

PLANNING PROPOSAL REQUEST

No. 229 Macquarie Grove Road, Cobbitty

(Camden Council)



Prepared For:
Trustees of the Sisters
Of the Good Samaritan
Prepared By:



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Appendix 7
Biodiversity Overview and Management Principles
(Travers Ecological)

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Appendix 7. Bushland Conservation Management Plan

Wivenhoe Conservation Management Plan & Bushfire Management Plan



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Terms & Abbreviations

APZ – Asset Protection Zone

CMP – Conservation Management Plan and Bushfire Management Plan

CMS – Conservation Management Strategy

Conservation land – comprises all land identified as conservation management zones

DA – Development Application

Development land – comprises development areas (e.g. residential, commercial) and transport corridors

ELA – Eco Logical Australia Pty Ltd

IPA – Inner Protection Area

LMZ – Land Management Zone

Local provenance – refers to plant material collected from within a range of the site that natural genetic exchange is likely to occur

Management area – on-ground area to be managed as a single unit

Management region – classification of future environmental conditions i.e. Riparian Region, Woodland Region, Open Woodland Region, Grassland Region, Playing Fields (ELA 2005)

Management zone – classification of existing environmental conditions i.e.

- Sustainable grassland
- Degraded grassland
- Sustainable grassy open woodland
- Degraded grassy open woodland
- Sustainable woodland
- Degraded woodland
- Sustainable riparian
- Degraded riparian

OPA – Outer Protection Area

RFS – Rural Fire Service

SFAZ – Strategic Fire Advantage Zone

Executive Summary

This combined Conservation and Bushfire Management Plan, addresses the ongoing management requirements of the Wivenhoe Conservation Lands, owned by the Sisters of the Good Samaritan, to be protected as part of the Wivenhoe Residential Development Project.

This plan provide a background of the site and existing ecological condition, with specific detail regarding management zones, monitoring requirements, bushfire management, costs and task schedules for the first 5 years and in-perpetuity.

Based on adaptive management models the conservation area has been broken into three major management zones with the management tasks geared towards ensuring that the areas be restored to sustainable ecosystems within the first 5 years of plan implementation. This plan will need to integrated with the requirements for the conservation of existing European and Aboriginal Heritage values throughout the Wivenhoe Property.

The Sisters of the Good Samaritan will retain ownership of the conservation lands, and in accordance with a Voluntary Planning Agreement with Camden Council, Mbark will contribute \$4 million and be responsible for management and maintenance of the conservation lands within the first 5 years. The Wivenhoe Environment Trust, will then be set up to *'fund ongoing environmental management of the Wivenhoe Conservation Lands to meet the performance criteria of the Conservation Management Plan'*.

PART A – INTRODUCTION



1. Context

The Sisters of the Good Samaritan (the 'sisters') own the land known as 'Wivenhoe' in Sydney's south-west. The land subject to this plan has a total area of approximately 150 ha. Wivenhoe has been rezoned, enabling approximately 30 ha for residential use, approximately 80 ha for conservation and the remaining area to be maintained for heritage protection.

Development of Wivenhoe is subject to a Planning Agreement between the sisters and Camden Council. The Planning Agreement and Camden Local Environmental Plan No.139 require conservation land to be managed in accordance with a Conservation and Bushfire Management Plan (CMP).

Mbark Pty Ltd is developing Wivenhoe in conjunction with the sisters and will implement the CMP on the Sisters behalf. The CMP will be implemented over five years under the Planning Agreement. After completion of the CMP program, responsibility for managing the conservation land will transfer to:

- Camden Council for land that becomes public reserves
- The Sisters through a fully funded environmental trust covering the remaining conservation lands

Mbark will endeavour to progress the conservation lands to sustainable ecosystems within the five year timeframe so that long term conservation management costs are based on maintenance of a sustainable ecosystem, rather than reconstruction of degraded ecosystems.

Camden Natural Assets Policy

The CNAP provides a classification of environmentally significant lands and identifies minimum offset ratios should there be potential impacts on such lands.

During the Local Environment Study undertaken for the site, it was recognised that the native grasslands on the site were of moderate ecological value and are relatively quick and easy to reconstruct. As such it was not desirable for them to be lumped with woodland on the site in the category of 'Regional Core'. In accordance with Clause 1.5 of the policy, CNAP offset multipliers were applied to the woodland on site with the result being a surplus of 24 hectares as indicated in Table 3. This offset result indicates that the land which is being set aside for protection within the conservation zone, will provide 24Ha more than that required by the CNAP (82Ha) to offset the loss of vegetation due to proposed development.

Recognising the potential to integrate native grassland with heritage curtilages, a substantial area of the 5A zoned land is to be reinstated as native grasslands to offset the loss of grassland within the development precincts.

Offset calculations contained in Table 3 are based on the development footprint (lots, roads and residential parks), the conservation lands and restoration of native

grassland within the heritage zoned lands that are not required for ongoing or future school operations.

Table 1 Application of CNAP multipliers

CNAP CSA	Multiplier	Development (including parklands)	Heritage	Required Offset	Conservation	Heritage Grassland Reconstruction	Difference
Regional Core	6.00	10.75		64.51	78.72		14.20
Support Core	4.00		3.67	14.66			-11.00
Other Native Vegetation	3.00		0.63	1.90			-1.27
Native Grassland		18.87		0.00	9.22		9.22
Open Water		0.01		0.00	1.07		
Cleared		3.47	11.85	0.00	3.56	9.78	13.34
Total		33.10	16.15		92.56	9.78	24.49

2. Report structure

The CMP is to be read in conjunction with other plans and studies, including the:

- Ecological Assessment (ELA 2004)
- Conservation Management Strategy (ELA 2005)
- Landscape Master Plan (Hassell 2007)
- Precinct Plans (Hassell 2007)
- Ecological Impact Assessment (ELA 2008)
- Statements of Environmental Effects (APP 2007)

Part B of the CMP provides the framework for management of conservation land at Wivenhoe. It outlines the planning and development context, including relevant planning history and current land use zones. The methodology used to categorise conservation land and determine a suitable management regime is described. Monitoring and record-keeping requirements and performance indicators are identified, and costs estimated.

Part C of the CMP describes the tasks to be undertaken. It focuses on bushfire management, and measures to protect or improve environmental conditions across the conservation land. It refers to activities in the development land that may affect the conservation land.

Species lists and a detailed timetable of tasks to be implemented in each management zone of the conservation land are appended.

PART B – MANAGEMENT FRAMEWORK



3. Background

3.1 Location

The Wivenhoe development site has an area of approximately 150 hectares. The site is bound by Cobbitty Road to the north and the Mater Dei School access driveway to the west. The eastern boundary is defined by Macquarie Grove Road and Harrington Grove West. The site and its immediate surrounds are illustrated in Figure 1.

3.2 Land use planning

3.2.1 Land use history

Prior to European settlement of the district in the 1800s, the Camden area was characterised by River-flat Forests along the Nepean River and South Creek, and Cumberland Plain Woodlands (Benson & Howell 1990). Much of the native vegetation was cleared to create pasture for sheep and cattle. The municipality retains its rural character although there has been extensive urban development in recent years (Clive Lucas, Stapleton and Partners 2004).

3.2.2 Planning history

Wivenhoe is being developed by Mbark Pty Ltd in conjunction with the Sisters of the Good Samaritan. Mbark, Camden Council and NSW government agencies have negotiated a strategic land use plan that balances residential development with environmental conservation objectives. Highlights of the planning history include:

- Approval of a Natural Assets Policy by Camden Council in 2003
- Detailed investigations that were undertaken in 2004 for a Local Environmental Study, including an ecological assessment by ELA
- Gazettal of the Camden Local Environment Plan (LEP) No.139 – Mater Dei following preparation of precinct plans and a Conservation Management Strategy (CMS) (ELA 2005). The CMS identified five management regions within Wivenhoe based on landscape character. These regions are jointly referred to as conservation land, and the remainder of Wivenhoe is development land (Figure 1)
- Development Applications (DAs) submitted to Council for Precincts A, B, C and D include Ecological Impact Assessments, Bushfire Assessment and this Conservation Management Plan (CMP). Locations of each precinct are depicted in Figure 1
- A trust that will be established with an in-perpetuity management fund to manage the conservation lands that will be retained by the sisters.

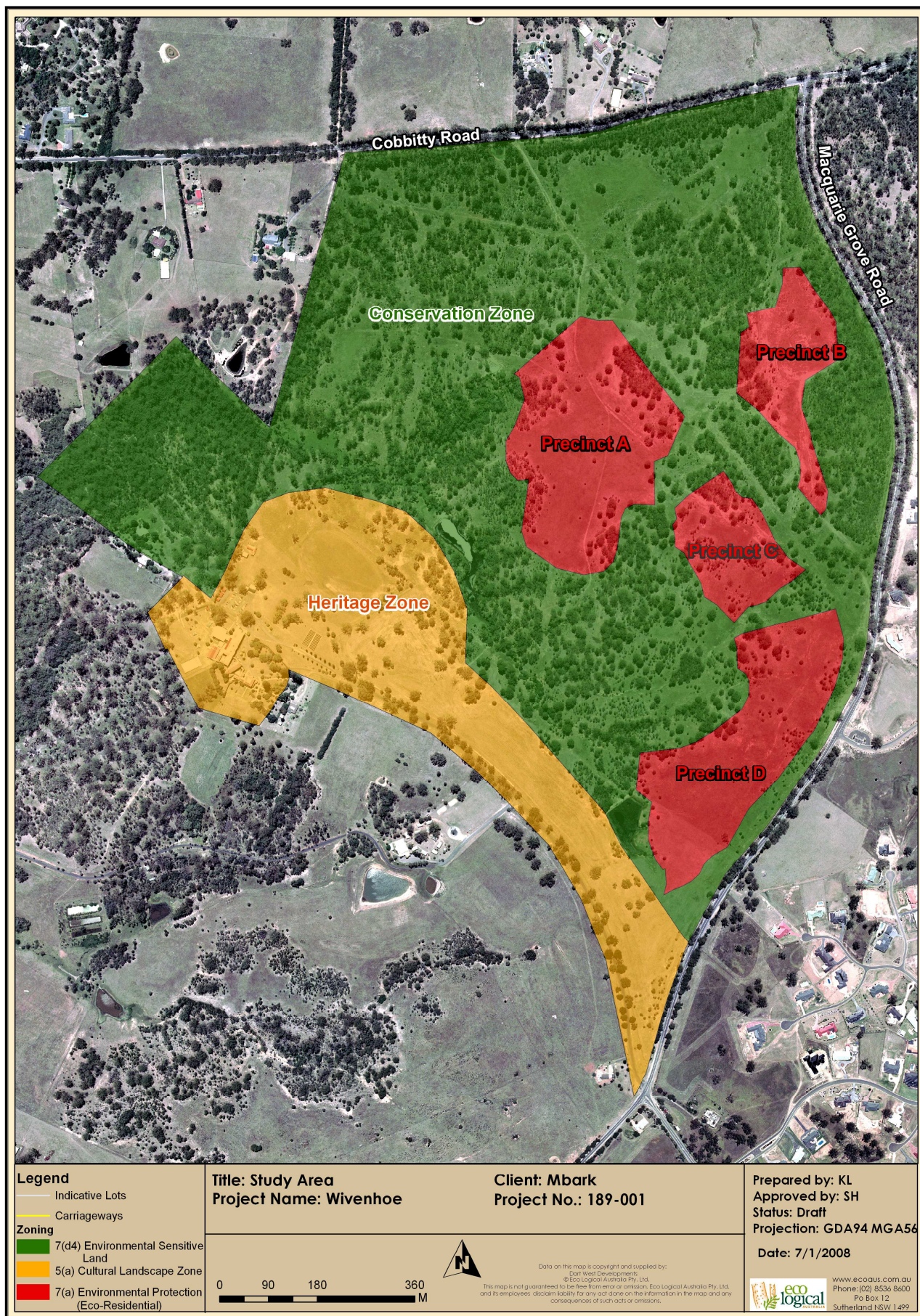


Figure 1 Study area and precincts

3.2.3 Land use zones

Camden LEP No. 139 land use zoning map is shown as Figure 1. The LEP defines suitable land uses for Wivenhoe. These include:

- Environmentally sensitive land that aims to conserve biodiversity
- Eco residential development
- Cultural landscape

The CMP reflects the LEP's objectives and requirements for conservation land.

Table 2 Land use zones for precincts in Wivenhoe

Precinct	LEP zone
Precinct A	7(d4) Environmental Protection (Eco Residential)
Precinct B	7(d4) Environmental Protection (Eco Residential)
Precinct C	7(d4) Environmental Protection (Eco Residential)
Precinct D	7(d4) Environmental Protection (Eco Residential)
Conservation Lands	7(a) Environmental Sensitive Land
Heritage Curtilage	5(a) Cultural Landscape

3.3 Need for CMP

A CMP is needed to guide the detailed conservation and restoration activities within the conservation land of Wivenhoe. The CMP builds on the CMS (ELA 2005) and aims to satisfy the broader conservation objectives of the LEP and the Natural Assets Policy (Camden Council 2003). The environmental character that the CMP will aim to achieve are summarised in Table 3. Benchmark conditions for these attributes can be observed at Gundangarra Reserve, Mount Annan.

Table 3 Future attributes of management regions (ELA 2005)

Management Region	Future character
Woodland Region	Native groundcovers, grasses, shrubs and canopy species
Grassy Open Woodland Region	Native groundcovers and grasses, and canopy trees widely spaced to prevent overlapping canopies
Native Grassland Region	Native grasslands dominate, with isolated trees
Riparian Region	Character of the riparian region will reflect that of the underlying region
Development Region	Retain existing native trees where possible; landscaping works to utilise local provenance native species

3.4 Adaptive management approach

An adaptive management approach will be taken in applying the CMP because of the size of the site, the complexity of the ecosystems present and the changing conditions. The CMP therefore includes a description of the methodology that was used (Section 4) to determine the most ecologically and economically efficient tasks to be applied given current understanding of the site conditions and development proposal. The methodology can be reapplied as site conditions change over time and the development proceeds. Implementation of the CMP is a long-term undertaking and this report represents the first stage in this process.

The adaptive management approach places an emphasis on encouraging the natural resilience of the site and integration with natural processes to restore the ecological values of the site. In this manner, direct planting will be minimised and only implemented where natural resilience is low, or environment/land use requires immediate responses (e.g. on steep slopes).

3.5 Scope of CMP

3.5.1 Ecology

The CMP indicates how the strategic objectives for each management region within the conservation land will be achieved on-ground. It examines how to:

- Protect remnant vegetation
- Restore highly disturbed and weed infested areas
- Rehabilitate cleared areas
- Use fire as an ecological management tool
- Ensure fuel loads are kept within controllable levels
- Control feral animals
- Use local provenance native species in landscaping
- Integrate biodiversity management with heritage features, visual amenity and community involvement
- Ensure development areas do not become a source for weed invasion
- Monitor against performance criteria
- Minimise costs, especially in the long term

3.5.2 Landscaping

Ecological constraints and objectives identified by Hassell (2007) in the Landscape Master Plan (full reference to be update for final report) are based on the CMS (ELA 2005). The objectives are to:

- Reinforce and enhance the conservation areas
- Reinststate indigenous flora species and enhance fauna habitat
- Maximise recreation use and connections in non-core conservation areas
- Establish low impact walking trails and implement a program of education and interpretation
- Conserve and enhance existing landscape elements and heritage curtilage zones with appropriate landscape treatment

Parklands and recreational facilities for Wivenhoe are shown in Figure 2 and include:

- Local pocket parks
- Informal recreation zones (areas of low to moderate conservation significance that allow for example bush walking, mountain bike riding, casual play activities; sensitive habitat areas will be protected from access)
- Conservation areas (areas of high natural and cultural conservation significance to be conserved and enhanced, and allow only low impact recreation and interpretation activities)

Other features of the Landscape Master Plan (Hassell 2007) of relevance to the conservation land include:

- Native plant species, preferably of local provenance, will be used in landscaping at entries and along street edges
- A network of cycleways and footpaths has been designed to 'activate spaces within parklands, tie in with low impact recreational activities in conservation areas and generate activity on park boundaries'

Appendix A lists species that are suitable for landscaping in the conservation land and development land.

3.5.3 Engineering

Roads, stormwater, water, sewer and telecommunications infrastructure will also pass through the conservation land. These have been designed by Maunsell and Michael Bell & Partners, and are indicated in DA documentation. Where possible, these services will be located in the road easement or existing disturbed/cleared areas. Where impacts to the conservation lands are unavoidable, remediation works will take place following construction.

The principles for sighting footpaths, cycleways and roads through the conservation area focus on avoiding and minimising construction and operational environmental impact. Such principles include;

- Avoid hollow bearing trees
- Avoid threatened species locations
- Avoid areas of steep slopes
- Avoid areas of Aboriginal or European heritage value
- Restrict high use routes to least sensitive areas (e.g. disturbed areas)

It is recommended that materials to be used for access through the conservation zone reflect their respective uses and immediate environment, e.g. high use tracks through steep slopes will need to be well stabilised to prevent erosion and be well defined to prevent track widening. Where possible, materials should be of eco-sensitive design and be sourced on site e.g. wood from trees removed within the residential development footprint.

Management of stormwater quality and quantity is of particular relevance to the CMP because of the potential ecological impacts. Any water structures located in the conservation land need to be consistent with conservation objectives. The

stormwater management strategies by Maunsell adopt the principles of total catchment management and water sensitive urban design (WSUD).

Following development of Wivenhoe, the peak stormwater runoff will not exceed pre-development levels and there will be no decline of water quality in the creek system. To achieve this, the stormwater management strategy adopts a best management practice treatment train for stormwater:

- Rainwater tank to be installed at each lot for internal and external water reuse
- Gross pollutant traps (GPTs)
- Grass lined dry detention sediment basins
- Bioretention systems downstream of GPTs and sediment basins

The locations of swales, dual use detention basin/wetlands and gross pollutant traps are indicated in Maunsell's reports accompanying the DA. These structures will:

- Store flood waters temporarily during storm events to reduce the impact of flooding as a result of the proposed development
- Treat polluted stormwater runoff from proposed development areas to acceptable water quality targets
- Provide habitat for native species
- Provide recreation for the nearby community
- Educate the community about flooding and water quality issues

Technical specifications are given in the DA documents by Maunsell.

In accordance with the *NSW Rivers and Foreshores Improvement Act 1948*, a detailed Vegetation Management Plan (VMP) will be prepared for locations where infrastructure is planned within 40 m of a protected waterway. The VMP will support a Part 3A permit application.

In general all drainage facilities traversing the conservation areas should;

- Be located outside core riparian zones, or at least no closer than 20m from the top of bank of a watercourse if they do not compromise the integrity of the corridor.
- Be offline from existing watercourses.
- Be constructed according to relevant Department of Water and Energy Guidelines.
- Not impact upon
 - Large hollow bearing trees
 - Threatened flora or fauna
 - Areas of Aboriginal or European heritage significance
 - Soil stability

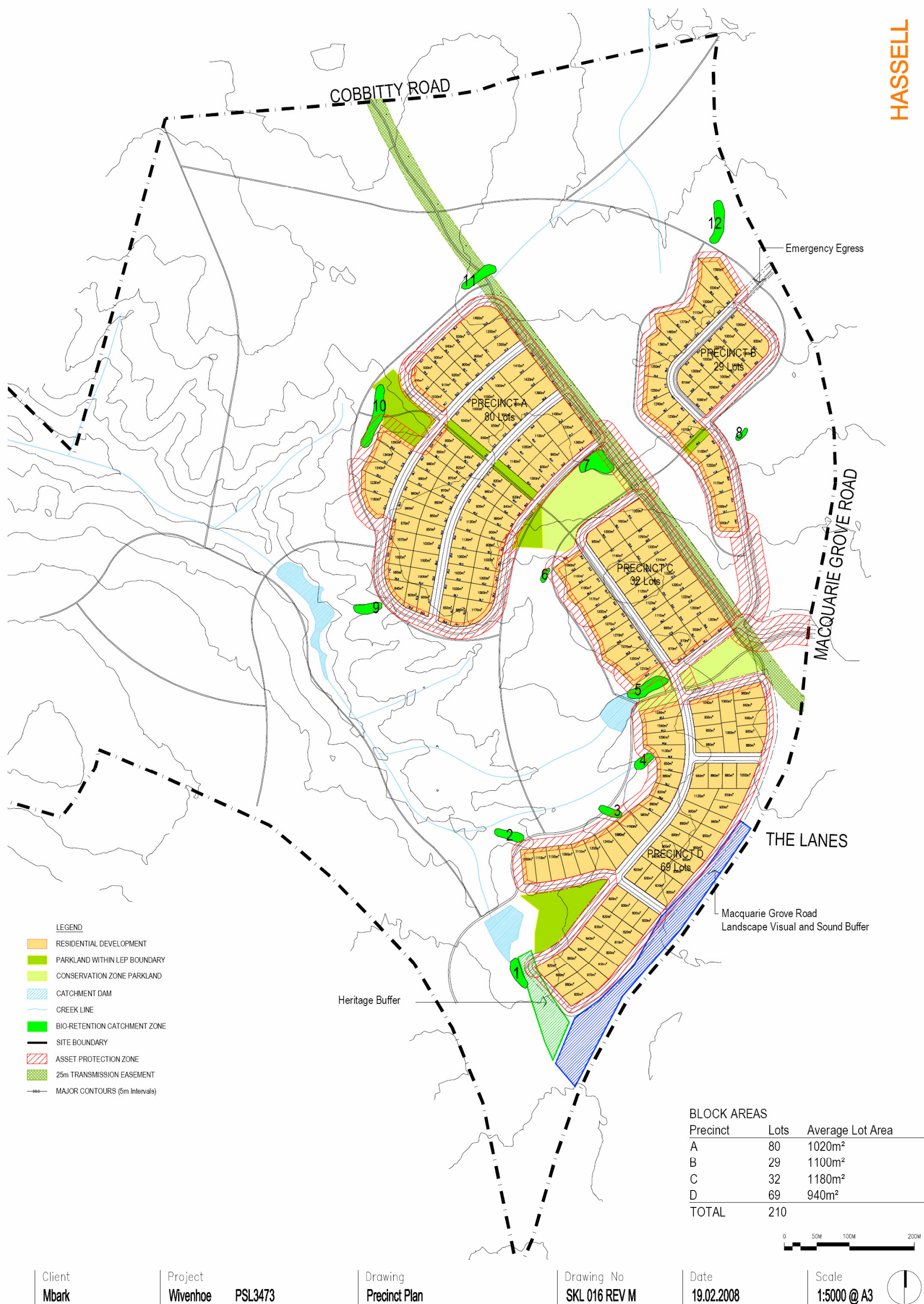


Figure 2 Precinct Plan (Hassell 2007)

4. Methodology

This section outlines the methodology used to prepare and implement the CMP. These steps can be repeated in the future, as required.

4.1 Existing condition

Conditions at Wivenhoe vary from highly degraded to sustainable indigenous ecosystems. Vegetation resilience maps prepared by ELA (2005) were reviewed in the field during October 2007 and used to classify the condition of vegetation across Wivenhoe. The following definitions were applied:

- Degraded – a significant presence of weed species, most species not appropriate to the designated management region. Also includes substantial areas of regrowth where vegetation structure needs to be modified to achieve desired outcome (e.g. areas of dense *Eucalyptus* regrowth)
- Sustainable – the majority of species are appropriate to the designated management region

4.2 Management zones

The five management regions identified in the CMS (ELA 2005) were combined with information about the condition of vegetation to classify land. The resultant three management zones within conservation lands are listed below:

- Degraded grassland
- Sustainable woodland (1=good, 2=moderate condition)
- Degraded woodland (1=poor, 2=very poor condition)

This process was applied to vegetation within Wivenhoe in 2007 and the results are mapped in Figure 3.

An additional category was mapped to reflect the future location of water infrastructure within the conservation land.

4.3 Tasks schedule

Field conditions and the tasks presented in Part C of the CMP were reviewed to determine suitable tasks to improve or maintain conditions for each mapped area. The results are summarised in Appendix B as a matrix of management areas, tasks and implementation timeframes.

4.4 Work plans and approvals

A detailed work plan will be prepared and implemented for each management area. Each work plan will identify:

- the area to which it applies
- a recent description of site conditions (baseline monitoring – see Section 6.3)
- contact details for personnel involved in the work
- the tasks to be undertaken
- a timetable for those tasks
- monitoring requirements (Section 6)
- a safe work method statement
- financial details
- record of work done
- comparison to performance criteria
- photographic records

4.4.1 First five years

Mbark will be responsible for preparing and implementing work plans in the first five years following development approval, in accordance with the Heads of Agreement with Council. As discussed in Section 6, Mbark will submit regular monitoring reports to Council. If the monitoring reports indicate that the task schedule needs to be revised, this will be done by agreement between Council and Mbark.

4.4.2 After five years

In the long term, Council will take control of public reserves and the CMP will no longer apply to these areas. A Plan of Management under the NSW *Local Government Act* 1993 will be required for public reserves. Council will be responsible for preparing, implementing and monitoring this process.

Responsibility for other conservation land will transfer from Mbark to the trust scheme. A committee from the trust will be responsible for ongoing implementation of the CMP in accordance with a management statement.

4.5 Monitoring and reporting

Requirements for monitoring and reporting performance are provided in Section 6.

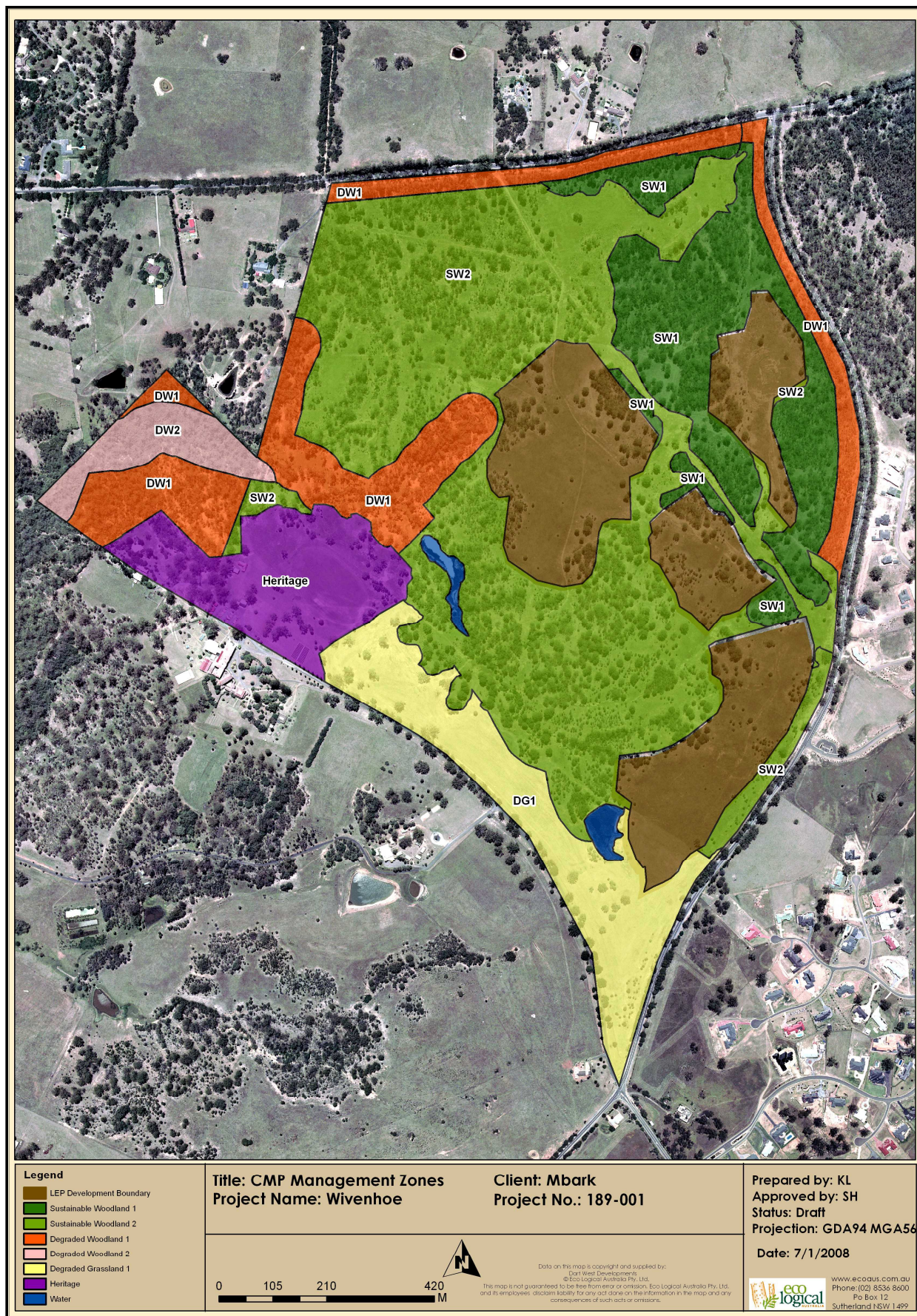


Figure 3 CMP Management Zones

5. Timetable

5.1 Development staging

It is anticipated that infrastructure in the conservation and development lands at Wivenhoe will be constructed over five years. The planned location of infrastructure within the conservation land needs to be surveyed and pegged prior to implementation of CMP tasks (e.g. bush regeneration). By identifying the planned location of infrastructure in advance, CMP tasks can proceed without concern that efforts (and costs) may be wasted when infrastructure development occurs at a later date.

5.2 Schedule of CMP tasks

In overview, the timetable involves removing stock and stabilising active erosion in the short term, weed removal and establishing native plants in the medium term, and ongoing weed control and prescribed burns in the long term. Implementation of some CMP tasks should commence immediately (e.g. seed collection) to allow for the long lead time required for plant propagation and growth. Where possible, the conservation tasks will be implemented over a broad area to achieve economies of scale (e.g. mechanical weed control) rather than be limited to areas adjacent development precincts.

The timing of each CMP task at each site is shown in Appendix B as yearly milestones.

Monitoring schedules are discussed in Section 5.

The conservation works will be deemed complete upon the issue of a report to that effect by a suitably qualified practising ecological consultant appointed by the developer and approved by Council.

6. Measuring performance

6.1 Objectives

It will not be possible to achieve the environmental benchmarks set in Section 3.3 for all parts of the conservation land within the five year timeframe of this CMP. However, substantial environmental improvements toward these benchmarks are required to satisfy Council of the effectiveness of the CMP and minimise long term environmental management costs.

A comprehensive monitoring program will gauge the effectiveness of the CMP and, in accordance with the adaptive management approach, identify if the program of tasks needs to be adjusted. Incremental improvements are expected at each monitoring stage after implementing CMP tasks (unless a site is deemed sustainable, in which case it needs to be maintained). If monitoring indicates that the CMP tasks are not resulting in ecological improvement or maintenance, the task program will be revised.

In addition to changes that may be needed in response to monitoring, new techniques for performing CMP tasks may become available and should be considered as part of the adaptive management approach.

6.2 Performance criteria

The following performance criteria have been assigned to the different management zones across the site. They include a combination of qualitative and quantitative measures. The quantitative measures, which relate to removal of threats, particularly exotic species, need to be firm criteria, however flexibility must be provided to allow for the impact of uncontrollable climatic conditions (e.g. drought), natural disasters (e.g. wildfire, flooding) and pestilence. In these situations it may not be possible to achieve the quantitative targets for native species cover, in which case the target should be revised and at the very least require progressive improvement in native species cover and certainly no increase in exotic species cover. Any modifications to performance criteria as a result of the conditions above are to be negotiated in good faith by Council and Mbark.

Table 4 Performance criteria for CMP

Management zone	Performance criteria
Sustainable grassland	1. Management tasks implemented according to schedule 2. Year 1 – 5 : <10% exotic cover
Degraded grassland	1. Management tasks implemented according to schedule 2. Year 1: <70% exotic cover 3. Year 2: <60% exotic cover 4. Year 3: <40% exotic cover 5. Year 4: <20% exotic cover 6. Year 5: <10% exotic cover
Sustainable woodland	1. Management tasks implemented according to schedule 2. Year 1: 100% treatment of seeding woody weeds 3. Year 5: Increase in native species diversity
Degraded woodland	1. Management tasks implemented according to schedule

Management zone	Performance criteria
	2. Year 1: <70% exotic cover 100% treatment of seeding woody weeds 3. Year 2: <60% exotic cover 4. Year 3: <40% exotic cover 5. Year 4: <20% exotic cover 6. Year 5: <10% exotic cover
Water bodies & immediate surrounds	1. Management tasks implemented according to schedule 2. Removal of all litter from water body and surrounds within two weeks of rainfall event 3. Year 1: Remove all weeds 4. Year 2: Successful establishment of seedlings 5. Year 3: Increase native species diversity 6. Year 4 & 5: < 10% weed presence

* 'Exotic cover' refers to the proportion of native versus exotic species in the dominant sub-canopy stratum. Random 2 metre wide quadrats used to determine cover, minimum 5 per unit.

An area will be deemed to be sustainable if it satisfies the biometric benchmarks (Gibbon *et al* 2005) relevant to its vegetation type (Table 5). The rate at which different areas reach sustainability will vary across the site, depending on initial conditions, effectiveness of CMP works, and on-going maintenance and management. Once sustainability is reached, maintenance will be required to prevent degradation from external factors (e.g. rubbish, weeds).

Table 5 Biometric benchmarks

Variable	Method (plot or transect type)	Vegetation Type	
		Cumberland Shale Hills Woodland	Cumberland Shale Plains Woodland
Native plant richness	20 x 20 m plot	29	29
Native over-storey	At 10 points along a 50 m transect	19-24	21-26
Native mid-storey	At 10 points along a 50 m transect, or 20 x 20 m plot	20-30	26-31
Native ground cover (grasses)	At 50 points along a 50 m transect, or 20 x 20 m plot	23-31	27-31
Native ground cover (shrubs)	At 50 points along a 50 m transect, or 20 x 20 m plot	0-5	0-5
Native ground cover (other)	At 50 points along a 50 m transect, or 20 x 20 m plot	12-20	15-19
Number of trees with hollows	50 x 20 m plot	1	1
Total length of fallen logs	50 x 20 m plot (log at least 0.1 m diameter and 0.5 m long)	5	5

Source: Gibbon *et al* (2005)

6.3 Monitoring program

The CMP task program was developed in response to field data (e.g. primary weed removal is needed where weeds are present). To assess if these tasks are appropriate and effective, conditions at each management zone will be monitored to identify changes over time. The first step is therefore to record baseline conditions **prior to implementing CMP improvements**.

Baseline conditions in each management zone will be defined by:

- One full floristic vegetation quadrat (20 m x 20 m) with photo monitoring points
- One, 30 minute diurnal bird survey site (undertaken within two hours of sunrise, temperature range between 20°C and 25°C)
- One anabat recording site (one hour recording immediately after sunset. Temperature to be between 25°C and 30°C)

The above sites will overlap and be located by GPS/map for ongoing reference. A marker will be installed in the south-west corner of each monitoring site. Photographs will be taken looking from the south-west corner to the north-east corner.

After baseline conditions have been established, sites will be monitored using the same methodology at the following intervals:

- Six monthly for the first two years
- Annually in late November/early December every year after

6.4 Log books

Monthly log books will record all work relating to implementation of the CMP (e.g. weeding, plant propagation, bushfire) and are to be completed by the CMP project manager. The log books will be retained permanently by Mbark then the Wivenhoe Trust (or Council for areas that become public reserves) as a record of environmental change. The log books will be made available to Council on request.

6.5 Monitoring report

A monitoring report will be submitted to Council four weeks after monitoring has finished. The report will be structured to address:

- What environmental threats have been reduced?
- What environmental improvements have been achieved?
- What tasks have been successful?
- What has not been successful?
- What measures, if any, have been taken to rectify problems?
- What issues need to be addressed?
- What are the outcomes of the management activities?
- Recommendations for revising the task program, if necessary

Any issues that affect the program of tasks need to be resolved within three weeks of the CMP manager submitting a copy of the monitoring report to Council. Unresolved issues will be dealt with under the dispute resolution clause of the Planning Agreement.

6.6 Bushfire Monitoring

Any fires will be mapped and the date of burn and approximate intensity of the fire will be recorded. Interfire periods are to be analysed annually to identify those areas that are close to or have exceeded thresholds, and identify priority areas for future burns.

6.7 Auditing

An independent qualified environmental practitioner will audit the monitoring program every two years. The results of this audit will be supplied to Council.

7. Cost estimates and responsibilities

7.1 Costs

Costs for implementing this CMP over the first five years (excluding GST) and ongoing in-perpetuity costs have been estimated and are shown in Table 6. Project management and monitoring costs are included in the overall estimate.

Table 6 Cost estimates

		Rates (\$/Ha)					
Vegetation Condition	Area (ha)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6 (ongoing)
good	14.6	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$1,500
moderate	61.2	\$10,000	\$5,000	\$5,000	\$4,000	\$4,000	\$2,000
native grassland - reconstruction	13.3	\$20,000	\$10,000	\$5,000	\$5,000	\$5,000	\$0*
poor	17	\$20,000	\$10,000	\$10,000	\$5,000	\$5,000	\$2,500
very poor	3.9	\$30,000	\$10,000	\$10,000	\$10,000	\$10,000	\$3,000
Grand Total	110.5						

		Cost (\$)					
Vegetation Condition	Area (ha)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6 (ongoing)
good	14.6	\$43,800	\$43,800	\$43,800	\$43,800	\$43,800	\$21,900
moderate	61.2	\$612,000	\$306,000	\$306,000	\$244,800	\$244,800	\$122,400
native grassland - reconstruction	13.3	\$266,000	\$133,000	\$66,500	\$66,500	\$66,500	\$0*
poor	17	\$340,000	\$170,000	\$170,000	\$85,000	\$85,000	\$42,500
very poor	3.9	\$117,000	\$39,000	\$39,000	\$39,000	\$39,000	\$11,700
Grand Total	110.5	\$1,378,800	\$691,800	\$625,300	\$479,100	\$479,100	\$198,500

* Seed collection from the native grasslands will pay for ongoing management costs in this area.

In addition to the figures above a contingency amount of \$350,000 is required for additional access, signage and maintenance works to be spent in the 5th year of the program.

The above costs exclude the construction of fencing, path & trails, landscaping works or installation of irrigation systems.

7.2 Responsibilities

A working group comprising representatives from The Sisters of the Good Samaritan, Mbark, APP, Hassell and Eco Logical Australia has met regularly to plan and design the Wivenhoe development. It is anticipated that many members of the working group will continue to be involved in construction and implementation of the CMP. This will assist the integration of conservation works with development activities. Organisations with responsibility for implementing the CMP are identified in Table 7.

An environmental induction will be held for any contractors working on Wivenhoe.

Penalties will apply if organisations or individuals do not adequately fulfil their responsibilities. These will be linked to contractual agreements. Additional penalties can apply through legislative regulation (e.g. *NSW Environmental Offences and Penalties Act 1996*).

Table 7 Responsibilities

Organisation	Role
Mbark Pty Ltd	Manage development & implement CMP in initial five years
Sisters of the Good Samaritan and Wivenhoe Environment Trust	Manage CMP activities after five years on land owned by the Sisters using funds from the trust
Camden Council	DA approvals & review monitoring
Department of Environment and Climate Change	Statutory approvals
Department of Planning	Statutory approvals
Bush regenerators	Bush regeneration & monitoring
Engineers	Design & construct roads, drainage, community facilities
Builders	Construct dwellings
University of Western Sydney and/or Wollongong	Research

7.3 Wivenhoe Environmental Trust

The Wivenhoe Environmental Trust (WET) will be the funding mechanism by which the long term management (from year 6) of the Conservation Lands will be payed for. Details of how the trust will be funded are identified in the Voluntary Planning Agreement.

The WET Trustees will comprise of representatives of the Sisters of the Good Samaritan. The sole aim of the trust is to:

'fund ongoing environmental management of the Wivenhoe Conservation Lands to meet the performance criteria of the Conservation Management Plan'

A management committee will direct how the Trust funds should be spent to meet the above aim. The management committee will comprise of;

- A representative of the Sisters of the Good Samaritan
- A representative of Camden Council
- A representative of the Wivenhoe development (initially MBark)

The deed of trust will outline governance and management requirements, further detail on the deed of trust is contained in the Voluntary Planning Agreement.

PART C - TASKS



8. Bushfire Management

Bushfire management will be undertaken for the primary purpose of ecological management. Where possible, Asset Protection Zones (APZs) have been located within the development footprint, principally within road easements, perimeter trails and front yard setbacks where necessary. In the limited instances where APZs extend outside these areas, some manual maintenance will need to be undertaken. Sufficient protection will therefore be afforded to the development without the need to undertake extensive hazard reduction programs across the conservation lands.

8.1 Ecological Management

Ecological management can be divided into:

- Stimulation of seedbank and treatment of weeds for ecological restoration
- Maintenance of ecological interfire periods
- Use of fire regimes to achieve desired management character

Fire is a key ecological process in many Australian ecosystems, stimulating seedbanks, reducing senescence and encouraging ecological diversity. The main elements of fire are seasonality, frequency and intensity. These factors influence species differently and can be used as a management tool to favour certain species or habitat types. A detailed review of fire regimes and the likely impacts on Cumberland Plain ecosystems has been undertaken, and a summary of the key elements in relation to desired management outcomes is provided below.

Cumberland Land Snail (*Meridolum corneovirens*) is the only threatened species known to occur on the site that has a specific bushfire related recovery action:

- *Implement appropriate fire regimes (ones that allow build up of grass and litter layers).*

8.1.1 Fire Frequency

Fire frequency is usually presented as interfire periods. The minimum interfire period is the minimum amount of time between fires that will enable sufficient recruitment and recharge of seedbanks. Maximum interfire period refers to the maximum amount of time between fires before senescence may begin.

Short interfire periods encourage species that have short lifecycles (e.g. annuals and grasses) over species that take longer to reach reproductive stages (e.g. trees and many shrubs). Short interfire periods are therefore preferable where a predominantly grassy/herbaceous understorey is desirable.

In Cumberland Plain Woodland the following is generally observed:

- Short interfire periods – results in grassy understorey, often dominated by *Themeda australis*
- Long interfire periods – often results in dominance by *Bursaria spinosa* and lower diversity/abundance of ground cover species

A variety of differing opinions are available on interfire periods, the most relevant to this site and their preferred periods are identified in DEC (2005).

Table 8 Interfire Periods

Source	Type	Grasslands	Grassy Open Woodlands	Woodlands
Recovering Bushland on the Cumberland Plain (DEC 2005)	Cumberland Plain Woodland	NA	4 – 12 years	4 -12 years
Bushfire Environmental Assessment Code (RFS 2006)	Cumberland Plain Woodland	NA	No fire more than once every 7 years	No fire more than once every 7 years
	Strategic Fire Advantage Zone (SFAZ)	Minimum interval of 2 years	Minimum interval of 5 years	Minimum interval of 5 years
	Land Management Zone (LMZ)	Minimum interval of 3 years	Minimum interval of 8 years	Minimum interval of 8 years

8.1.2 Fire Seasonality

Fire seasonality needs to integrate with the lifecycles of native species, and preferably be counter to the requirements of exotic species. As such ecological burns are recommended between the periods of August and January to coincide with native plant life cycles (DEC 2005). However, due to bushfire danger periods it may not be practical to burn over the summer months, hence the window of opportunity narrows to August – November. Occasional Autumn burns may also be implemented.

Burning may also be complemented with slashing of grasses, preferably immediately prior to flowering of exotic annual grasses.

8.1.3 Fire Intensity

Hotter burns are preferable as they may encourage native species over exotic species. However, this will be significantly limited by the amount of fuel available for burning and constraints on burning during the warmer months. More moderate burns are recommended for steeper slopes to reduce the potential for exposure of mineral earth and subsequent erosion.

8.1.4 Implementation Principles

The following principles will be considered when implementing fire management works:

- LMZ Grassy open woodland areas to have an interfire period of 4 – 8 years
- Woodland areas to have an interfire period of 4 – 12 years
- All fires are to be monitored, mapped and progress towards interfire thresholds identified annually
- No more than 20% of the site is to be burnt in any one year
- Burns generally to be implemented between August - November

- Hotter burns are preferable except on steep slopes
- Interfire periods across the site are to be mosaiced spatially and temporally

8.2 Bushfire Management Zones

Consistent with the guidelines for Bushfire Risk Management Plans, the site has been divided into the following bushfire management zones;

- Asset Protection Zones (APZ)
- Land Management Zones (LMZ)

Analysis of fuel accumulation in Cumberland Plains Woodland by Watson (2005) indicates that fuel loads peak at around 9 tonnes per hectare at a time approximately 10 years after fire. This low fuel loading significantly reduces the maximum fire intensity likely across the site and allows for greater integration of bushfire and ecological objectives in close proximity to development areas.

Strategic Fire Advantage Zones (SFAZ) are not considered to be required across the site, as the natural fuel load of Cumberland Plains Woodland falls within the required guidelines for these zones.

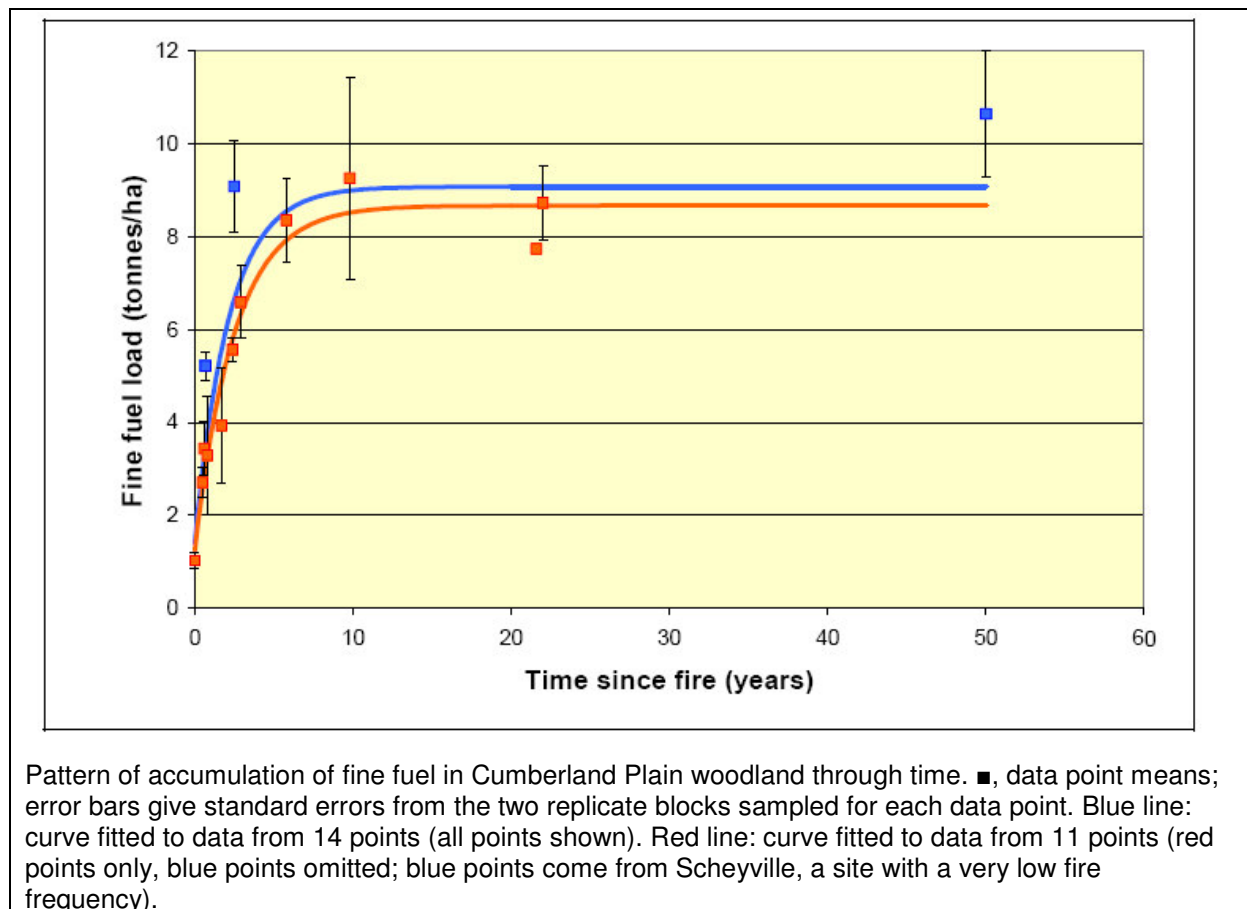


Figure 4 Fuel Accumulation (Watson 2005)

8.2.1 Asset Protection Zone (APZ)

The majority of APZs are located within the development footprint, principally road easements, perimeter trails and front yard setbacks. However, where APZs extend into conservation land, or land management regimes within the conservation area are consistent with APZ objectives (e.g. recreation parks), such areas may be utilised for the purposes of asset protection.

Description

- Area surrounding a development and managed to reduce bush fire hazard
- Only has inner protection area (IPA)
- APZ widths and fuel reduction treatment determined by slope and nature of assets
- APZs generally located within the development boundary, however some parkland areas and areas neighbouring development within the conservation zone are utilised as APZs
- Reduction techniques will include:
 - Mowing, raking and slashing
 - Bush regeneration, involving initial weed removal and long term weed management. This method should be combined with hand removal of ground fuels and manual removal of shrub and middle storey layers

Aims

- To protect human life and property
- To protect assets

Prescriptions

Inner Protection Area (IPA)

IPA's will generally be subject to a management regime of regular mowing and slashing. According to the NSW RFS (2001), the performance of the IPA must be such that:

- There is minimal fine fuel at ground level which could be set alight by a bushfire (grasses must be kept below 10cm in height); and
- Any vegetation in the IPA does not provide a path for the transfer of fire to the development – that is, the fuels are discontinuous, vertically and horizontally.
- The presence of a few shrubs or trees in the IPA is acceptable provided that they:
 - do not touch or overhang the building;
 - are well spread out and do not form a continuous canopy;
 - are not species that retain dead material or deposit excessive quantities of ground fuel in a short period or in a danger period; and
 - are located far enough away from the house so that they will not ignite the house by direct flame contact or radiant heat emission.
- Woodpiles, wooden sheds, combustible material storage areas, large areas/quantities of garden mulch, stacked flammable building materials etc should not be permitted in the IPA.

Figure 5 Typical APZ cross section

TYPICAL 20m APZ LANDSCAPE TREATMENT

Source: Hassell & Associates

8.2.2 Land Management Zone (LMZ)

LMZs are principally managed for biodiversity conservation and comprise the bulk of the conservation lands on the site.

Description

- Broader areas of the landscape, managed for the purpose of biodiversity conservation
- If required reduction techniques will include:
 - burning
 - weed control

Aims

- Protection of natural and cultural heritage values
- Maintenance of ecological processes

Prescription

- Maintenance of ecological processes
- Fire management to meet conservation objectives for species, habitats, populations and cultural heritage values, including:
 - to control breaches in minimum fire thresholds and address maintenance of fire age (vegetation age) mosaic, including maximum fire thresholds
 - to provide a mosaic of interfire periods across the site

8.3 Access Trails

Perimeter roads and trails are a key component of the development and will be located both within the development areas and conservation lands. Perimeter roads will be built according to the specifications contained in *Planning for Bushfire Protection (NSW RFS, 2006)*.

Perimeter/fire/walking trails are proposed throughout Wivenhoe (figure 7). These trails will be integrated walking trails that are suitable for fire truck access i.e. a 4m wide all weather fire trail with a 2m wide concrete path with 1m of gravel along both sides. In addition to access/egress improvement, the perimeter trails will serve as part of the APZ for adjacent lots. The trails must be maintained in a serviceable condition and remain accessible to fire fighters at all times.

8.4 Provision of Water

Development precincts will include fire hydrants meeting the requirements of AS2419.1 – 1994 Fire Hydrant Installations.

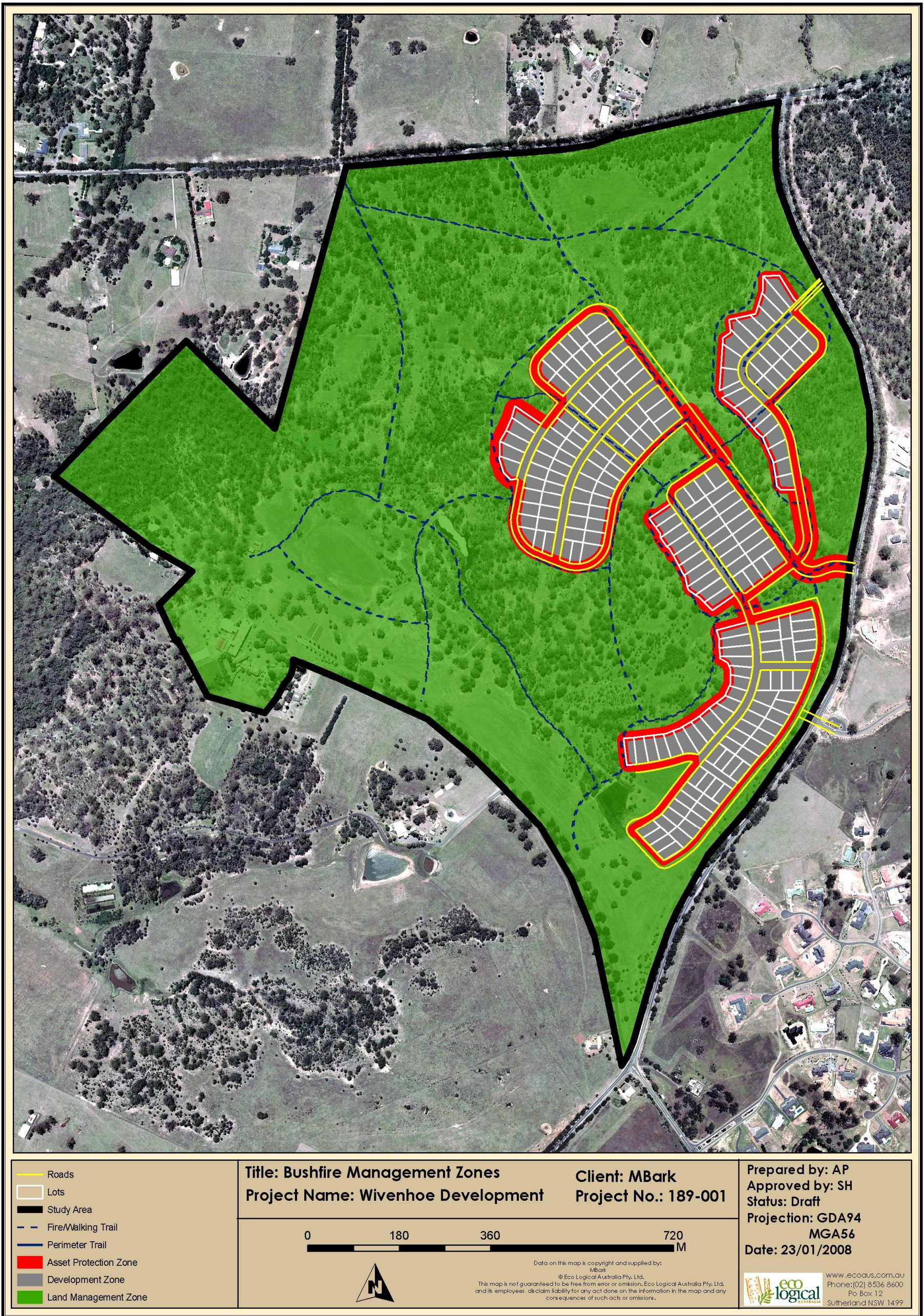


Figure 6 Bushfire management zones

8.5 Bushfire Management Schedules

Consistent with RFS requirements as part of the Bushfire Safety Authority for the site, the following bushfire management schedules are provided.

Administration			
Contact Person	TBA	TBA	Longer-term, the contact person will become the manager of the community scheme

APZ Construction Schedule and Maintenance Schedule						
	Location	Establishment Timing	Establishment Works	Establishment Certification	Maintenance Works	Maintenance Monitoring
Standard APZ	Within road reserve, perimeter tail and front yard setbacks. Some areas extend into conservation lands.	To be established prior to occupation commencing	Construction of roads and trails, landscaping of road verges and front yards, and manual mowing, raking and slashing consistent with IPA specifications	To be certified by an experienced bushfire professional or RFS officer	Regular mowing of grass, annual maintenance of trees	Six – monthly monitoring reports prepared for community scheme by an experienced bushfire professional or RFS officer

Bushland Management Schedule						
	Approach	Establishment Timing	Establishment Works	Establishment Certification	Maintenance Works	Maintenance Monitoring
Remnant Bushland Management	To be implemented according to the ecological management regime	Nil	Nil	Nil	Management of ecological fire regimes, primarily through conducting environmental burns	Annual monitoring and reporting of fuel accumulation, interfire period, potential hazards and management responses to be prepared by a qualified bushfire and ecological professional

Access Schedule			
Road/trail	Description/specification	Management	Monitoring
Perimeter and internal Roads	Sealed roads within the development precinct owned by Council	Council	Council
Perimeter/fire/walking trails	4m wide all weather fire trails with a 2m wide concrete path with 1m of gravel along both sides	TBA	TBA

Review and Update Schedule	
Review Period	The Conservation and Bushfire Management Plan is to be reviewed every 5 years
Changes to Contact Details	Any changes to contact details are to be noted in the quarterly monitoring reports

9. Conservation management task descriptions

Appendix B indicates the tasks required in each area or management unit at Wivenhoe. A timetable for implementation is also provided. Each task listed in Appendix B is described in detail below to assist with implementation of the CMP.

9.1 Fire

9.1.1 *Fire trial*

The response of the vegetation to bushfire and the potential for regeneration from the soil seed bank at the site is unknown at this stage. A series of small bushfire trials, including ecological pile burns will be conducted to measure:

- The rate of vegetative response
- Changes in native plant biodiversity
- Response from the soil seed bank
- Effects on weed populations
- Effects on soil stability and erosion

Initial trials will be conducted in areas of sustainable vegetation in combination with weed control works. If the vegetation responds positively, programmed ecological burns will be implemented on a wider scale to assist with regeneration.

9.1.2 *Pile burns*

In degraded areas, fire will be used on a smaller scale in the form of small burn piles to determine if a native soil seed bank is present and can be encouraged to germinate. Pile burns would make use of debris from woody weed control works piled and burnt on selected sites.

9.1.3 *Programmed ecological burns*

Ecological burns will be implemented across the site to encourage higher biodiversity by varying fire regimes, assist in achieving desirable management characters and to ascertain their effectiveness in stimulating regrowth in degraded areas. Principles for implementation of ecological burns have been provided in Section 5.

9.2 Livestock grazing

9.2.1 *Exclusion of livestock*

The removal of livestock from areas of high resilience vegetation, gullies, ephemeral creek lines and steep slopes is the highest priority task for the site. This can be achieved using existing fence lines and installing additional temporary fencing where required. Highly degraded areas dominated by introduced pasture grasses, primarily couch (*Cynodon dactylon*), can remain stocked in the short term at low stocking rates until they are to be developed or regeneration works are scheduled to begin. The retention of stock in these areas will keep weed biomass down and prevent the spread of weeds into other areas.

9.2.2 Strictly controlled livestock grazing

Intermittent grazing of livestock in selected areas of grassland and grassy open woodland within the conservation zone will be considered in the long term as a management tool. Livestock can be used to maintain grassland ecosystem functions (Whalley 2005). Grazing livestock in these areas can assist in management by reducing biomass of weed grasses to reduce seed set and fire hazard and by reducing the biomass of native dominant species such as *Themeda australis* which declines due to self-shading if the biomass is not removed (p45 DEC 2005). The use of livestock will complement the use of fire and mechanical slashing.

Stock movement will be strictly controlled and off line water points provided away from dams and ephemeral creek lines. Livestock movements will be managed so they do not facilitate the spread of weed seed.

9.3 Fencing

Fencing will be required throughout the site to protect and delineate the conservation zone. Temporary erosion control fencing will be installed along the conservation/development interface prior to construction and removed once construction is complete.

Any temporary fencing installed must:

- be fire resistant
- allow passage of, and not be a risk to, macropods and other fauna
- exclude trail bikes and other vehicles
- be aesthetically appealing
- be regularly maintained

Metal post and thick wire cable fencing is considered a suitable option as it satisfies the above criteria. The use of timber post and rail fences should only be used in areas where the use of fire is not recommended as a management option. Temporary strained 3-wire fences should be installed immediately on the perimeter of areas to be developed to prevent incursions into the conservation zone during development. Existing stock fences throughout the conservation zone will be retained to allow for the management of potential livestock pulse grazing in the future. Temporary electric fencing can also be used to retain stock in future development areas prior to development.

9.4 Log, brush matting and topsoil recovery

This task is limited to areas within the development land that have a high proportion of native species. Existing trees will be retained for inclusion in the urban landscape where possible. Other elements of the native vegetation will be recovered for use in the conservation land.

Features that are suitable for recovery and reuse include logs, seed bearing native vegetation for brush matting and topsoil. These will be used to provide habitat and contribute to regeneration within the conservation lands. Areas within the development land with a high proportion of native species and are suitable for these

works will have to be more closely identifying prior to development works commencing. Areas of groundcover with potential for topsoil recovery will be given time to regenerate from the history of grazing to determine which areas are suitable where possible.

9.4.1 Log recovery

Large trees which will not be retained can be harvested and milled for possible resale as dressed timbers to future residents. Other trees will be felled and other logs and woody debris will be strategically relocated into the conservation land as habitat and to assist in erosion control and regeneration.

9.4.2 Brush matting recovery

Brush matting consists of branches cut from trees and shrubs (particularly *Bursaria spinosa*) that are seed bearing. Spreading these cut branches in selected areas is an efficient method of reintroducing seed of native species into an area and creates rough mulch that reflects the litter layer of intact ecosystems. The harvesting of brush matting will be timed so harvested branches and shrubs contain viable seed.

9.4.3 Topsoil recovery

Topsoil recovery will be undertaken in areas that have a high proportion of native vegetation and few weeds in the ground layer of vegetation. Topsoil is harvested to salvage the native soil seed bank and reintroduce seed bank back into areas of the conservation land where it has been depleted by past land use such as intensive grazing.

The method of topsoil recovery involves removing all plants and leaf litter then stripping the topsoil to a depth of approximately 20 mm using earthmoving machinery. The topsoil is relocated immediately to a site within the conservation zone where the native soil seed bank has been depleted. These areas can be identified by the dominance of weed species. The site receiving the topsoil has its topsoil including the weed growth stripped and disposed of. The relocated topsoil is spread evenly and mulched lightly using the vegetation and leaf litter removed from the source site.

9.5 Weed control

Weed control will be undertaken as a component of overall bush regeneration activities to encourage natural resilience. The objective of weed control works is to replace weed species with native vegetation and address the cause of the initial weed infestation.

The stages of weed control - primary, follow up and maintenance - are outlined below. The time allowed for each stage will depend on the degree of weed infestation and the response of native species once the weeds are removed. The costs and resources required for weed control are expected to decrease over time as native vegetation establishes. Regular, long-term monitoring and maintenance of all weed control works will help prevent re-infestation and ensure long-term success.

Areas of high resilience native vegetation will be given priority in weed control works. Large seed producing weeds will be immediately targeted to prevent their further spread. Following from this, areas with a high density of mature seed producing weeds will be given high priority in order to reduce the production of weed seed over the site and prevent their spread.

Weeds will be treated using standard bush regeneration techniques (Buchanan 1989). These include manual removal (e.g. hand weeding, slashing and chainsaw work) and herbicide spraying. The use of herbicides will be minimised and less toxic chemicals (as determined by their chemical schedule) will be used in preference. Herbicide use in sensitive areas such as riparian zones and adjacent water bodies will be minimised.

Techniques such as mechanical mulching using an excavator will be used in highly degraded areas where woody weeds are dominant. Fire will also be used to control weed growth. The appropriate use of these techniques will reduce overall labour costs while encouraging healthy native vegetation communities.

9.5.1 Primary weed control

The aim of primary weed control is to reduce the weed biomass in highly degraded areas targeting mostly woody weeds such as African olive (*Olea europaea subsp. cuspidata*), African boxthorn (*Lycium ferocissimum*), and large-leafed privet (*Ligustrum lucidum*). Primary weed control works will minimise disturbance to any native species and the soil. Works will be staged to ensure that resources are available for follow up and so that previously treated areas are not neglected. Techniques that minimise secondary weed growth will be used thus reducing time required for follow up treatment.

Woody weed control in higher resilience areas with low densities of woody weeds will consist primarily of the cut and paint (with herbicide) treatment and the drill and inject (with herbicide) technique where felling them will disturb surrounding native vegetation. Where weed trees are felled, the logs and branches, if free of seeds, will be left on site and used as erosion control where possible by placing them across slopes and in areas being eroded such as steep slopes or gullies. Seed bearing branches will be piled where practical with any subsequent seed growth treated.

9.5.2 Mechanical primary weed control

Mechanical primary weed control will be undertaken mostly on large stands of dense Privet and African Olive. Large thickets of African boxthorn will also be mulched to prevent any piles of treated debris becoming habitat for feral hares. The method of mechanical primary weed control for African olive and privet involves:

- Mechanical mulching using an excavator with a mulching head attached, with mulch left in situ
- Remaining stumps will be recut with a chainsaw as low as possible and treated with herbicide using the cut stump method
- Where the mulching machine cannot access due to slope or other obstacles, olives will be felled using chainsaws and treated with herbicide using the cut

and paint method. Large logs will be left in situ and smaller branches trimmed and dragged to a point where they can be mulched

- After treatment of large olives any seedlings remaining will be sprayed with herbicide within two weeks
- Areas will be closely monitored after treatment and any re-shooting stumps or seedlings will be retreated
- Where olives are among *Bursaria* thickets or if *Bursaria* is limiting access, both species will be mulched but only the olive will be treated with herbicide (the *Bursaria* will readily re-shoot)
- Follow up treatment will control regrowth of olive and any subsequent weed regrowth

Note: the choice of herbicide will have to be considered carefully. 600g/L Triclopyr (eg Garlon™) is registered for use on olive with a diesel solvent; however this is a soil active herbicide and will not be used in the vicinity of native vegetation including trees. This is particularly relevant if the basal bark treatment is being used. 360g/L Glyphosate (eg Roundup™) will be used to treat olives when they are actively growing/flowering in autumn.

9.5.3 Follow up weed control

Follow up weed control follows primary measures and controls weeds that grow from the increase in available resources (e.g. light, moisture and nutrients) following the removal of large woody weeds. Follow up control involves treatment of weeds whilst ensuring the regeneration of native species is not inhibited or negatively effected. Techniques include:

- Selective hand removal
- Selective herbicide spraying
- Cutting and painting with herbicide woody weeds and other persistent weeds with hand tools and chainsaws
- Slashing herbaceous weeds using brush cutters or lawn mowers to prevent seed set
- Collection of all weed material which has set seed or is able to propagate vegetatively and removal to central areas where it is contained and composted on site

9.5.4 Maintenance weed control

Weed control has been included as a task in the areas of vegetation mapped as sustainable condition type. The time required within these areas will be minimal, but regular monitoring and follow up will be necessary to control new weed incursions and prevent their spread. This will be particularly important after any disturbances including programmed ecological burns.

Maintenance weeding will be required on an on-going basis to prevent reinfestation of previously treated areas. It is expected that the amount of maintenance weeding required will decrease once the native plants become established.

The most cost effective method of minimising the amount of maintenance weed control required is by maintaining healthy native vegetation communities and preventing the introduction of new weed sources. This is achieved by avoiding:

- Unplanned soil disturbance
- Importing contaminated soil to the site
- Sudden physical changes to native vegetation (e.g. clearing)
- Growing plants with weed potential in neighbourhood gardens that can be dispersed by garden refuse dumping, animals (especially birds), wind and water
- Stormwater impacts (stormwater can change soil moisture and nutrients, and can carry weed propagules and seeds).

9.5.5 Fire as weed control

Appropriate fire regimes will help maintain a healthy native vegetation community and has been shown to control certain weed species. It is anticipated that in the large areas of sustainable woodland, the programmed ecological burns will assist in the control of African olive with a stem diameter less than 20 mm (von Richter et al. 2005). Large olives will be treated manually (cut and paint method). The control of African olive will be a long-term maintenance requirement, as recruitment of young olives will continue as seed is brought onto the site from surrounding infestations by birds and other animals. Using fire will reduce the amount of labour required to maintain these areas.

Careful follow up of burnt areas will be required to ensure that the growth of any opportunistic weeds is controlled. It is vital that all forms of disturbance to burnt areas is avoided and access is strictly controlled following all programmed ecological burns to avoid unnecessary soil disturbance which will encourage weed growth.

Fire will be avoided on steep slopes due to the potential to increase erosion hazards.

9.5.6 Weed control on site boundaries

Allowance has to be made for weed control in the adjacent road corridors surrounding the site. Neglecting to control these weeds will result in reinfestation of treated areas within the site. Control in these areas will be coordinated with the appropriate authorities.

9.5.7 Grassland weed control

Areas of degraded grassland have considerable potential for regeneration once grazing pressure from livestock is removed. Currently these areas are grazed to stubble and identification of the grass species present is difficult. These areas will be allowed time for the ground layer to grow once grazing is removed before final decisions are made regarding management. Sufficient time will allow more accurate identification of the proportion of native species already present within the ground layer. This will influence the management techniques adopted and the extent of works required.

Slashing, burning or grazing to prevent seed set will control weedy annual grasses. This will be undertaken in early spring to allow the growth and seed set of summer dominant perennial native grasses. Trials with the addition of carbon in the form of sugar or sawdust to reduce available nitrates will also suppress weedy annual grasses and reduce competition on native perennial grass species which are tolerant of lower nitrate levels (Prober and Thiele 2005).

Perennial weed grasses particularly couch (*Cynodon dactylon*) are more persistent. Control of couch will focus on over planting with vigorous native tussock grasses such as *Themeda australis* and *Poa labillardieri* to out compete and replace it. Slashing, burning or grazing to prevent seed set and herbicide spraying to kill large tussocks will also be used to control perennial weed grasses.

9.6 Seed collection

Seed collection will be undertaken in accordance with the Australian Florabank Guidelines (2000). Collected seed will be dried, sorted, packaged, labelled and stored in a controlled environment. Records of the original seed provenance, collection habitat, date collected, storage conditions and history will be kept in a database for all collected and purchased seeds. Germination testing will be conducted records kept.

The use of seed of local provenance will be strictly adhered to. Species that occur commonly on the site will be collected primarily from within the site. Species that are infrequent or not present on the site but may have originally occurred on site will be collected from nearby areas with ranges to be determined according to the Florabank guidelines. When collecting seed off site the habitat of the area to be planted will be matched as closely as possible by the collection habitat.

Collection of seed from existing native grasslands both on and off site will be minimised to prevent any negative impacts from over harvesting on these areas. Seed orchards will be established to provide seed required for direct seeding and revegetation.

Seed will not be collected in any area burnt within the past two years.

9.6.1 Seed orchards

Seed orchards will be established as a high priority task in order to provide seed required for direct seeding and revegetation works on the site. Seed orchards will primarily focus on the production of the dominant, quick growing grass species *Themeda australis*. Other grass species will be used to a lesser extent; these include *Microlaena stipoides*, *Chloris* sp., *Danthonia* sp. and *Poa labillardieri*. Small shrub orchards will also be established forming small thickets of shrubbery within the grassland areas. These will include *Acacia* sp., Fabaceae species and *Lomandra longifolia*. Once the seed requirements of the site are met the seed produced in these areas can be sold off site.

Seed orchards will be located in areas with a low proportion of native species (<10% cover). Orchards will be situated and planned so the natural growth habit and

habitat of the species being grown is reflected in the orchards design. For example *Lomandra longifolia* orchards will be grown in low lying, moist areas near creek lines. Larger orchards will be restricted to species that naturally grow in dense large clumps or near monocultures, for example *Themeda australis*. Shrub orchards will be small thickets of the one species distributed through grassland areas. The orchards will be designed to fit into the natural landscape with straight, square perimeter boundaries and straight rows avoided.

Grass orchards will be intensively planted and drip irrigated to maximise seed production. Irrigation will use existing site dams or constructed stormwater wetlands. Orchards will be planted mechanically where possible or established by direct seeding, various direct seeding trials will be undertaken as part of these establishment of the orchards. Grass orchards will be harvested mechanically where possible.

Existing areas of good native grass cover, particularly within the development land will be managed like the seed orchards and irrigated to maximise seed production before the areas are cleared.

Strict records will be kept of the provenance of the plants grown in the orchards, with plants of different provenance kept in distinct areas.

Seed of less common grassland herbs which are less suited to mass cultivation in the field will be grown for seed production. Techniques will follow those being developed by The Grassy Groundcover Research Project (The Grassy Groundcover Research Project 2006). Seed harvested from these will be used in direct seeding trials or grown on to reintroduce these species into areas of degraded grassland and grassy open woodland. Plants which will form the parent stock will be grown from seed collected on site or plants recovered from within the development footprint and transferred to the nursery for seed production.

9.7 Soil remediation

Highly degraded areas with a history of intense grazing may require some soil remediation works to improve soil structure to facilitate regeneration. Soil remediation may include deep ripping to alleviate soil compaction and to increase water infiltration and reduce surface run off. Before any remediation works that will further disturb the soil, grazing will be removed and the grass sward allowed time to recover and minimise any areas of bare soil.

In areas of low resilience, particularly those on slopes, minor earthworks may also be used to create shallow swales to divert or retain surface run off and allow it to infiltrate. This task will be undertaken in association with revegetation or direct seeding works.

9.8 Direct seeding

Direct seeding is a technique of re-establishing native vegetation by sowing seed directly into the field without the need to plant tube stock. Mechanical direct seeding will be undertaken over large areas using equipment such as the Rodden tree and shrub seeder while direct seeding by hand will be used for smaller areas.

Direct seeding will be undertaken in moderately disturbed areas that already contain components of the native vegetation particularly in areas adjacent high quality remnant vegetation.

9.8.1 Site preparation

Site preparation is required to improve the success of direct seeding works. Site preparation will be dependent on the species and the site conditions. Preparation may include slashing and spraying of the ground layer vegetation to remove biomass and reduce initial competition with germinating seeds. Minor soil disturbance may also be beneficial to create a suitable seedbed for germination. Site preparation may also include the retention of ground layer vegetation as this may provide protection to young seedlings.

In areas where native groundcover species are prevalent, site preparation will be limited to slashing. Areas dominated by groundcover weeds may be sprayed with herbicide prior to direct seeding. Minor soil disturbance to the topsoil through raking will create more favourable conditions for seed germination but will be restricted to smaller areas where follow up weed control of these disturbed areas will be undertaken.

The techniques of site preparation described above including removal of biomass and soil disturbance will also be used to create conditions to allow naturally dispersed seed to establish and to encourage germination from the soil seed bank. These works will be undertaken on a smaller scale in areas such as below remnant canopy trees where ground layer vegetation is dominated by weeds. These techniques will be used along with pile burns to attempt to encourage regeneration from the soil seed bank.

9.8.2 Timing and irrigation

Direct seeding works will be timed to mimic natural seed fall patterns and to take advantage of seasonal rain to increase the chances of survival of sown seed. Where a water source such as an existing dam or stormwater detention wetland is readily available, irrigation of direct seeded areas will improve the chances of germination and survival of seedlings.

9.8.3 Maintenance

Maintenance of direct seeded areas is vital to ensure success and will include weed control, irrigation and pest and feral animal control.

9.8.4 Mechanical direct seeding

Mechanical direct seeding will be undertaken with the Rodden tree and shrub seeder. Mechanical direct seeding is more cost effective than planting however the results are less certain. Mechanical direct seeding is suited to a limited range of commonly occurring species as it requires a large quantity of seed. Mechanical direct seeding will be coordinated with large-scale revegetation to achieve desired species diversity.

Mechanical direct seeding will also be used in areas where there is potential for natural regeneration but the quick establishment of perennial native species such as *Acacia* sp. is beneficial. This includes erosion prone areas with a high proportion of existing native groundcovers.

Pre-treatment of seed prior to sowing will increase chances of success. Pre-treatment will include heat treatment for species with hard seed coats such as *Acacia*, Fabaceae species and *Dodonaea* sp. and cold stratification for *Bursaria*. Site preparation is usually limited to slashing of groundcover vegetation when using mechanical direct seeders.

9.8.5 Hand direct seeding

Hand direct seeding will be undertaken on a smaller scale with smaller quantities of seed than mechanical direct seeding. This technique will be used in small disturbed areas surrounded by higher quality vegetation. It will facilitate the natural spread of seed and increase the rate of colonisation of native plants into these disturbed areas. Hand direct seeding will utilise seed collected from the immediate vicinity of the site to be seeded and spread soon after collection. Site preparation will include slashing of weedy vegetation and raking of the soil surface to create conditions suitable for germination. In exposed areas seed will be sown within plant protectors (otherwise known as grow bags which consist of a small plastic sleeve held in place with 3 stakes). These will provide a suitable microclimate and protect germinating seeds.

The seed of less common grassland herbs which are to be grown intensively and will be used in hand direct seeding works.

As with all other works, records will be kept to monitor the success of all hand direct seeding works.

9.8.6 Native grass direct seeding

During the establishment of the grass seed orchards, direct seeding techniques will be used to establish the *Themeda australis* orchards. These techniques include the use of seed bearing hay and direct seeding using unprocessed seed heads (Cole and Lunt, 2005). The seed produced in the seed orchards will be used to direct seed existing areas of degraded grassy open woodland. *Themeda* will be the dominant species and other grass species will be used as well as the less common grassland herbs as described above.

9.9 Brush matting

Brush matting will be used to introduce seed of woody vegetation to areas of degraded woodland and grassy open woodland. Site preparation required is similar to that described for direct seeding. Brush matting is particularly useful in areas subject to erosion, as the added rough mulch will help protect the soil and provide protection to any seeds that germinate. Areas prone to erosion include slopes and ephemeral creek lines. As described in section 9.4, brush matting will be collected from areas within the development land which are to be cleared and will consist of seed bearing tree braches and the tops of shrubs with ripe fruit. This material will be spread on the prepared site on the same day as it is harvested and not stockpiled.

9.10 Spreading recovered topsoil

The techniques involved in topsoil recovery are described in section 9.4.3. Sites suitable to receive salvaged topsoil will be open degraded areas with a low proportion (<10%) of native species. The sites will be flat and preferably adjacent to an existing water source such as a dam or stormwater wetland to allow the site to be irrigated.

9.11 Planting

Encouraging the site's natural resilience through bush regeneration techniques and direct seeding will be used in preference to planting. Planting will be restricted to areas where natural regeneration is unlikely or will be slow due to past disturbances. These areas include areas currently dominated by introduced pasture grasses, areas that are too far removed from remnant vegetation to receive input of propagules or areas that have been heavily degraded by past land use and will immediately benefit from increased vegetation cover. This includes riparian zones and headwater catchments.

9.11.1 Species selection and densities

Species that are suitable for planting are listed in Appendix A according to the type of management region (e.g. grassland). In deciding what species will be planted, consideration will also be given to the adjacent vegetation community, species present on site in the same mapped vegetation community and species known to occur in that community as described by NSW NPWS (2002).

Some areas will be planted as thickets to mimic the natural distribution of certain species. These thickets will act as seed sources for future revegetation on site as described in section 9.6.1 and may be used as a seed source for upcoming regional revegetation projects.

9.11.2 Landscape planting

Some landscape plantings are proposed within the conservation zone. Provenance local indigenous species are to be used where possible. Where other native species are used, their effect on the ecology of the surrounding conservation zone must be considered. For example, large flowering hybrid Grevilleas provide an abundant food source for common and native miner birds and large native wattlebirds which are aggressive and drive away small native birds.

9.11.3 Plant propagation

It is recommended that an on-site nursery be established to propagate any plants required for revegetation works. The nursery will include areas for all weather propagation and hardening off.

9.11.4 Irrigation

Newly planted stock will be irrigated where possible depending on rainfall. Additional irrigation will be required for replacement tube stock. Existing dams will be retained as a source for irrigation until no longer required. Alternatively, tanks or tanker trucks will be used for irrigation.

Irrigation can also be used as a trigger technique in areas of regeneration. Note that revegetation and direct seeding will be deferred until rain where irrigation is not possible.

9.11.5 Maintenance

Irrigation, weeding, rubbish removal, pest and disease control and replanting will be undertaken until the plants are established and weed growth is minimal.

9.11.6 Mechanical planting

For large areas of highly degraded low resilience land, mechanical planting is an efficient way to increase the ecological value of the area. The Treeliner mechanical planter will be used. Planting rows will be made as sinuous as possible to disguise the appearance of the rows as much as possible. On steeper slopes rows will be on contour. The rows will be located as close to each other as the machine will allow, leaving enough space for a slasher. The area between rows will be mechanically slashed on a regular basis to reduce competition from groundcover weeds. Grow-bags may be used to protect seedlings if deemed to be necessary.

9.11.7 Hand planting

Hand planting will be used in smaller areas with fewer plants. Hand planting may also be required on slopes too steep for mechanical planting. During hand planting all holes will be dug with an auger to increase efficiency.

9.12 Thinning of Eucalypt regrowth

To achieve a vegetation structure consistent with grassy open woodland, areas of dense *Eucalyptus* regrowth will be thinned so that the plant density does not restrict the growth rate and limit the size of mature trees. Thinning will involve removal of selected trees that have a diameter at breast height (dbh) of less than 20 cm, the weakest tree with the lowest dbh will be removed preferentially. Trees will be cut with a chainsaw as close to the ground as practical. The objective is to space trees so that their centres are approximately 5 to 10 m apart for sustainable woodland.

Logs and branches will be left in situ within the area they are felled to provide habitat and return woody debris to the woodland ecosystem which has historically been cleared as a part of the sites management for grazing. The resulting coverage by

woody debris following thinning operations will be less than 30%. Excess logs and branches will be relocated into adjacent open areas as brush matting.

Programmed ecological burns are likely to kill some of the younger eucalypt saplings. Where an area is proposed to be burnt, thinning will be deferred till 2-3 years after the burn. Thinning will be undertaken out of the breeding season of native fauna. Each plant will be checked for nests prior to removal.

9.13 Erosion and sediment control

Gully erosion is advanced in some ephemeral creek lines. Some minor earthworks and stabilisation are required in these degraded gullies. These earthworks will aim to recreate the original natural geomorphology of the gullies. This geomorphology includes shallow depressions containing *Juncus usitatus* and is still present in the headwaters of gullies on site.

Head wall erosion will be addressed by revegetating cleared riparian areas in the headwaters of these creek lines. Some of the creek lines within the woodland areas have good canopy cover yet the gully sidewalls are still denuded. These gullies will be resnagged with woody debris from thinning of regrowth works. Resnagging will involve placing logs and smaller branches along the length of the gully across the flow path, to capture sediment and help create niches for plant establishment within the creek base on gully sidewalls.

Areas of earthworks in gullies will be immediately revegetated. Where native vegetation has re-established in these gullies no earthworks will be undertaken which will disturb this vegetation.

9.14 Feral animal control

Feral cats and foxes predate native fauna, and rabbits cause erosion by their burrows and by consuming ground cover vegetation. These species will be targeted for eradication from the site in consultation with the Rural Lands Protection Board.

Options to control the plague mosquito-fish (*Gambusia holbrooki*) will be explored if they persist in any remaining water bodies.

9.15 Litter

Litter includes paper and plastic rubbish, and dumped garden waste and soil. It is aesthetically unpleasing and can negatively impact the ecosystems by:

- Smothering vegetation
- Increasing nutrient levels in bushland and waterways
- Spreading weed propagules
- Killing fauna

Litter will be managed by regular inspections, especially after storms, and regular cleaning of litter traps.

Future littering and dumping will be reduced through the provision of adequate fencing and supply of bins in passive recreation areas.

9.16 Community involvement

The Landscape Master Plan describes the types and locations of interpretive signs and walking trails. These aim to encourage community interaction with the natural and cultural environment.

Bushcare groups will provide a forum for the community to actively participate in caring for their local bushland. Opportunities will be provided for the involvement of community members in activities such as planting and seed collection.

Landowners will be advised on species appropriate for their private gardens. This will contribute to the ecological value of the site and minimise risk of undesirable species, including weeds.

9.17 Research

The University of Western Sydney and University of Wollongong will be invited to conduct scientific studies of ecological processes within Wivenhoe. Information resulting from these studies may be incorporated in performance reports.

9.18 Approvals

According to the *Camden Local Environmental Plan No.139 –Mater Dei*, no development approvals are required for tasks identified in this CMP.

Approvals for ecological burns are not required from the RFS, however approvals for hazard reduction works require assessment under the *Bushfire Environmental Assessment Code (NSW RFS 2006)*.

Approvals associated with infrastructure development are mainly dealt with under the *NSW Environmental Planning and Assessment Act 1979* and are not discussed here.

9.19 Environmental management in development land

Environmental management in development land includes:

- Opportunities to take natural resources from the development land during construction and use them in the conservation land (e.g. brush matting, seed collection, topsoil reuse) (discussed previously in Section 8)
- Managing conditions in the development land prior to construction so that adverse impacts to the conservation land are avoided
- Managing environmental conditions in the development land in the short and long term

Statements of Environmental Effects for Wivenhoe (APP 2008 – to be completed) describe how the environmental qualities of development land will be managed during construction and in the long term as urban land use. These cover issues such

as site preparation (e.g. broad area weed removal and erosion control along drainage lines), soil and erosion control during construction, and post construction environmental management and monitoring.

Economies of scale and environmental benefits can be gained by integrating environmental management of the development land with CMP tasks. Prior to construction commencing at each precinct, the CMP schedule will be reviewed so that environmental management of the conservation and development regions can be integrated, where possible.

The community will be responsible for environmental conditions of their neighbourhood in the long term, including impacts from urban land use on the conservation land. This will be managed by community education, involvement in environmental management and regulation. Mechanisms for achieving this will be included in the Trust Scheme.

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Appendix A. Flora species list

Family Name	Species Name	Type
Acanthaceae	<i>Brunoniella australis</i>	Herb
Acanthaceae	<i>Brunoniella pumilio</i>	Herb
Adiantaceae	<i>Cheilanthes sieberi</i>	Herb
Adiantaceae	<i>Pellaea falcata</i>	Herb
Amaranthaceae	<i>Alternanthera denticulata</i>	Herb
Amaranthaceae	<i>Alternanthera nana</i>	Herb
Amaranthaceae	<i>Alternanthera spp.</i>	Herb
Anthericaceae	<i>Arthropodium minus</i>	Herb
Anthericaceae	<i>Caesia vittata</i>	Herb
Anthericaceae	<i>Dichopogon fimbriatus</i>	Herb
Anthericaceae	<i>Tricoryne elatior</i>	Herb
Apocynaceae	<i>Parsonia straminea</i>	vine
Asphodelaceae	<i>Bulbine bulbosa</i>	Herb
Asteraceae	<i>Calotis cuneifolia</i>	Herb
Asteraceae	<i>Calotis dentex</i>	Herb
Asteraceae	<i>Calotis lappulacea</i>	Herb
Asteraceae	<i>Cotula coronopifolia</i>	Herb
Asteraceae	<i>Cymbonotus lawsonianus</i>	Herb
Asteraceae	<i>Olearia viscidula</i>	Shrub
Asteraceae	<i>Senecio hispidulus</i>	Herb
Asteraceae	<i>Senecio quadridentatus</i>	Herb
Asteraceae	<i>Vernonia cinerea</i>	Herb
Asteraceae	<i>Solenogyne dominii</i>	Herb
Asteraceae	<i>Solenogyne bellioides</i>	Herb
Asteraceae	<i>Ozothamnus diosmifolius</i>	Shrub
Asteraceae	<i>Chrysocephalum apiculatum</i>	Herb
Asteraceae	<i>Chrysocephalum semipapposum</i>	Herb
Asteraceae	<i>Glossogyne tannensis</i>	Herb
Asteraceae	<i>Brachycome angustifolia</i> var <i>angustifolia</i>	Herb
Asteraceae	<i>Cassinia spp.</i>	Herb
Azollaceae	<i>Azolla pinnata</i>	Aquatic
Campanulaceae	<i>Wahlenbergia communis</i>	Herb
Campanulaceae	<i>Wahlenbergia gracilentia</i>	Herb
Campanulaceae	<i>Wahlenbergia gracilis</i>	Herb
Campanulaceae	<i>Wahlenbergia spp.</i>	Herb
Casuarinaceae	<i>Casuarina cunninghamiana</i>	Tree
Casuarinaceae	<i>Casuarina glauca</i>	Tree
Casuarinaceae	<i>Allocasuarina spp.</i>	Tree
Chenopodiaceae	<i>Atriplex semibaccata</i>	Herb
Chenopodiaceae	<i>Chenopodium pumilio</i>	Herb
Chenopodiaceae	<i>Einadia hastata</i>	Herb
Chenopodiaceae	<i>Einadia nutans</i>	Herb
Clusiaceae	<i>Hypericum gramineum</i>	Herb
Colchicaceae	<i>Wurmbea biglandulosa</i>	Herb

Family Name	Species Name	Type
Commelinaceae	<i>Commelina cyanea</i>	Herb
Convolvulaceae	<i>Dichondra micrantha</i>	Herb
Convolvulaceae	<i>Dichondra repens</i>	Herb
Crassulaceae	<i>Crassula sieberiana</i>	Herb
Cyperaceae	<i>Carex appressa</i>	Sedge
Cyperaceae	<i>Carex inversa</i>	Sedge
Cyperaceae	<i>Eleocharis acuta</i>	Sedge
Cyperaceae	<i>Lepidosperma laterale</i>	Sedge
Cyperaceae	<i>Eleocharis sphacelata</i>	Sedge
Cyperaceae	<i>Fimbristylis dichotoma</i>	Sedge
Cyperaceae	<i>Eleocharis spp.</i>	Sedge
Dilleniaceae	<i>Hibbertia diffusa</i>	Shrub
Epacridaceae	<i>Lissanthe strigosa</i>	Shrub
Euphorbiaceae	<i>Poranthera corymbosa</i>	Herb
Euphorbiaceae	<i>Phyllanthus virgatus</i>	Herb
Euphorbiaceae	<i>Poranthera microphylla</i>	Herb
Euphorbiaceae	<i>Chamaesyce drummondii</i>	Herb
Fabaceae (Faboideae)	<i>Daviesia ulicifolia</i>	Shrub
Fabaceae (Faboideae)	<i>Desmodium rhytidophyllum</i>	Herb
Fabaceae (Faboideae)	<i>Desmodium varians</i>	Herb
Fabaceae (Faboideae)	<i>Glycine clandestina</i>	Herb
Fabaceae (Faboideae)	<i>Glycine tabacina</i>	Herb
Fabaceae (Faboideae)	<i>Hardenbergia violacea</i>	vine
Fabaceae (Faboideae)	<i>Glycine microphylla</i>	Herb
Fabaceae (Faboideae)	<i>Dillwynia juniperina</i>	Shrub
Fabaceae (Faboideae)	<i>Desmodium spp.</i>	Herb
Fabaceae (Mimosoideae)	<i>Acacia binervia</i>	Small Tree
Fabaceae (Mimosoideae)	<i>Acacia decurrens</i>	Small Tree
Fabaceae (Mimosoideae)	<i>Acacia floribunda</i>	Small Tree
Fabaceae (Mimosoideae)	<i>Acacia longifolia</i>	Shrub
Fabaceae (Mimosoideae)	<i>Acacia parramattensis</i>	Small Tree
Fabaceae (Mimosoideae)	<i>Acacia spp.</i>	Shrub
Geraniaceae	<i>Geranium solanderi</i>	Herb
Goodeniaceae	<i>Brunonia australis</i>	Herb
Goodeniaceae	<i>Goodenia hederacea</i>	Herb
Goodeniaceae	<i>Goodenia heteromera</i>	Herb
Haloragaceae	<i>Myriophyllum spp.</i>	Herb
Hypoxidaceae	<i>Hypoxis hygrometrica</i>	Herb
Juncaceae	<i>Juncus usitatus</i>	Sedge
Juncaginaceae	<i>Triglochin procera</i>	Aquatic
Juncaginaceae	<i>Triglochin procerum</i>	Aquatic
Lamiaceae	<i>Ajuga australis</i>	Herb
Linaceae	<i>Linum marginale</i>	Herb
Lobeliaceae	<i>Pratia purpurascens</i>	Herb
Lomandraceae	<i>Lomandra filiformis</i>	Herb
Lomandraceae	<i>Lomandra longifolia</i>	Herb

Family Name	Species Name	Type
Lomandraceae	<i>Lomandra multiflora</i>	Herb
Lomandraceae	<i>Lomandra spp.</i>	Herb
Loranthaceae	<i>Amyema cambagei</i>	Mistletoe
Loranthaceae	<i>Amyema miquelii</i>	Mistletoe
Loranthaceae	<i>Amyema pendulum ssp pendulum</i>	Mistletoe
Malvaceae	<i>Sida corrugata</i>	Herb
Marsileaceae	<i>Marsilea mutica</i>	Fern
Myoporaceae	<i>Myoporum debile</i>	Herb
Myoporaceae	<i>Eremophila debilis</i>	Herb
Myrtaceae	<i>Angophora floribunda</i>	Tree
Myrtaceae	<i>Angophora subvelutina</i>	Tree
Myrtaceae	<i>Eucalyptus amplifolia</i>	Tree
Myrtaceae	<i>Eucalyptus eugenioides</i>	Tree
Myrtaceae	<i>Eucalyptus moluccana</i>	Tree
Myrtaceae	<i>Eucalyptus tereticornis</i>	Tree
Myrtaceae	<i>Kunzea ambigua</i>	Shrub
Myrtaceae	<i>Melaleuca linariifolia</i>	Tree
Myrtaceae	<i>Eucalyptus baueriana</i>	Tree
Myrtaceae	<i>Angophora floribunda subvelutina intergrades</i>	Tree
Onagraceae	<i>Ludwigia peploides</i>	Aquatic
Orchidaceae	<i>Eriochilus autumnalis</i>	Orchid
Oxalidaceae	<i>Oxalis perennans</i>	Herb
Phormiaceae	<i>Dianella longifolia</i>	Herb
Phormiaceae	<i>Dianella spp.</i>	Herb
Pittosporaceae	<i>Bursaria spinosa var spinosa</i>	Shrub
Pittosporaceae	<i>Bursaria spinosa</i>	Shrub
Poaceae	<i>Austrostipa scabra</i>	Tussock Grass
Poaceae	<i>Austrodanthonia racemosa</i>	Tussock Grass
Poaceae	<i>Austrodanthonia bipartita</i>	Tussock Grass
Poaceae	<i>Agrostis avenacea</i>	Tussock Grass
Poaceae	<i>Aristida ramosa</i>	Tussock Grass
Poaceae	<i>Aristida vagans</i>	Tussock Grass
Poaceae	<i>Bothriochloa macra</i>	Tussock Grass
Poaceae	<i>Chloris truncata</i>	Tussock Grass
Poaceae	<i>Chloris ventricosa</i>	Tussock Grass
Poaceae	<i>Cymbopogon refractus</i>	Tussock Grass
Poaceae	<i>Danthonia caespitosa</i>	Tussock Grass
Poaceae	<i>Danthonia linkii</i>	Tussock Grass
Poaceae	<i>Danthonia pilosa</i>	Tussock Grass
Poaceae	<i>Danthonia racemosa</i>	Tussock Grass
Poaceae	<i>Danthonia tenuior</i>	Tussock Grass
Poaceae	<i>Dichelachne micrantha</i>	Tussock Grass
Poaceae	<i>Echinopogon caespitosus</i>	Tussock Grass
Poaceae	<i>Echinopogon ovatus</i>	Tussock Grass
Poaceae	<i>Entolasia marginata</i>	Tussock Grass
Poaceae	<i>Microlaena stipoides</i>	Tussock Grass

Family Name	Species Name	Type
Poaceae	<i>Oplismenus aemulus</i>	Tussock Grass
Poaceae	<i>Panicum simile</i>	Tussock Grass
Poaceae	<i>Phragmites australis</i>	Tussock Grass
Poaceae	<i>Themeda australis</i>	Tussock Grass
Poaceae	<i>Cynodon dactylon</i>	Grass
Poaceae	<i>Danthonia linkii</i> var <i>linkii</i>	Tussock Grass
Poaceae	<i>Chloris virgata</i>	Tussock Grass
Poaceae	<i>Danthonia racemosa</i> var <i>racemosa</i>	Tussock Grass
Poaceae	<i>Echinopogon caespitosus</i> var <i>caespitosus</i>	Tussock Grass
Poaceae	<i>Microlaena stipoides</i> var <i>stipoides</i>	
Poaceae	<i>Imperata cylindrica</i> var <i>major</i>	Tussock Grass
Poaceae	<i>Elymus scaber</i>	Tussock Grass
Poaceae	<i>Aristida</i> spp.	Tussock Grass
Poaceae	<i>Austrodanthonia</i> spp.	Tussock Grass
Poaceae	<i>Danthonia</i> spp.	Tussock Grass
Poaceae	<i>Echinochloa</i> spp.	Tussock Grass
Polygonaceae	<i>Rumex brownii</i>	Herb
Polygonaceae	<i>Persicaria decipiens</i>	Herb
Portulacaceae	<i>Portulaca oleracea</i>	Herb
Potamogetonaceae	<i>Potamogeton tricarlinatus</i>	Aquatic
Ranunculaceae	<i>Clematis aristata</i>	Vine
Ranunculaceae	<i>Clematis glycinoides</i>	Vine
Ranunculaceae	<i>Ranunculus lappaceus</i>	Herb
Rosaceae	<i>Rubus parvifolius</i>	Herb
Rubiaceae	<i>Asperula conferta</i>	Herb
Rubiaceae	<i>Opercularia aspera</i>	Herb
Rubiaceae	<i>Opercularia diphylla</i>	Herb
Rubiaceae	<i>Richardia stellaris</i>	Herb
Rubiaceae	<i>Opercularia</i> spp.	Herb
Santalaceae	<i>Exocarpos cupressiformis</i>	Small Tree
Sapindaceae	<i>Dodonaea viscosa</i> ssp <i>cuneata</i>	Shrub
Sapindaceae	<i>Dodonaea viscosa</i> ssp <i>spatulata</i>	Shrub
Scrophulariaceae	<i>Veronica</i> spp.	Herb
Solanaceae	<i>Solanum prinophyllum</i>	Herb
Solanaceae	<i>Solanum pseudocapsicum</i>	Herb
Stackhousiaceae	<i>Stackhousia viminea</i>	Herb
Sterculiaceae	<i>Brachychiton populneus</i>	Tree
Typhaceae	<i>Typha orientalis</i>	Semi-Aquatic
Typhaceae	<i>Typha</i> spp.	Aquatic
Violaceae	<i>Viola hederacea</i>	Herb

Appendix B. Wivenhoe Conservation Area site tasks and timetable

Location	Area (ha)	Tasks (refer to Section 9 of CMP)	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
TOTAL	111.81						
Sustainable Woodland	75.15						
Sw1		Exclusion of livestock	x				
		Primary weed control	x				
		Fire to be excluded	x	x		x	x
		Reintroduction of woody debris in eroded gullies	x				
		Seed collection	x	x	x	x	x
		Maintenance weed control	x	x	x	x	x
Sw2		Exclusion of livestock	x				
		Seed collection	x	x	x	x	x
		Primary weed control	x				
		Follow up weed control		x			
		Reintroduction of woody debris in eroded gullies	x				
		Programmed ecological burns			x		
		Maintenance weed control	x	x	x	x	x
Degraded woodland	21.52						
Dw1		Fencing to protect from exotic garden sp.	x				
		Primary weed control	x				
		Follow up weed control		x			
		Spreading recovered topsoil	x				
		Brush matting	x				

		Erosion and sediment control - Minor earthworks in open degraded gullies to restore geomorphology	x					
		Hand planting (only after monitoring period)				x		
		Maintenance weed control					x	x
Dw2		Exclusion of livestock	x					
		Primary weed control	x					
		Follow up weed control			x			
		Brush matting	x					
		Hand direct seeding			x			
		Maintenance weed control				x	x	x
		Erosion and sediment control - Minor earthworks in open degraded gullies to restore geomorphology	x					
Degraded grasslands	15.14							
G1		Strictly controlled livestock grazing	x					
		Grassland weed control			x		x	x
		Soil remediation				x		
		Hand planting to supplement natural regeneration of native grasses			x			
		Seed orchards	x					
		Retain dam for irrigation						
		Maintenance weed control				x	x	x