guidelines as if they were to apply.

Ultimately, it is intended that the geographic boundaries between the riparian and BioBank management zones will be later removed via a S96 modification in consultation with OEH. A separate BioBanking application will be made with the OEH to include the VMP management zones. Onsite offset credits will be sought in relation to the vegetation management measures and any other eligible management measures proposed, which are in addition to those contained within the VMP’s five (5) management timeframe.

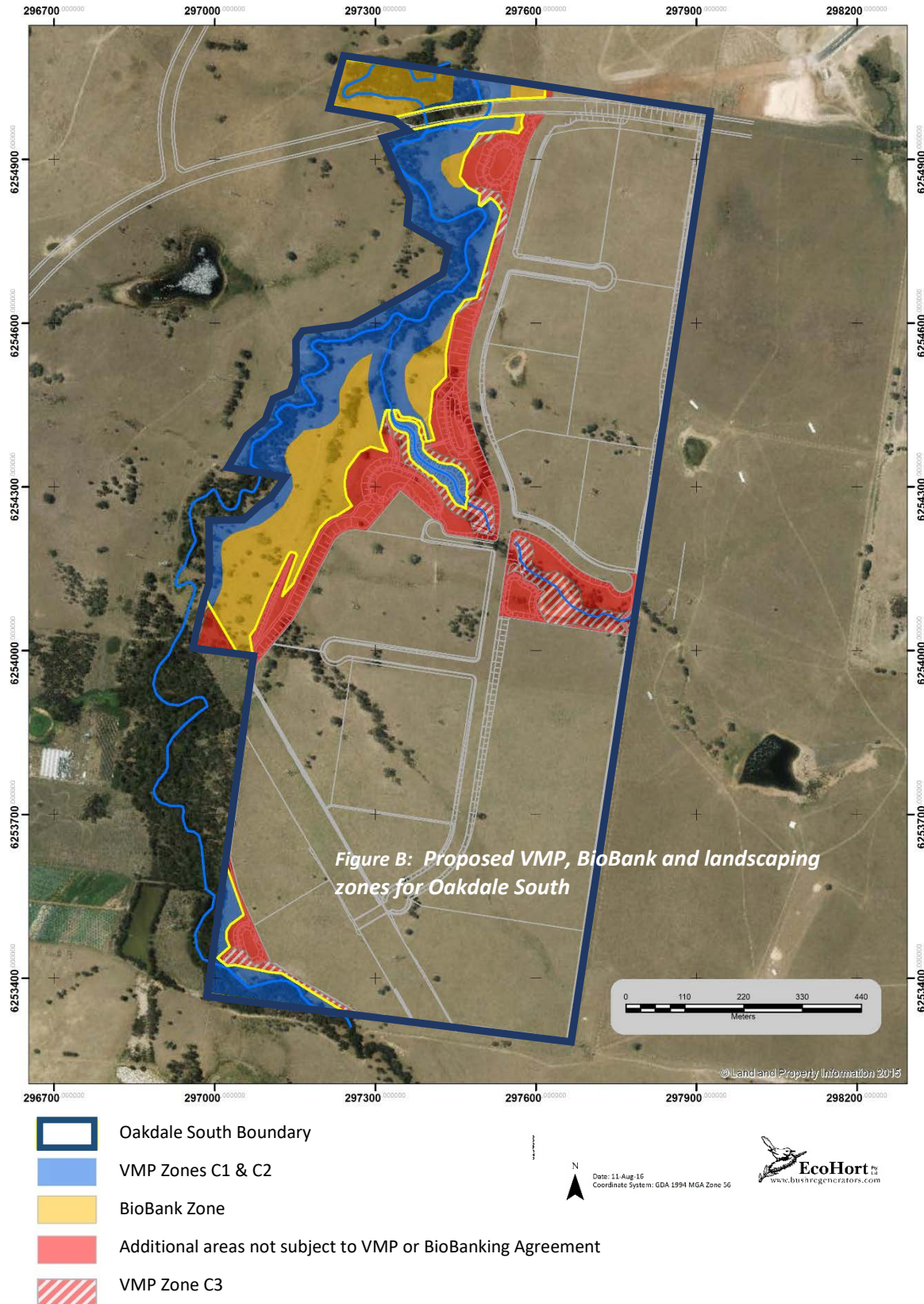


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SECTION 1: SITE OVERVIEW

1.1 SITE DESCRIPTION

1.1.1 Site Location

The Oakdale South study area (from now on referred to as “the study site”) includes riparian areas located within the proposed development site within Lot 12 DP11778389 and Lot 87 DP752041, along Ropes Creek and a small upper Ropes Creek tributary which have their headwaters within or just beyond the extent of the proposed development site. The site is located between Old Wallgrove Road and Ropes Creek Horsley Park, south of the Oakdale Central development within the Penrith Local Government Area (LGA).

The study site primarily includes a mixture of remnant and naturalised bushland and with a mix of native and exotic grassland. The location of these areas, which were identified during field investigations, are outlined in Figure 3 of this report and are further described in section 1.1.5 of this report. The remnant bushland occurring at the site has been identified as containing the endangered River-Flat Eucalypt Forest (RFEF) ecological community (NPWS 2002). The remnant RFEF community at the study site is being threatened by weed competition from both noxious and environmental weed species, and past and present land use activities.

1.1.2 Soil Landscapes

Soil landscape information for the study area was sourced from the Soil Landscapes of the Penrith 1:100 000 Sheet (Bannerman and Hazelton, 1990) and is displayed below as Figure 1. The soil landscape concept integrates geological and soil data with topographic or landform information of an area into one inclusive unit. Each soil landscape grouping has specific features, which are described and are capable of being presented on a map.

Soil landscape information can assist in determining a number of land management issues including:

- * Limitations to rural and urban development,
- * Erosion potential, general soil fertility & structure
- * Native plant community distribution.
- * The management of disturbed bushland remnants, including predicting responses to bushland regeneration, weed ecology and determining species selection in areas where native vegetation reconstruction works are needed, i.e. where original vegetation has been removed.

The dominant soil landscape grouping in the area of the study site is recorded by Bannerman and Hazelton (1990) as being a part of the Blacktown soil landscape group. The exact boundaries between the soil landscape groupings in Bannerman and Hazelton (1990) are not clear. The soil landscape map for the region Bannerman and Hazelton (1990) was originally prepared at a 1:25 000 scale and published on a 1:100 000 scale. The adjustment in scale has meant that localised soil landscapes of less than 40 ha in size are excluded from this map and boundaries between soil landscapes would be in some cases more gradual in their transition, than presented on the 1:100 000 scale maps.

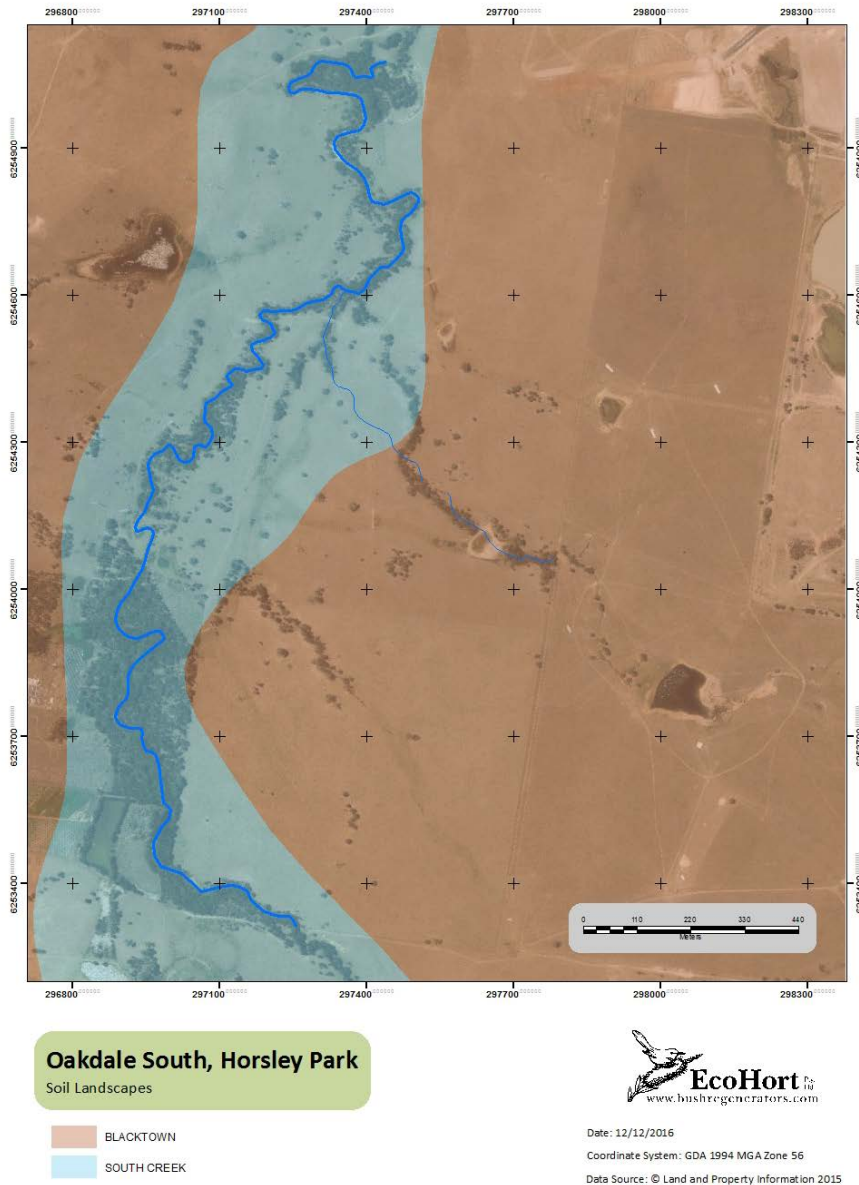


Figure 1: Soil landscapes as mapped by Bannerman and Hazelton (1990).

The Blacktown Soil Landscape Group generally occurs on the gently undulating rises of Wianamatta Shales with local relief of 10-30 metres and slopes generally less than 10%. Crests and ridges separating local creek catchments are typically broad (200-600 m) and rounded with convex upper slopes grading into concave lower slopes. This soil type is found on the higher slopes, above the drainage depressions where the South Creek grouping dominates.

The Ropes Creek riparian zone occurs in the South Creek soil landscape (Bannerman and Hazelton, 1990). The South Creek soil landscape is typical of the floodplains, valley flats, drainage depressions and incised channels of the Cumberland Plain. The underlying geology is Quaternary alluvium derived from Wianamatta Shales.

This dynamic soil landscape has many areas of erosion and deposition zones that occur on the stream banks and associated flood plains. Erosion and deposition are essentially natural processes, but in some cases have been compounded by the clearing of native vegetation and urbanisation of the catchment areas.

1.1.3 Overview of Remnant Native and Naturalised Vegetation and Threatening Processes

Mapping undertaken by NSW NPWS (2002) throughout the Western Sydney area indicates that the Oakdale South study area is mainly represented by cleared land with the exception of the riparian corridors (Figure 2). The upper Ropes Creek tributary is mapped as containing Alluvial Woodland with Shales Plains Woodland remnants located in adjoining areas (DEWCC, 2007). Field observations further identified that the Alluvial Woodland within the study site corresponded with the determinations for River-Flat Eucalypt Forest (RFEF).

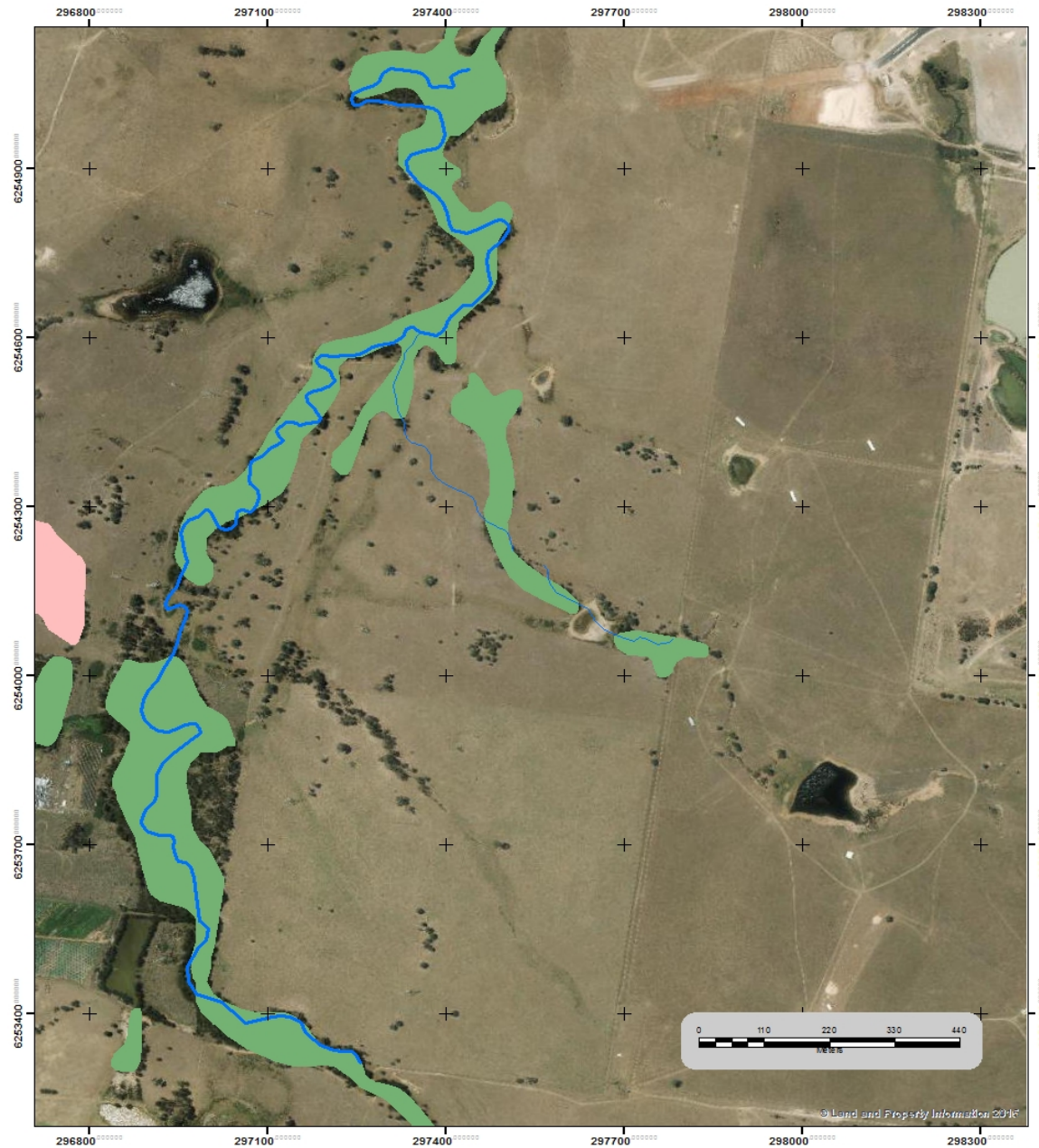
The main tributary is dominated by a canopy of *Casuarina glauca* with individuals occurring throughout the riparian corridor of *Angophora floribunda*, *Eucalyptus amplifolia*, *E. eugenoides*, *E. moluccana*, *E. tereticornis* and *Melaleuca styphelioides*. Despite the shrub layer being subjected to historical disturbances in relation to land clearing and grazing, a moderate level of diversity is still represented within the study area. Represented species include *Bursaria spinosa*, *Breynia oblongifolia*, *Acacia parramattensis*, *A. implexa* and *A. decurrens*. Despite being subjected to grazing and the historical encroachment of exotic pasture grasses, the ground layer supports grasses *Austrodanthonia* spp, *Aristida ramosa*, *Chloris ventricosa*, *Entolasia marginata* and *Danthonia* spp. with *Microlaena stipoides* located in more sheltered locations adjoining the creek line and beneath remnant trees. Other native ground covers observed within the riparian corridor included *Tetragonia tetragonoides*, *Asperula conferta*, *Pratia* spp, *Commelina cyanea*, *Dichondra repens*, *Centella asiatica*, *Dianella longifolia*, *Glycine* spp, *Brunoniella australis* and *Eremophila debilis*.

Exotic shrub species are generally limited within the areas supporting remnant riparian vegetation with scattered African Boxthorn and Green Cestrum the most commonly occurring. The dominant exotic species within the creek line itself is *Juncus acutus* with individuals scattered along the entire length of Ropes Creek, with *Tradescantia fluminensis* also well represented in the more protected locations. The grassy ground layer along the floodplain is generally grazed in most locations with the exotic species interwoven with the native grasses identified above. Along the creek line Couch (*Cynodon dactylon*), Kikuyu (*Pennisetum clandestinum*) and *Ehrharta* are all present accompanied by Paddy's Lucerne (*Sida rhombifolia*), *Solanum pseudocapsicum*, and Fireweed (*Senecio madagascariensis*). Isolated infestations of Blackberry (*Rubus anglocandicans*) are also present.

The southernmost remnant within the study site is not accessible to cattle grazing due to the creek line and existing adjoining stock-proof fence lines. With grazing limited to native macropods, some natural regeneration has occurred in this corner of the site however a more diverse representation of weeds is also present. These include African Olive (*Olea europaea* subsp. *cuspidate*), Lantana (*Lantana camara*), Bridal Veil Creeper (*Asparagus asparagoides*), Mother of Millions (*Bryophyllum delagoense*), Madeira vine (*Anredera cordifolia*), Dirty Dora (*Cyperus difformis*), Moth Vine (*Araujia sericifera*), and Creeper Mallow (*Modiola caroliniana*).

A number of naturally occurring shallow drainage basins or swales are located within the site, occurring along the headwaters of the smaller tributaries, on in the case of the largest basin, as a natural overflow basin to the main tributary, Ropes Creek. *Carex appressa* represents the most commonly occurring ground layer in these damp areas, accompanied by *Ranunculus inundatus* and *Persicaria decipiens*.

The grazed grasslands beyond the riparian corridor are dominated by exotic grasses with *Paspalum* (*Paspalum dilatatum*), Couch (*Cynodon dactylon*), *Briza subaristata* and Crab grass (*Digitaria sanguinalis*) the most commonly occurring. Native grasses are amongst the mix with *Aristida* spp, *Austrodanthonia* spp and *Bothriochloa* spp all located, with populations of *Microleana stipoides* observed in sheltered locations beneath remnant tree species. Native broadleaf species located within the grazed grasslands include *Glycine* spp, *Desmodium varians* and *Rubus* spp, with some regenerating local *Acacia* spp also located within close proximity to adjoining RFEF zones.



Oakdale South, Horsley Park

Remnant Vegetation within the Study Site

- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland

Figure 2: Remnant Native Vegetation - adapted from the NPWS Cumberland Plain Woodland mapping project.



Date: 12/12/2016
Coordinate System: GDA 1994 MGA Zone 56
Data Source: The Native Vegetation of the Cumberland Plain (DECCW, 2007)



While the remnant mapping by NPWS (2002) identified the remnants of bushland along the two creek lines as being RFEF, the Biodiversity Assessment Report for the Oakdale South site carried out by Cumberland Ecology (2015) identified these remnants as being Swamp Oak Floodplain Forest.

Swamp Oak Floodplain Forest (SOFF) is recorded by the Department of Environment and Conservation (2005b) as occurring below 10 metres elevation and on rare occasions up to 20 metres; and while the community is listed as supporting a dense to sparse tree layer in which *Casuarina glauca* is the dominant species, Eucalyptus species are not amongst the indicative species for the community.

River-Flat Eucalypt Forest (RFEF) is recorded as generally occurring below 50 metres elevation, and can occur up to 250 metres above sea level. Elevations for the project site range from 50 to 90 metres above sea level (NSW LPI, 2001) and as such are more indicative of elevation ranges recorded for RFEF than those listed for SOFF. Indicative tree species for RFEF include *Eucalyptus tereticornis*, *E. amplifolia* and *Angophora floribunda* with *Casuarina glauca* amongst the small tree species associated with the community (Department of Environment and Conservation, 2005a). These species have been observed at the site during field investigations and were previously described in the Biodiversity Assessment Report (Cumberland Ecology, 2015). It is recognised that the site has been referenced as being SOFF in Cumberland Ecology's, (2015) study, however it was considered more appropriate, (mainly from a revegetation species viewpoint), to refer to the vegetation at the site as being RFEF, from this point onwards in the VMP.

As of November 2016, and since the time of investigations undertaken for both the VMP and Biodiversity Assessment Report, a major upgrade to the NSW Plant Community Type (PCT) took effect for the Sydney Metropolitan region, with the publication of the approved classification changes in the BioNet Vegetation Classification database.

Appropriate to the Oakdale South site, is the inclusion of "Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley" (HN 674) which is a more appropriate PCT than SOFF (HN594). Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley is also included in the determinations for the River-Flat Eucalypt Forest (RFEF) EEC.

Table 1 in section 1.1.5 gives more detailed descriptions of the native and naturalised vegetation that occurs at the study site.

1.1.4 Summary of Threatening Processes Affecting Remnant Native Vegetation

This section gives an overview of the generic threatening process and management issues that are currently affecting native vegetation at the study site.

In the past remnant native vegetation within the study area and throughout the LGA has been extensively cleared and fragmented due to localised rural development, urbanisation, quarrying activities and more recently industrial developments. Remaining areas outside the designated areas of National Parks Estate tend to be narrow in shape and are threatened due to factors such as: agricultural practices and the high nutrient content of runoff; erosion and other impacts from infrastructure development works, and weed competition, which have simplified the floristic and structural diversity of these remnants.

The native vegetation at the study site has been significantly altered by past clearing, soil disturbances, and subsequent weed infestation. Weed associations now occur at varying percentage cover levels over the study area, with most areas being represented by weeds in all habitat niches, previously occupied by native plant species and communities.

Tables in Section 1.1.5 give zone specific descriptions of the generic threatening process and management issues currently affecting native vegetation at the study area.

1.1.5 Native Vegetation Categories and Threatening Process Overviews


The varying landscape settings, structural and floristic associations of the remnant native vegetation and degraded areas supporting naturalised plant associations at the study site were classified into 3 condition categories. These categories are described in the following Table 1, whilst the location of each category is depicted in Figure 3. The delineation of these categories was determined by considering abiotic and biotic factors outlined in section (iii) of this report.



Also included in Table 1 are estimates on native plant resilience, the main threatening processes and management issues affecting native vegetation health and structure at each category. The relative resilience level of each category was classified using the following rankings: high; medium to high; medium; low to medium; low; and very low.

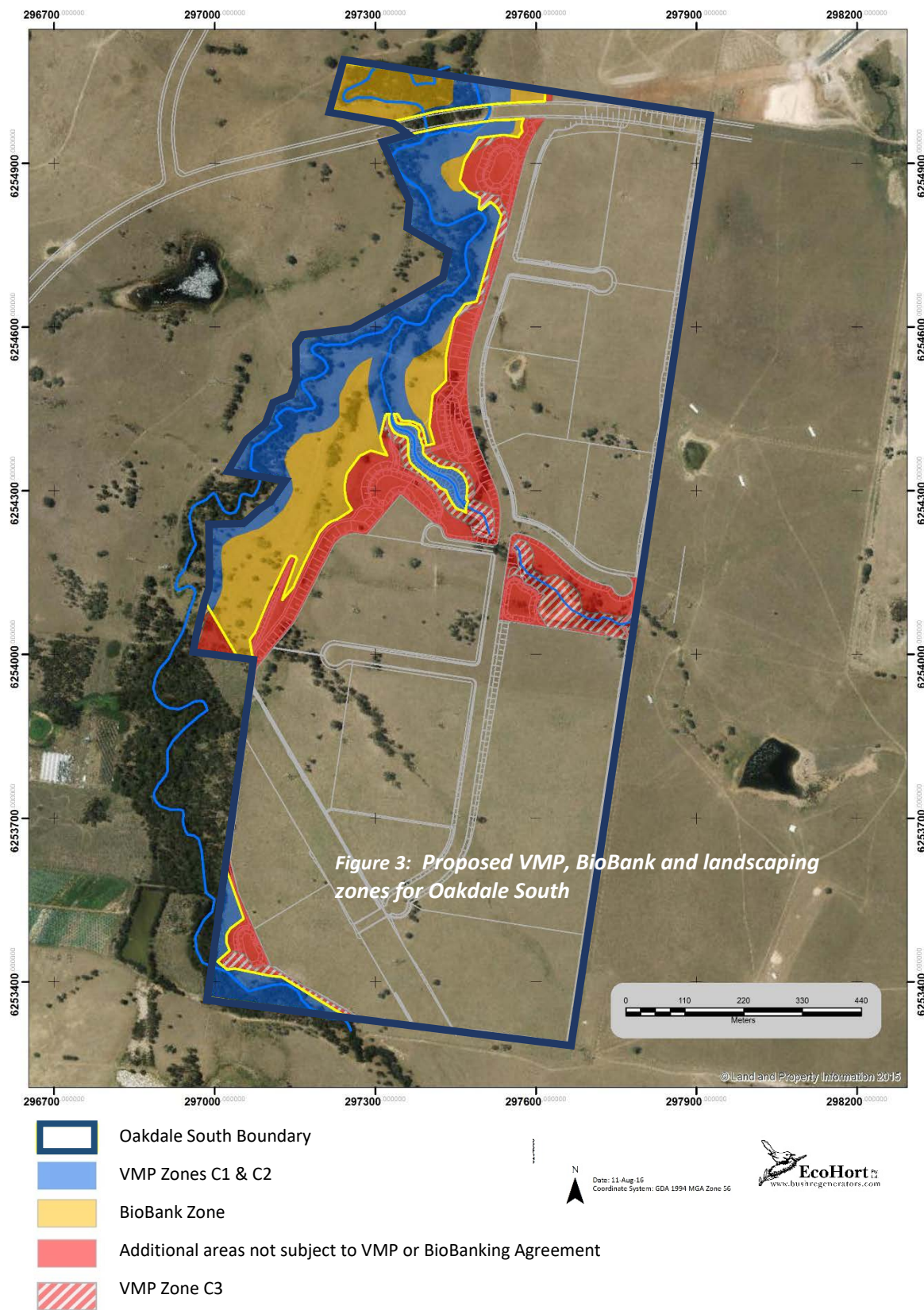
The 3- vegetation categories described at the study site are:

- | | |
|----|--|
| C1 | Remnant RFEF vegetation dominated by a canopy of <i>Casuarina glauca</i> - Swamp Oak open forest on riverflats of the Cumberland Plain |
| C2 | Mainly grazed open naturalised grassland, on Forest Red Gum-Rough-barked Apple grassy woodland of low condition habitat. |
| C3 | Regenerating Red Gum-Rough-barked Apple grassy woodland |

Table 1: Descriptions of various vegetation zones at the Oakdale South project site.

Category	Photo Example	Description	General Location	Resilience of Native Vegetation	Main Naturalised Plant Associations	Threatening Processes Affecting Native Vegetation
C1		Remnant RFEF vegetation dominated by a canopy of <i>Casuarina glauca</i> .	Located along Ropes Creek within the project site as well as along the banks of the main tributary.	This category is dominated by a canopy of remnant <i>Casuarina glauca</i> accompanied by <i>Eucalyptus eugenioides</i> , <i>E. tereticornis</i> , <i>E. moluccana</i> , <i>Angophora floribunda</i> and <i>Melaleuca styphelioides</i> . Various <i>Acacia</i> species are well represented in the shrub layer with <i>Acacia implexa</i> , <i>A. decurrens</i> , <i>A. floribunda</i> and <i>A. parramattensis</i> being present with scattered <i>Bursaria spinosa</i> occurring in areas particularly further away from the creekline. A diverse variety of native ground layer plant species are scattered throughout with <i>Microleana stipoides</i> , <i>Tetragonia tetragonoides</i> , <i>Pratia purpurascens</i> , <i>Commelina cyanea</i> , <i>Dianella longifolia</i> , <i>Galium propinquum</i> , <i>Brunoniella australis</i> , <i>Eremophila debilis</i> , various <i>Austrodanthonia</i> spp, <i>Cheilanthes sieberi</i> and <i>Entolasia marginata</i> , all being well represented present. Given the extent of remnant vegetation within the category, a medium to high level of natural resilience is expected.	Sections of the creekline are supporting scattered populations of <i>Juncus acutus</i> within the channel. Areas adjoining the creek bank are supporting moderate populations of grazed exotic grasses particularly couch and Kikuyu with scattered individuals of African Boxthorn, Green Cestrum and Blackberry. Additional naturalised species are located in areas not subjected to grazing including Madeira Vine, Moth Vine, Bridal Veil Creeper, Ehrharta, Wandering Jew and Turkey Rhubarb.	Remnants of RFEF vegetation within the project area are small and fragmented. Past and present land uses have resulted in the clearing of neighbouring vegetation, disturbance and compaction of soils and the encroachment of pasture grasses of exotic sedges, all of which have put pressures on the ability for the remnant to regenerate and expand.

Category	Photo Example	Description	General Location	Resilience of Native Vegetation	Main Naturalised Plant Associations	Threatening Processes Affecting Native Vegetation
C2		Mainly open naturalised grassland dominated grazed Forest Red Gum-Rough-barked Apple grassy woodland of low condition.	Located in grazed areas away from tributaries and Ropes Creek.	Despite being subjected to grazing, this category does support a low percentage cover of native grass species including <i>Aristida</i> spp, <i>Austrodanthonia</i> spp and <i>Bothriochloa</i> spp, with <i>Microleana stipoides</i> also occurring in more sheltered situations. Additional native species scattered throughout this category include <i>Glycine</i> spp, <i>Desmodium</i> varians, <i>Rubus</i> spp and various <i>Acacia</i> spp seedlings. It is estimated that this category has a representative native ground layer cover in excess of 10%.	High percentage cover of naturalised grasses dominate this grazed category with <i>Paspalum</i> , Couch and Crab Grass the most commonly occurring, accompanied by Fireweed and Paddys Lucence. Isolated thickets of Blackberry and individual African Boxthorn are also present.	Areas falling into this category have been subjected to historical land clearing as well as ongoing pressures from grazing stock. This combined with soil compaction has favoured the pasture grasses and limited the opportunities for native vegetation to regenerate.
C3		Regenerating Red Gum-Rough-barked Apple grassy woodland.	Located south of the large central biodiversity zone as well as isolated pockets that include remnant trees and natural drainage swales in the head waters of the smaller tributaries.	Areas included within this category are displaying moderate levels of natural resilience. Regenerating <i>Eucalyptus</i> spp are accompanied by <i>Bursaria spinosa</i> and <i>Acacia</i> spp. with <i>Bothriochloa</i> spp, <i>Microleana stipoides</i> , <i>Echinopogon</i> spp, <i>Aristida</i> spp, <i>Pratia purprescens</i> and <i>Asperula conferta</i> . Natural drainage swales support <i>Carex appressa</i> , <i>Persicaria decipiens</i> , <i>Ranunculus inundatus</i> and <i>Marsilea hirsuta</i> .	Exotic plant species present within this category are comparable with the diversity of those in this category. Crab Grass, Couch, <i>Paspalum</i> , African Lovegrass and <i>Briza subaristata</i> are common ground layer species with localised infestations of Blackberry present.	Historically category 3 has been subjected to historical land clearing and grazing pressures comparable to adjoining this category area however given the regeneration that has occurred, it appears that recent grazing pressures have reduced in comparison to adjoining C2 areas.



1.2 LEGISLATIVE AND BEST PRACTICE CONSIDERATIONS

It is anticipated that the implementation of site-specific, best practice bushland restoration measures recommended in this VMP within the identified management areas will contribute to abating the threatening processes that are impacting on the remnant bushland at the study site.

Impacts resulting from proposed developments carried out in, on or under waterfront land and within 40 metres of a river, lake or estuary are required to be assessed by the NSW Office of Water for approval as a controlled activity under the Water Management Act (2000). The purpose of the act is to ensure that the development will result in minimal harm to waterfront land and that the riparian areas are protected or restored to maintain or improve the geomorphic form and ecological functions of the watercourse (Department of Water and Energy, 2008).

The Oakdale South development falls under Part 3A (Major Projects) of the Environmental Planning and Assessment Act (EPA Act) 1979 and while developments assessed under Part 3A of the EPA Act do not require a permit under the Water Management Act (2000), consultation with the Office of Water regarding riparian management is a requirement of the assessment (AECOM, 2014).

The recommendations outlined in this VMP support the aims of the Water Management Act (2000), creating a transition zone between terrestrial and aquatic environments. A Riparian Corridor Assessment for the Oakdale South development site has been produced by AECOM (2015) and outlines the stream categories at the project site.

Ropes Creek was identified as a 3rd Order Watercourse, with the tributary which runs from east to west through the Biodiversity zone was classified as a 1st Order Watercourse. As such the recommendations regarding restoration works within the riparian zones as outlined in Table 2 include a Vegetated Riparian Zone of 10 metres from the top of the bank for a 1st Order Waterway, and 30 metres for a 3rd Order Waterway. The resulting riparian corridor is required to be maintained or rehabilitated with fully structured native vegetation.

Table 2: Stream Categories and recommended riparian zones for the Oakdale South project site

Stream	Waterway Category	Vegetated Riparian Zone Width (each side of watercourse)	Total Riparian Corridor Width
Upper Tributary	1 st Order	10 metres	20m + channel width
Ropes Creek	3 rd Order	30 metres	60m + channel width

From the Riparian Corridor Assessment: Oakdale South (AECOM, 2015)

The above recommendations for the riparian zone at Oakdale South are consistent with the NSW Office of Water, Water Management Act (2000) guidelines, and as such have been adopted within this VMP.

The control of a broad range of weeds during proposed restoration works would ensure that weed species that occur at the study site and require suppression under the provisions of the Noxious Weeds Act 1993 are controlled. Mother of Millions (*Bryophyllum delagoense*) was the only plant observed during field investigations that appear under the Noxious Weeds declaration for the Penrith LGA as class 3 meaning that plants are required to be fully and continuously suppressed and destroyed.

Other species listed under the LGA's declaration located onsite are class 4. These are African Boxthorn, African Olive, Blackberry, Bridal Creeper and Lantana.

All proposed performance based restoration recommendations outlined in this VMP should ensure compliance to recognised bushland management best practice guides, such as:

- Bush Regeneration, Recovering Australian Landscapes (Buchanan 1993);
- The Bush Regeneration Handbook (National Trust of Australia NSW, 1991);
- Bringing Back the Bush to Western Sydney-Best Practice Guidelines for Bush Regeneration on the Cumberland Plain (DWE 2003);
- Methods advocated by the Australian Association of Bush Regenerators on their website: www.aabr.org.au.

SECTION 2: BUSHLAND MANAGEMENT RECOMMENDATIONS

2.1 RESTORATION OVERVIEW

Section 2 outlines the various restoration treatments recommended for the abatement of threats and restoration/reconstruction of the biodiversity areas at the Oakdale South study site along Ropes Creek and an upper tributary, Horsley Park. A summary of these recommended protection and management treatments is summarised in Table 3 with a map of the proposed management zones included in Figure 4.

The following factors were considered in determining the most appropriate restoration and rehabilitation methods for the study site:

- Adapting best practice restoration principles and techniques and conforming to statutory requirements outlined in Section 1.2.
- Liaison with various practitioners and providers of established and innovative restoration and rehabilitation techniques and products.
- Feedback from the client to assist in the formulation of the most appropriate restoration and rehabilitation designs and strategies for the project

A total of 3 management zones, Zones 1, 2, and 3, (and 1 sub-zone, Zone 1a), all with varying management recommendations, as depicted in Table 3, were applied to the VMP study site.

Bushland regeneration works should be implemented in areas where natural regeneration is likely, by removing obstacles and making amendments to abiotic conditions to effect the regeneration of remnant native vegetation with varying resilience levels. Bushland regeneration weeding is to be implemented within Zones 1 and 2 at the Oakdale South site.

“Reconstruction” or “Reconstruction through Revegetation” strategies that aim to restore a diverse range of native plant species and associations from all structural layers of the local native vegetation communities should be implemented in areas where native plant resilience has been depleted. Revegetation activities at the Oakdale South site are to be implemented within selected areas of Zone 2 and all of Zone 3.

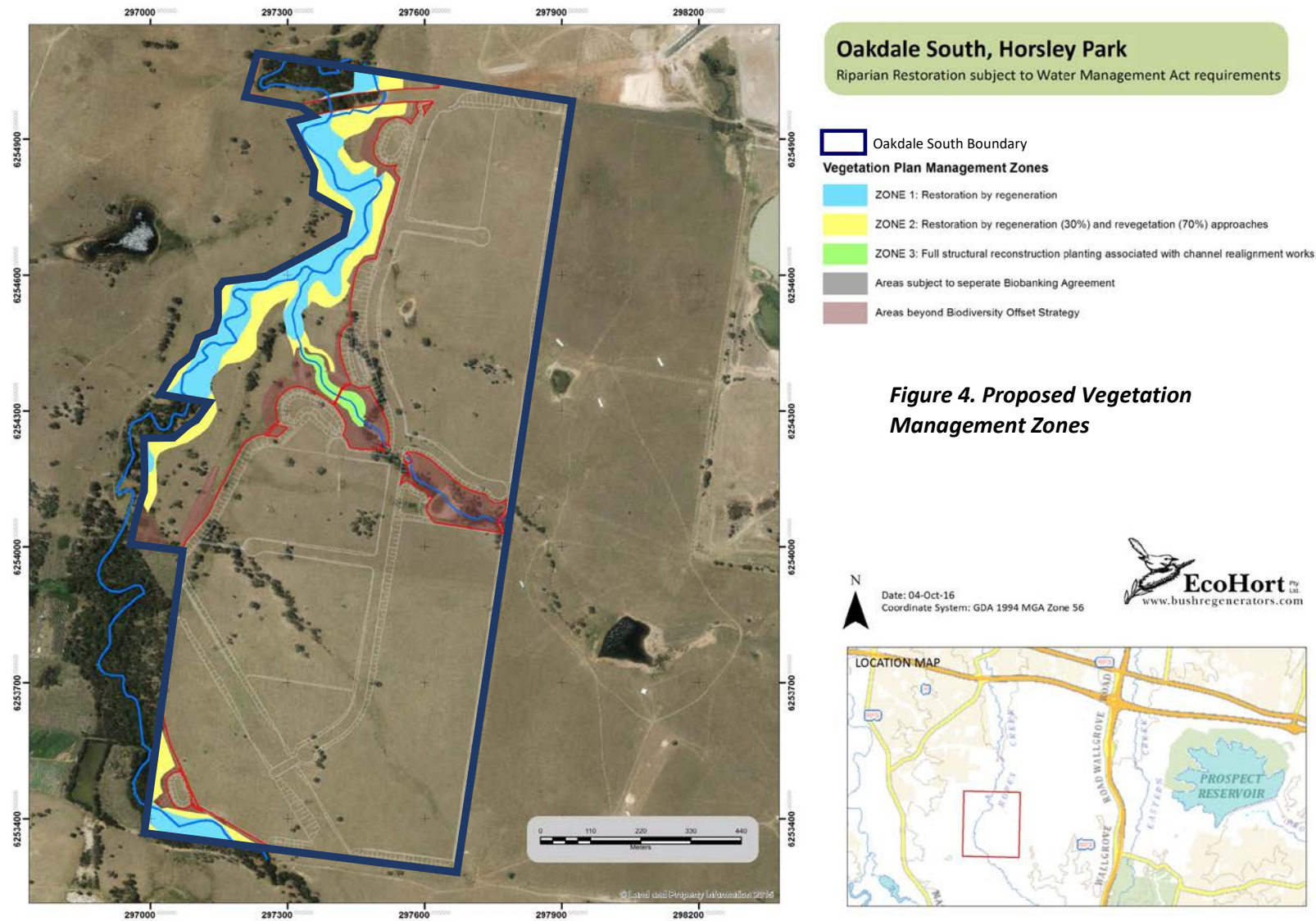
Appropriately experienced and qualified bush regeneration contractors should carry out all proposed bush regeneration and reconstruction works.

Table 3: outlines the general restoration treatments recommended for each management zone within the Oakdale South project area.

Zone	Description	Treatment
1	Remnant RFEF vegetation dominated by a canopy of <i>Casuarina glauca</i> , which will be subject to bush regeneration treatments	<ul style="list-style-type: none"> • Hand removal of scattered Green Cestrum, Lantana and African Boxthorn using cut/scrape and paint techniques. • Chipping up of woody weeds and removal of green waste. • Hand weeding around non-target native plant species in preparation for spraying activities. • Slashing of <i>Juncus acutus</i> followed by non-selective spot spraying of slashed Juncus and exotic ground layer species. • Skirting and scrape and painting/spot spraying of naturalised climbers. • Follow up maintenance.
1a	Remnant RFEF vegetation dominated by a canopy of <i>Casuarina glauca</i> , within the Transmission Line easement	<ul style="list-style-type: none"> • Management for Zone 1a is the same as for Zone 1, and even though the area may be subject to periodic Transmission Line related maintenance activities by the relevant Utility Management entity, it was deemed necessary to manage this area as a part of this VMP, to prevent weeds encroaching from Sub-Zone 1a into adjoining parts of the VMP works area.
2	Mainly open naturalised grassland dominated heavily grazed and regenerating grassy woodland	<ul style="list-style-type: none"> • Hand removal of scattered African Boxthorn using cut/scrape and paint techniques. • Chipping up of woody weeds and removal of green waste. • Targeted selective spraying of Blackberry • Hand weeding around non-target native plant species in preparation for spraying activities. • Slashing of <i>Juncus acutus</i> followed by non-selective spot spraying of slashed Juncus and exotic ground layer species. • Spraying out of exotic grasses using a combination of selective and non-selective herbicides and high volume and low volume applications. • Direct seeding using native grass seeds over low resilience areas of the zone (up to 70% of total zone), using a combination of hand sowing, direct drilling and hydroseeding as and where appropriate. • Installation of local RFEF tree species in V93 Hiko containers at a density of 1 plant per 16m² across the areas subjected to direct seeding. • Installation of local RFEF shrub species in V93 Hiko containers at a density of 1 plant per m² across 50% of the areas subjected to direct seeding. • Follow up maintenance

Zone	Description	Treatment
3	Realigned drainage line channel area	<ul style="list-style-type: none"> • Ensure that the site soils in Zone 3 have been ameliorated to the standards outlined in the SESL (2015) soils report that applies to this section of realigned drainage channel, as a part of the civil/bulk earthworks phase of this overall project, before any subsequent VMP specified works are undertaken. • Supply & install a 75mm layer of weed free woodchip/leaf mulch to areas above the immediate flood zone of the channel. This treatment is estimated to occur over 70% of the Zone 3 realigned channel area. • Supply & install 800gsm jute matting, as per product specifications, as a mulch layer for the areas within the immediate flood zone of the channel. An allowance has been made for this treatment to occur over 30% of the Zone 3 realigned channel area. • Installation of local RFEF grasses, sedges and ground cover species in V93 Hiko containers at a density of 4 plants per m². • Installation of local RFEF shrub species at a density of 1 plant per m² over 50% of the zone. • Installation of local RFEF tree species at a density of 1 plant per 16m² over the entire zone. • Follow up maintenance

Figure 4. Vegetation Management Zones



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2.2 BUSHLAND REGENERATION DEFINITION

McDonald (1993) gives the following definition for bush regeneration:

- *Where resilience exists...and only removal of obstacles and minor amendment of abiotic conditions are needed to effect recovery by natural regeneration.*
It applies to areas (of disturbed bushland) where there is perceived native plant resilience in the form of soil stored and/or nearby propagules, which together with time and some degree of intervention in the form of hydrological or heat treatments and weed control will affect recovery by natural regeneration

The Australian Association of Bush Regenerators defines bush regeneration as: *the practice of restoring bushland by focusing on reinstating and reinforcing the system's ongoing natural regeneration processes.*

DWE (2003) define "Assisted Natural Regeneration" as: *aiming to trigger the growth of native propagules (such as seed, tubers or rhizomes etc) already present on site or having the ability to migrate onto the site, and aided by suitable management, to allow natural regeneration processes to occur.*

From this point forward this form of *in-situ* restoration will be collectively referred to as: "bushland regeneration".

2.3 BUSHLAND RECONSTRUCTION DEFINITION

McDonald (1993) gives the following definition for bushland reconstruction: *where resilience is depleted...and abiotic condition or biotic elements need wholesale importation or major amendment before ecosystem functions can recommence.*

Bushland reconstruction should be implemented in areas where native plant resilience is depleted due to past disturbance mechanisms, but site conditions are still suitable for the "reconstruction" (re-planting and /or re-seeding) of local River-Flat Eucalypt Forest (RFEF) species and associations.

This may also include restoring currently missing structural layers such as the shrub or tree layers in areas where resilient native ground layer species still persist and have the potential to spread naturally.

DWE (2003) define Reconstruction through Revegetation as: *involving the introduction of locally indigenous plant species, modelled on the diversity and structural characteristics of the original plant community. It is carried-out by planting or re-introducing propagules.*

From this point forward this form of *ex-situ* restoration will be collectively referred to as: "bushland reconstruction."

2.4 PROPOSED BUSHLAND REGENERATION WORKS

2.4.1 Aims and Summary of Proposed Bushland Regeneration Works

The aims of the proposed bushland regeneration program are to achieve the following performance based outcomes, using a range of integrated best practice techniques:

- Control threats, affecting the health of remnant RFEF inhibiting the regeneration potential of these plant communities.
- Increase species diversity and percentage cover of RFEF plant species throughout designated bushland areas within the study site.

- Make the RFEF bushland areas more resistant to future weed colonization and establishment related threats, by affecting the two above aims.
- Working towards adequately resourcing vegetation restoration works at the Oakdale South project site.
- Use measurable indicators to monitor the progress and success of bush regeneration works.

Proposed bushland regeneration works should be approached using the strategies outlined in Sections 2.4.2 to 2.5.7.

Bush regeneration weeding alone is proposed in Zone 1, whilst a combination of bush regeneration weeding and some supplementary bushland reconstruction native grass seeding and planting is proposed in Zone 2.

Consideration should be given to implementing supplementary planting or seeding if natural regeneration does not occur at anticipated levels in low resilience parts of the designated zones. Also the extent of mulching in low resilience parts of the site should be limited so that any potential natural regeneration is not inhibited in these areas, (should supplementary planting and mulching be deemed necessary in such areas).

2.4.2 Primary Weeding

Primary weeding is the first stage of bushland regeneration. Primary weeding may involve techniques such as: the selective spraying of weeds with herbicides; cutting/scraping and painting deep rooted woody weeds and climbers with hand tools, chainsaws and brushcutters and painting cut stumps with herbicide; target drilling and injecting certain large tree weeds such as willow and privet with herbicides such as Glyphosate and a garlon/diesel mix; and selective hand removal of weeds.

Damage to native plant species should be avoided during any bush regeneration weeding works. All seed, flowering and invasive vegetative parts of weeds should be bagged and disposed of site in an appropriate green waste recycling facility.

Primary weeding is required in all zones of the Oakdale South site. Initial weeding of woody and noxious weeds should be undertaken across all management zones during year 1. It would be expected that follow-up weeding would be required between 2 and 4 months following the completion of primary weeding, and continue for a period of 2 years as outlined in the costing table included section 3.1.

Mulch that may be produced from any woody weed material that is chipped during the primary weeding process should in general not be placed in parts of the site where it is intended to promote natural regeneration to ensure that the regeneration process is not inhibited.

2.4.3 Follow up Weeding

Follow-up weeding should be undertaken in areas that have received past primary weeding treatments. Follow-up weeding involves the selective removal or treatment of weeds, whilst allowing regenerating or planted native plants to increase in size, abundance and percentage cover. All weeds should be targeted during the follow up weeding phase. The follow-up bushland regeneration works are likely to be required at least every 2-4 months at a site until weeds are at negligible levels.

It is recommended that woody weeds, climbers and key herbaceous weeds are subject to a program of intense follow up weeding, around any patches of regenerating native herbaceous plants, to encourage the spread of these desirable native plant species for a minimum period of 5-years.

2.4.4 Maintenance Weeding

Maintenance weeding is undertaken in areas where native plant regeneration has significantly progressed to the stage where native plants occur at high percentage cover levels.

It can be expected that the bushland areas at the study site will always require a certain level of bushland regeneration maintenance weeding, as weed seeds and vegetative propagules make their way on site from the soil stored seedbank, and via wind and bird droppings. However, it can be expected that, the amount of weeding required will decrease once the regenerating native plants grow, recover and become more resistant to disturbance and weed colonisation.

All herbaceous weeds should be managed to be at very-low percentage cover levels, (as a minimum), or better. Particularly problematic herbaceous weeds with wind-blown seeds should be prevented from seeding at all times throughout the site.

Pasture grasses should be prevented from spreading into any bushland zones by applying a spot glyphosate herbicide spray application on the 1-metre wide buffer zone, on a monthly basis or as required.

Adaptive management/restoration practices should be adopted if any of the recommended actions do not lead to expected levels of native plant species regeneration.

2.5 PROPOSED BUSHLAND RECONSTRUCTION WORKS

2.5.1 Aims and Summary of Proposed Bushland Reconstruction Works

The aims of the bushland reconstruction strategies at the site are to achieve the following performance based outcomes, using a range of integrated best practice techniques:

- Decrease the extent of weed competition and other RFEF degrading threats in defined localised zones (as outlined in section 1.1.5).
- Strengthen currently degraded, resilience depleted areas against future weed colonization and establishment related threats by reconstructing a competitive and potentially diverse range of native plant species and associations from all structural layers of the RFEF, using a variety of specified revegetation treatments.
- Reconstructing certain structural elements within core bushland areas, in instances where local native plants from these structural layers are unlikely to regenerate naturally, using prescribed techniques, (e.g. high density groundlayer plantings within the immediate drainage line channels).
- A variety of reconstruction strategies that involve the re-planting of local RFEF plant species should be implemented. These include reconstructing plants from tree, shrub and ground structural layers throughout areas with depleted native plant resilience as appropriate.
- Use measurable indicators to monitor the progress and success of Bushland Reconstruction works in the designated management zones and to assist in prioritising bushland reconstruction works during the proposed works program. These indicators include:
 - A revegetation success rate of between 90-100%. Provision has been made for a 10% plant replacement component in this VMP, however this may need to be adjusted to reach the prescribed 90-100% revegetation success rates.
 - An 80-100% reduction in weed cover within all revegetation zones.

Recommended reconstruction strategies in the above-outlined zones should include:

- Control of weeds using bushland regeneration techniques and conventional best practice chemical and physical strategies.
- Specifically collecting local plant seed and vegetative material and the subsequent propagation of local native plant material in cell-grown seedling containers and for direct seeding of native grasses and forbs.
- Installing suitable propagated cell-grown seedlings, using specified techniques, species composition schedules and rates.
- Stabilising soils and suppressing weeds around reconstruction planting areas using products, such as jute/coconut fibre mats and mulch.
- Maintaining reconstruction treatments (including watering, weeding, replacing dead plant material and repairing / replacing weed mat/mulch), as a part of the 5 year maintenance program.

2.5.2 Selection of Suitable Species for Reconstruction Treatments

Local native RFEF plant species should be used for all proposed reconstruction planting works. This material should be collected using principles prescribed in 'Bringing the Bush back to Western Sydney' document (DWE 2003). Seeds and vegetative propagules are to be of local provenance collected from the local area within the Penrith and adjoining LGA's up to 15km from the study site.

Trees, shrubs, broadleaf herbs, grasses and sedges from the RFEF plant communities should be used in all proposed bushland reconstruction plantings (and supplementary seeding works), using schedules and densities outlined in other parts of this report. Table 4 summarises some of the suggested RFEF plant species, and additional notes that could be used for proposed reconstruction works.

Other species can be added onto these lists if propagation material is available during the proposed seed and vegetative material collection works periods. Some species in Table 4 and 5 may not be available due to rarity in the local area or because of poor morphological condition or seasonal conditions. Plant species not available can be substituted by other species from this list or from species collected from the local area.

Table 4: RFEF Plant species that can be used for proposed reconstruction plantings. All material should be collected from the site or within a 15 Kilometre radius of the site or along similar habitats along Ropes Creek

Plant growth form/genus species	Propagation method
Canopy and sub-canopy trees/large shrubs	
<i>Acacia implexa</i>	Seed
<i>Acacia decurrens</i>	Seed
<i>Acacia parramattensis</i>	Seed
<i>Angophora floribunda/subvelutina</i>	Seed
<i>Casuarina glauca</i>	Seed
<i>Eucalyptus amplifolia</i>	Seed

Plant growth form/genus species	Propagation method
<i>Eucalyptus crebra</i>	Seed
<i>Eucalyptus eugenioides</i>	Seed
<i>Eucalyptus moluccana</i>	Seed
<i>Eucalyptus tereticornis</i>	Seed
<i>Exocarpus cupressiformis</i>	Seed or cutting
<i>Melaleuca linariifolia</i>	Seed
<i>Melaleuca styphelioides</i>	Seed
Smaller shrubs	
<i>Acacia falcata</i>	Seed
<i>Acacia floribunda</i>	Seed
<i>Breynia oblongifolia</i>	Seed or cutting
<i>Bursaria spinosa</i>	Seed
<i>Clerodendrum tomentosum</i>	Seed
<i>Daviesia genistifolia</i>	Seed
<i>Daviesia ulicifolia</i>	Seed
<i>Dillwynia sieberi</i>	Seed
<i>Dodonaea viscosa spp cuneata</i>	Seed
<i>Goodenia ovata</i>	Seed or cutting
<i>Hardenbergia violacea</i>	Seed
<i>Indigophora australis</i>	Seed
<i>Notelaea longifolia</i>	Seed or cutting
<i>Ozothamnus diosmifolium</i>	Seed
<i>Pultenaea microphylla</i>	Seed
<i>Rubus parviflorus</i>	Seed or cutting
Broadleaf herbs, grasses and sedges	
<i>Alternanthera denticulata</i>	Seed or cutting
<i>Aristida ramosa</i> or <i>vagans</i>	Seed
<i>Arthropodium spp</i>	Seed or divide tubers
<i>Bothriochloa decipiens</i>	Seed
<i>Caesia spp</i>	Seed or divide tubers
<i>Capillipedium parviflorum</i>	Seed
<i>Centella asiatica</i>	Divide rhizome

Plant growth form/genus species	Propagation method
<i>Chloris truncata</i>	Seed
<i>Chloris ventricosa</i>	Seed
<i>Commelina cyanea</i>	Cutting or rhizome
<i>Cyperus gracilis</i>	Seed or rhizome
<i>Danthonia</i> spp (various local native species)	Seed
<i>Dianella longifolia</i>	Seed
<i>Dianella revoluta</i>	Seed
<i>Dicanthium sericeum</i>	Seed
<i>Dichelachne micrantha</i>	Seed
<i>Dichondra repens</i>	Divide rhizome
<i>Einadia hastata</i>	Seed or cutting
<i>Einadia polygonoides</i>	Seed or cutting
<i>Einadia trigonus</i>	Seed or cutting
<i>Elymus scaber</i>	Seed
<i>Eragrostis leptostachya</i>	Seed
<i>Eriochloa pseudoachritcha</i>	Seed
<i>Eremophila debilis</i>	Seed or cutting
<i>Entolasia marginata</i>	Seed
<i>Glycine tabacina</i>	Seed or cutting
<i>Hydrocotyle penduncularis</i>	Divide rhizome
<i>Imperata cylindrica</i>	Seed or divide rhizome
<i>Lomandra longifolia</i>	Seed
<i>Mentha diemenica</i>	Seed or cutting
<i>Microlaena stipoides</i>	Seed
<i>Oplismenus imbecillis</i> or <i>aemulus</i>	Seed or cutting
<i>Poa labillardieri</i>	Seed
<i>Pratia purpurascens</i>	Cutting
<i>Ranunculus plebius</i>	Seed
<i>Rumex brownii</i>	Seed
<i>Scaevola albida</i>	Cutting
<i>Solanum prinophyllum</i>	Seed
<i>Sorghum leiocladum</i>	Seed
<i>Themeda triandra</i>	Seed

Plant growth form/genus species	Propagation method
<i>Vittadinia spp</i>	Seed or cutting
<i>Wahlenbergia spp</i>	Seed
Climbers	
<i>Clematis glycinoides</i>	Seed
<i>Convolvulus erubescens</i>	Seed
<i>Geitonoplesium cynosum</i>	Seed or cutting
<i>Polymeria calycina</i>	Seed
Wetland Plants	
<i>Alisma-plantago aquatica</i>	Seed
<i>Baumea articulata</i>	Seed or divide rhizome
<i>Bolboschoenus caldwelli</i>	Seed or divide rhizome
<i>Carex appressa</i>	Seed
<i>Eleocharis gracilis</i>	Seed or divide rhizome
<i>Eleocharis spachelata</i>	Seed or divide rhizome
<i>Juncus prismatocarpus</i>	Seed or divide rhizome
<i>Juncus usitatus</i>	Seed or divide rhizome
<i>Ludwigia peploides</i>	Seed, cutting or divide rhizome
<i>Marsilea hirsuta</i>	Divide rhizome
<i>Myriophyllum spp</i>	Seed or divide rhizome
<i>Nymphoides germinta</i>	Seed or divide rhizome
<i>Ottelia ovalifolia</i>	Seed
<i>Paspalum distichum</i>	Seed or divide rhizome
<i>Phragmites australis</i>	Seed or divide rhizome
<i>Ranunculus inundatus</i>	Seed or divide rhizome
<i>Schoenoplectus validus</i>	Seed or divide rhizome
<i>Triglochin procerum</i>	Seed or divide rhizome

2.5.3 Collection and Containerised Plant Production Procedures for Plant Material for Proposed Bushland Reconstruction Treatments

Prior to the initiation of bushland reconstruction planting works it will be necessary to collect or source suitable quantities of local native seed and vegetative material, to ensure suitable numbers of local provenance RFEF seed and vegetative material stocks are available for the plant propagation phase of the proposed bushland reconstruction works program.

Seed and vegetative material collection programs should be implemented using techniques and principles outlined in the "Florabank Guidelines" and by DWE (2003).

Local native plants should be grown-on in "hiko" tube, maxi cell or viro-tube, or Forestry Tube-type containers. For the budgeting of works outlined in this VMP, ground layer, tree and shrub species have been costed for supply as V93 Hiko containers.

It may be necessary to get the required amounts of seed and vegetative material contract collected and grown-on by specialist nurseries.

2.5.4 Containerised Plant Installation Considerations

Planted material should be installed as per recommended plant densities and species mixes and maintained to ensure maximum survival.

To reduce initial water stress to newly planted cell-grown seedlings, it is recommended that mulch and water retention crystals are applied at planting.

The addition of slow release, low phosphorous fertiliser at planting may also assist in promoting rapid growth during the establishment period.

Planted and seeded areas should be maintained by appropriately qualified people selectively spot spraying and hand weeding weeds from around native plants, watering plants as needed and replacing dead plants as required. Plants that have died due to drought, flooding, vandalism or pest and disease should be replaced with appropriate stock, when available.

The plant installation costing in this VMP has assumed that V93 Hiko containers will be used.

2.5.5 Detailed Planting Regimes

2.5.5.1 Replanting Plants from Tree and Shrub Structural Layers

Areas where no native plants persist will have to be planted-out to reconstruct the tree and shrub layers using local native plant material.

Generally trees are to be planted at 4 metre spacings (i.e. 1 per 16m²), and shrubs at a density of 1 plant per square metre over 50% of the revegetated area. Sedges and grasses are to be installed at a density of 4 plants per square-metre squared. All tubestock will be supplied in V93 Hiko containers.

All naturalised plants in these designated cell-grown seedling planting sites should be treated to a slashing treatment followed-up by treatments with a non-selective herbicide spray to attain 100% kill of all weeds prior to any further soil preparation, mulching, jute/coconut fibre matting, direct seeding or planting. It may be necessary to treat herbaceous weeds to an additional non-selective weed treatment to ensure that all naturalised plants are eradicated.

2.5.5.2 Maintenance of Reconstruction Areas

After planting and native grass seeding and translocation works have been completed, treated areas should be maintained by appropriately qualified people, selectively spot spraying and hand weeding around native plants, watering plants and replacing dead plants as needed.

Provision should be made to irrigate newly reconstructed areas, as required, in the first 3 months after installation, (on at least 4-5 occasions, depending on rainfall conditions, more waterings if required). The Contractor is to be responsible for securing an appropriate water source for this purpose. On the provision that a licence is attained, this may involve pumping water for irrigation purposes directly from Ropes Creek. Otherwise water carts or mains water may be used for irrigating installed plants.

Re-growing environmental weeds such as vines, woody trees and shrubs, broadleaf annuals and naturalised grasses should be closely monitored and controlled using ecologically sensitive bushland regeneration hand weeding and spot-spraying methods, to ensure adequate weed control and native plant establishment.

Plants that have died due to drought, flood damage, vandalism or pest and disease damage should be replaced as required.

2.5.6 Direct seeding native grasses in the Low Resilience Parts 70% Parts of Zone 2

The groundlayer in the low resilience parts of Zone 2 and the batters of Zone 4 should be restored by direct seeding native grasses. In Zone 2 this should be undertaken after the areas have been subject to selective herbicide treatments to try to maintain as many native broadleaf peas as possible. It is estimated that this groundlayer restoration treatment is suitable for around 70% of the low resilience parts of Zone 2 at the study site. Initial non-selective weed control and slashing may be required on the Zone 4 batters before native grass sowing is initiated. Native grass direct seeding is also recommended over 100% of the Zone 4 batters, to restore a native grass dominated groundlayer that can act as a fuel reduced zone between the other fully structured restored VMP works zones and the adjoining development area.

The mix of native grass seed that is proposed is a good indicative mix of many of the common and dominant native grasses that occur in the local and greater western Sydney area. A mix of native grass seed including species such as *Chloris truncata*; *C. ventricosa*; *Themeda triandra*; *Bothriochloa macra*; *Austrodanthonia* spp; *Dicanthium sericium*; *Eragrostis leptostachya*; *Aristida ramosa/vagans* mix; *Microlaena stipoides*, *Poa labillardieri* and *Capillipedium spicigerum* can either be collected from the local area or sourced from specialist suppliers. This seed mix should be gently threshed into a blend for consistent mixing and ease of weighing, handling and hand-broadcasting.

It is recommended that this seed mix is sown either by hand, by direct drilling or hydroseeding at a rate of 5 grams per m² or 50kg per hectare.

Hand sown seed should be mixed with a peat moss and sand mix at a rate of 5kg of peat and sand per 1kg of grass seed. Covering the hand sown grass seed with a very thin, <5mm layer of clean lucerne mulch will assist in ensuring good moisture around seeds, thus improving overall seed germination.

Hydroseeded or direct drilled seed may need to be pelletised so that it passes through the appropriate equipment evenly without bunching or clogging.

The native grass seeded areas should be irrigated and subject to weed control to assist with the successful establishment of the sown native grassland areas.

2.5.7 Transplanting of Native Groundlayer Plant Sod

The translocation of native grass and herb sods is recommended from the remnant bushland areas that are proposed for clearing as a part of this development suitable low resilience parts of Zone 2.

Observations of similar translocation trials on similar grassy/groundlayer plant associations in the western Sydney region by the author have shown that entire sections of diverse grass and herb species can be relocated, without damaging most living herbaceous plants and keeping the integrity of the soil seed bank intact for future regeneration. Observations also indicate that the comparatively diverse range of plant species and associations that can be conserved, regenerated and kept in a relatively weed-free state using prescribed translocation methods, can exceed the results achieved using conventional revegetation methods, such as local native tubestock installation, direct seeding and topsoil conservation and respreading. Native grass and herb sod translocation has been implemented to varying levels of success, with similar plant associations on a relatively small scale in the Sydney Region (Berryman *pers. comm.*).

The donor sites are which are proposed for clearing and which are suitable for translocation are characterised by relatively high quality existing ground layer vegetation. These areas also typically have relatively low to very low percentage cover abundance levels of weed infestation and relatively

diverse native plant species richness. The patches identified with the highest potential for ground layer translocation were typically characterised by dense swards of *Microlaena stipoides*. Although *M. stipoides* is not considered to be stoloniferous, in these certain patches the density of vegetation and requisite thatching may provide for a more robust cut sod, better able to survive the translocation process.

Typically, the suitable recipient sites to receive translocated material are currently dominated by exotic vegetation, however they contain similar soils, localised elevation and hydrology to the original donor site. Areas considered suitable to receive translocation material are located throughout the low resilience parts of Zone 2.

Access to both donor and recipient sites will potentially limit translocation works. Sod cutting and transporting machinery will require access to and egress from suitable donor and recipient sites. Donor sites immediately adjacent to or within relatively close proximity to recipient sites are preferential. These sites allow for greater ease of transportation and installation of sod material. Timing of the native groundlayer sod cutting should occur before the donor sites are cleared and after suitable recipient sites have had preparatory weed control undertaken within them.

The soil of the final recipient sites should be prepared to maximise quick root establishment and provide enough nutrients to be able to support plant growth. In the case of this project recipient site, soil preparation can be limited good initial weed control. It is anticipated that other forms soil preparation such as soil ripping, cultivation and topsoiling will not be required in the recipient sites.

The anticipated prominence of obstacles such as uneven ground, logs, shrubs and trees will most likely preclude the use of conventional turf cutting machinery to cut native grass sod from bushland donor sites.

The thickness of cutting remnant native grass dominated sod/soil will need to be approximately 50-75mm in order to ensure that the cut sections of grassland remain intact during cutting from the relevant donor site, transporting and laying onto the prepared recipient site, whilst ensuring that plant material is kept alive.

A simple modification to a bucket on a bobcat, tractor front-end loader or excavator machine would be the most suitable tool to cut the comparatively thick 50-75mm thick native grass sod. The cut sections of native grassland sod will typically be the width of the relevant machine's bucket and about 300mm long. Conventional turf cutting machinery may also be used on flatter sections of the recipient sites. This cut sod should be carefully placed and packed together in a single layer on a flat surfaced pallet to ensure that there is minimal disturbance of the cut sod. The pallets containing the freshly cut native grass sod should then be loaded onto a flat-top truck and preferably transported directly to a suitably prepared recipient site for immediate laying and post-laying care.

Native grass and herbs slabs should be placed together as close as is possible at the permanent or temporary recipient site, to minimise gaps and weed growth between sods. A machine with a forklift attachment should be used to assist in the placement of native grass sods from the pallets onto the prepared recipient sites. A light machine with a bucket and hand tools should be used to assist in the finer details associated with the laying operation and to minimise gaps between the sods.

The permanent or temporary recipient areas should be irrigated at appropriate levels until established. The newly laid sections of native grass sod should be top-dressed with a granular fertiliser that contains relatively high levels of phosphorous and potassium to assist with rapid establishment. Also the newly laid sections sod should be drenched with a solution containing rooting hormones, immediately after laying. Also the newly translocated sections of native grass sod should be treated with an application of a transpiration-inhibiting polymer such as "Envy" immediately after laying.

The transplanting of the native groundlayer plant sod slabs should be carried-out by an appropriately qualified bush regeneration contractor. Maintenance irrigation and weeding should be incorporated in the translocated area as a part of the 5 year maintenance program of bushland and revegetation areas throughout the study site. A temporary irrigation system should be installed or the translocated material should be adequately watered to ensure that the native grass and herb

slabs establish successfully. Irrigation should be maintained for a period of some 2-3 months after translocation to the final Zone 2 recipient site.

2.5.8 Soil Amelioration

Minimal soil amelioration is required for the Zone 2 areas that will be have native grasses direct seeded and native groundlayer plant sod transplanted into it. It is anticipated that only good initial weed control will be required with these treatments.

2.5.9 Ecological and Hazard Reduction Fire Management Considerations

Consideration may be given to undertaking pile burning or grassland ecological burns in the Zone 1 and 2 remnant bushland and grassland areas in the earlier stages of the VMP works program. Ecological burns can be undertaken on piled- cut woody weed material in Zone 1 and sprayed-out or frosted-off grass in Zones 1 and 2, to encourage the recruitment of fire responsive native plant species.

Hazard reduction and ecological burning are typically undertaken by either the NSW Rural Fire Service (RFS), NSW Metro Fire Brigade, NSW National Parks and Wildlife Service (NPWS) or Forestry NSW, as these organisations are NSW government agencies that are exempt from prosecution should an ecological or hazard reduction burn become uncontrolled and cause injury or death to people or damage to property. Private companies are typically not afforded this type of indemnity. Although many bush regeneration contractors have staff that are members of the RFS, our legal advice is that you need to have people that are at Coordinator level within an organisation like the RFS to be able to adequately coordinate, supervise and safely implement a hazard reduction or ecological burn.

At the time of writing this VMP, obtaining appropriate Public Liability Insurance for undertaking burning activities is either not possible or highly problematic. Although burning bushland for good ecological results is a worthwhile activity, it is rare that these types of burns can be implemented by bush regeneration contractors due to the statutory, bureaucratic, WHS and community safety concerns. The preferred option for undertaking ecological burns at the VMP works site is to facilitate these in conjunction with the local RFS. It is recognised that ecological burning may not be possible at the site, if resources do not allow for this activity to be undertaken by the local RFS, in liaison with the project's bush regeneration contractor.

Cut woody weed debris removed from the Zone 1 bushland areas as parts of the initial bushland regeneration and weed clearing works may be piled, left to dry for 3-6 months and burned on-site to assist in stimulating native plant regeneration, in areas where heat and smoke responsive soil stored native plant seeds may be expected to germinate. This practice should not be used in areas that currently support significant levels of existing native plants and where soils have been significantly disturbed by cut and fill activities.

Woody weed piles should be constructed well away from fire sensitive native plants. Weed burn piles should not be stacked too high, as excessive heat generated by high (>1.5 metre) piles may adversely affect the viability of the native seed stored in the soil. Unburned piles should not be left on site for more than 6-months as they may provide habitat for feral animals. A useful guide for the burning of woody weed piles has been published by the NSW RFS on their web site. These guidelines should be followed when implementing woody weed pile burns at the study site.

Similarly, areas of naturalised grassland within the designated zones treated to primary weeding treatments (including within bushland regeneration areas), or areas of native and naturalised grassland which have been dried-out by winter frosts can be treated to a grassland burn, as outlined previously (using drip torches in appropriate weather conditions for ignition), to assist with stimulating the germination of local native fire and heat responsive plant species and to assist with naturalised grass control.

Appropriate interpretative signage should be installed and local community liaison should be established and coordinated to educate the community about the proposed VMP works and if any ecological burning is undertaken at the VMP works site.

The following points need to be considered, in relation to fire management at the study site, as applicable:

- The bush regeneration contractor should coordinate any pile and grass burns using acceptable Occupational Health and Safety techniques and after obtaining appropriate permits from (or in conjunction with) the relevant RFS representatives undertaking the burning activities, as resources from these agencies allow.
- As with other forms of native vegetation disturbance, it is important to monitor the regrowth of native and naturalised plant species after the implementation of the pile and grass burning treatments to gauge the success of ecological burns.
- Follow-up and maintenance bushland regeneration weed control programs should be implemented to control naturalised plant species that are likely to colonise areas after fire.
- Future ecological fire management needs of the site should be reassessed after the completion of the initial 2 and 5 year bushland regeneration works period.

SECTION 3: VMP IMPLEMENTATION

3.1 COST ESTIMATE FOR THE IMPLEMENTATION OF RESTORATION WORKS AT OAKDALE SOUTH, HORSLEY PARK

A cost estimate for the implementation of the VMP recommendations at the Oakdale South site is outlined below in Table 5.

Table 5: Oakdale South VMP Cost Estimation Table

Item No	Zone	Description of Proposed Activity	Unit	No Units	\$ Per Unit Ex GST	Sub Total \$ (Ex GST)
1.0	Initial Primary Weeding Activities					
1.1	1	Hand removal of scattered African Boxthorn, Green cestrum, blackberry and key climbing and herbaceous weeds using cut/scrap and paint techniques as well as hand weeding around non-target native plant species in preparation for selective herbicide spot spraying activities. Spot spraying mainly grassy and broadleaf herbaceous weeds using selective herbicides. Occurrences of <i>Juncus acutus</i> will be slashed using brushcutters and hand tools followed by spraying with a non-selective glyphosate herbicide.	m ²	64,820	\$1.50	\$97,230.74
1.2	2	Undertaking a combination of low and high volume spot spraying activities using a combination of woody weed selective, broadleaf selective, grass selective, C3 grass selective c4 grass selective and non-selective herbicides to spray exotic grasses from around significant populations of native grass and native broadleaf herbaceous plants species. In some instances hand weeding of exotic grasses will be undertaken before and after these proposed spot spraying weed treatments to remove these mainly exotic grass and broadleaf plant species growing in close proximity to regenerating native plant species. Large areas dominated by exotic grasses exclusively will be sprayed out using a high volume vehicle mounted spray unit and non-selective glyphosate herbicide, (in preparation for future native grass seeding). Also includes slashing these areas with either whipper snippers or tractor mounted slashers before and after herbicide treatments on at least 2-3-occasions. Also includes at least 2-follow-up spot sprays where required to ensure a successful kill rate of targeted herbaceous weeds has been attained.	m ²	53546	\$1.05	\$56,223.16

Item No	Zone	Description of Proposed Activity	Unit	No Units	\$ Per Unit Ex GST	Sub Total \$ (Ex GST)
1.3	3	Undertaking mostly high volume spraying activities using a mostly non-selective glyphosate herbicide solution to treat mostly regrowing spray exotic and broadleaf weeds and grasses in Zone 3 drainage line areas that have been subject to earthworks, and soil amelioration by the civil contractor. Once dead, targeted weedy broadleaf plant and grasses may be slashed down in preparation for mulching and replanting activities, (either with whipper snippers or a tractor mounted slasher) and given a final follow up spot spray, if and as required to ensure a successful kill rate has been attained.	m ²	6304	\$0.70	\$4,412.50
VMP Works Area Square-Metre (M²) sub-total and Ex GST \$ Sub Total for all Initial/Primary Weeding Activities (Exc GST)				124670		\$157,866.41
2.0	Mulching and Jute Matting Activities in the Zone 3 Realigned Creekline Area					
2.1	3	Supply and installation a 300mm diameter of leaf mulch at 75mm depth to the base of each installed tubestock in zone 2 to assist in soil moisture retention and weed suppression during plant establishment. 25m of mulch will be required with mulch for 180 plants being covered by a single cubic metre.	plant	4549	\$0.42	\$1,910.53
2.2	3	Supply and installation of a 75mm layer of weed free mulch to 70% of zone 4. Mulch is to be installed to the higher elevated areas of the zone. This will suppress weed regrowth, reduce soil water evaporation and provide a soil covering until such time that installed vegetation becomes established.	m ²	4413	\$3.7	\$16,326.26
2.3	3	Supply and installation of jute matting to 30% of zone 4. Jute matting will be used in lower elevated locations where the use of mulch is likely to be washed away. The jute matting will suppress weed regrowth, reduce soil water evaporation and provide a soil covering until such time that installed vegetation becomes established.	m ²	1891	\$5.70	\$10,779.12
Sub Total Mulching Activities (Exc GST)						\$29,015.91

3.0 Revegetation Activities						
3.1	2 & 3	Collection and processing of local seed material to produce the total quantity of required plants in tubestock containers for use in revegetation activities within the project area.	Plant	77434	\$0.10	\$7,743.40
3.2	3	Supply and installation of v93 hiko tubestock of RFEF grass and sedge species throughout zone 3. Ground layer species are to be installed at an average density of 4-plants per m ² throughout Zone 3. Cost per unit includes the supply, installation, establishment watering and a supply of water retaining crystals to each plant.	v93	69339	\$2.70	\$187,216.24
3.3	3	Supply and installation of v93 hiko tubestock of RFEF tree species within Zone 3. Tree species are to be installed at an average density of 1 plant per 16m ² to the entire zone. Cost per unit includes the supply, installation, establishment watering and a supply of water retaining crystals to each plant.	v93	394	\$2.70	\$1,063.73
3.4	3	Supply and installation of v93 hiko tubestock of RFEF shrub species within zone 3. Shrubs species are to be installed at an average density of 1 plant per 1m ² (i.e.. 1-metre spacings) to 50% of the zone. Cost per unit includes the supply, installation, establishment watering and a supply of water retaining crystals to each plant.	v93	3152	\$2.70	\$8,509.83
3.5	2	Supply and installation of v93 hiko tubestock of RFEF tree species over 70% of the low resilience parts of Zone 2. Tree species are to be installed at an average density of 1 plant per 16m ² to 70% of Zone 2. Cost per unit includes the supply, installation, establishment watering and a supply water-retaining crystals to each plant.	v93	2343	\$2.70	\$6,325.11
3.6	2	Supply and installation of v93 hiko tubestock of RFEF shrub species over 70% of the low resilience parts of Zone 2. Shrub species are to be installed at an average density of 1 plant per m ² over 50% of the low resilience 70% of Zone 2. Cost per unit includes the supply, installation, establishment watering and a supply of water retaining crystals to each plant.	v93	2206	\$2.70	\$5,956.88
3.7	2	Supply and installation of a RFEF native grass seed and sedge seed mix over 70% of the low resilience parts of Zone 2.	m ²	37482	\$3.50	\$131,187.38
Total Number Plants in v93 hiko containers, (note: does not include replacement plants)				77434		
Ex GST \$ Sub Total Revegetation Activities						\$348,002.56

4.0 Maintenance Activities for a 5-Year Period						
4.1	1	Maintenance weeding in Zone 1 bushland areas for a period of 2-years months after the completion of primary works with an increase in maintenance hours occurring throughout the warmer growing months.	m ²	64820	\$2.20	\$142,605.09
4.2	2 , 3	Maintenance weeding in Zones 2, 3 and 4 full and partly revegetated areas for a period of 2-years after the completion of primary works with an increase in maintenance hours occurring throughout the warmer growing months.	m ²	64820	\$2.60	\$155,608.56
4.3	2 & 3	Replace 10% of all installed trees, shrubs and grasses planted within Zones 2 and 3. Includes all associated supply, installation and establishment watering costs.	v93	7743	\$2.70	\$20,907.18
4.4	All	Maintenance in all Zone 1 remnant bushland areas and all Zone 2 and 3 full and partly revegetated areas for Years 3, 4 and 5.	m ²	124670	\$2.40	\$299,207.85
Sub Total Maintenance Activities (Exc GST)						\$618,328.68
Total Oakdale South VMP Works (Exc GST)						\$1,153,213.56

3.2 SKILL LEVELS TO IMPLEMENT BUSHLAND REGENERATION, RECONSTRUCTION AND OTHER WORKS

- Experienced and qualified (TAFE bushland regeneration certificate ii, or iii, or iv), bush regeneration contractors should be used to implement the primary, follow-up and maintenance bushland regeneration weeding works.
- The removal of African Boxthorn and similarly sized small trees and smaller woody weeds can be undertaken by appropriately certified bush regenerators with Chainsaw Operator Level 2 qualifications.
- An appointed bushland management consultant; plant ecologist; or landscape architect should undertake the following tasks: monitor the progress and effectiveness of all proposed works; as well as organize and manage all contracted works.

3.3 FAUNA HABITAT & FAUNA MANAGEMENT CONSIDERATIONS

The following fauna habitat conservation measures should be considered and implemented throughout the proposed VMP works program, as applicable:

- Any trees or shrubs with existing bird's nests or possum dreys should not be removed during the initial bushland regeneration works period. Such weedy trees and shrubs can be treated once the nests or dreys have been vacated. It is preferable that these vacated nests and dreys are removed prior to treating weeds and replaced in adjoining native trees or shrubs for potential utilization in following seasons.
- Not removing any native trees with hollows from within the VMP works area, (unless these trees present a realistic liability risk).
- Leaving and laying local habitat resources such as felled local weed tree logs for local terrestrial fauna habitat within the bushland remnants and suitable adjoining areas. No weed material which has the potential to spread or reshoot when left lying on the ground should be left in wet parts of the site, where there is a risk of this material reshooting and re-rooting. Excessive stacking of woody weed material should be avoided, so that bushland regeneration is not inhibited and not to pose an OH & S risk for workers.
- Designing any future reconstruction planting/seeding schedules to replicate elements of the structure and floristics of the local native plant communities and to maximise habitat for local native fauna. A general rule of thumb used by Freudenberger (2002) to define bird habitat quality, (in revegetation situations) is if you can see through it, it isn't a very useful habitat.

Domestic stock must be excluded from the VMP works area in order to avoid damaging native plants in this area. However, the locally abundant Eastern Grey Kangaroos at the site and any other similar native fauna should be encouraged to utilise the VMP works area, and potentially increase in numbers commensurate with the carrying capacity of the native restoration areas. Any fencing that may be installed to exclude domestic stock or the public from the VMP works and biodiversity offset areas should be designed and installed such that they do not exclude or injure native animals such as the Eastern Grey Kangaroos from using the VMP works area. In the short term, some of the plantings and seeded areas may need to be monitored to determine if there is any significant damage occurring to establishing native plants within the VMP works area from native fauna.

3.4 MONITORING AND ASSESSMENT OF RESTORATION WORKS DURING 5 YEAR PERIOD

A 6-monthly check by an appropriately qualified bush regenerator should be undertaken to ensure that the rehabilitation targets outlined in this VMP are being achieved, throughout all designated Bushland Zones at the study site. If weeds are not being managed or revegetation targets are not being achieved in accordance with this VMP, experienced bush regenerators should be used to treat affected areas, as required to reach these targets.

A 6-monthly report should be produced after the completion of primary works. This report should have the following items and activities contained within it:

- The time period of report and conditions during that time
- A summary of all revegetation, primary and follow-up/maintenance weeding activities undertaken in the reporting period
- Seed certification and local provenance (of any plantings or seeding works, including replacements).
- Identify the entity that does the propagation of plants or supplies the native grass seed for any revegetation works, (including replacements);
- Dates when planting or seeding was undertaken during the reporting period.
- Any agreed changes to plantings or seeding, species etc during the reporting period.
- Photos of the bushland restoration works progress during the reporting period from at least 3 fixed photo points from each management zone. These photo points should be marked with a durable steel post, (i.e. star post or similar), with appropriate weather proof/durable markings. The location of these posts should be recorded with a GPS point to assist with location the points, particularly if the making post goes missing. The direction and field of view of the photos should also be recorded.
- Densities planted or seeding rate utilised at given zones.
- Survival rates of plantings, coverage of seeded ground covers, native plant regeneration and weed cover percentages for each management zone at reporting. Notes should also be made on what weeds, native plants are regenerating or establishing particularly well.
- Any problems that impacted upon the survival and regeneration rates for that reporting period, (such as flooding etc).
- A marked-up management zone map showing parts of the site that have been treated during the works period.
- Demonstration of progress of fulfilling the targets of this VMP.
- Qualifications and experience of contractors/persons that undertook works within the reporting period.
- Provide Certification of Compliance that all works within the reporting period were undertaken by persons suitably experienced and qualified in such certification.
- A summary of works that need to be undertaken in the next 6-month works period.

3.5 VMP WORKS TIMING CONSIDERATIONS

This VMP applies to a 5-year works period.

It is understood that the revegetation and related VMP specified works on the Zone 3 realigned drainage line areas will be implemented as soon as the bulk earthworks are completed. The remaining VMP works in Zones 1 and 2 will be undertaken when the Oakdale South development works reach the 80% completion milestone to coincide with the conversion of the drainage basins from being on-site sediment basins to being bio-retention basins, in line with the agreed Development Consent conditions imposed by Penrith City Council. The VMP works timing may therefore have to be staggered to match with these two main civil works timing considerations.

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