# Landscape Management Plan

(incorporating Weed Management Plan)

Macquarie University

June 2017

context

## Document Control

| ISSUE | DESCRIPTION | SIGNED | DATE |
|---|---|---|---|
| A | Preliminary Draft Issued for Review | DM | 21/05/15 |
| B | Final Draft Issued for Review | DM | 27/05/15 |
| C | Final Issue | DM | 15/07/15 |
| D | Final Issue | DM | 31/07/15 |
| **E** | **Final Issue to update Precinct D** | DM | 16/06/17 |

# Landscape Management Plan
(Incorporating Weed Management Plan)

Macquarie University

June 2017

context

# Table of Contents

## Appendices

Appendix A – Illustrative Master Plan
Appendix B – Three Monthly Maintenance Audit Form
Appendix C – Reference Documents

## Figures

# 1.0 Introduction

This report has been prepared to support the Campus-wide Macquarie University Design Excellence Strategy and Urban Design Guidelines. The Design Excellence Strategy and Urban Design Guidelines are required under Condition B4 of the Concept Plan approval, and will act as a guiding document in implementing the recently completed Macquarie University Campus Master Plan 2014. In addition to the Design Excellence Strategy and Urban Design Guidelines, the Concept Plan conditions of approval also require detailed management plans to support new development in each precinct. These include the requirement to prepare a Landscape Management Plan as contained in this document.

The Landscape Management Plan (LMP) describes the landscape management activities to be undertaken by the Macquarie University Property Office or its agents for the long-term care of the Universities various open spaces. The historic and current landscape is discussed, the general landscape management principles of the University are outlined, and general landscape management activities are described. There is a focus on specific landscape types with particular management activities, and on landscape management activities which support the goals and objectives of the Design Excellence Strategy and Urban Design Guidelines. It proposes management activities which may be specific to and promote the landscape character of each precinct within the open space network.

The LMP covers the landscape management of both the existing and proposed future constructed landscapes, and the Vegetation Management Plan (VMP) prepared by CONTEXT/Lesryk Environmental Consultants 2015 covers the management of remnant native vegetation areas and habitat rehabilitation zones. There is some overlap as some areas of remnant vegetation, particularly in riparian corridors have been planted with introduced species over the years.

The campus open space is currently undergoing major changes as new projects are commenced and the Masterplan is implemented. For this reason the LMP does not provide a schedule or timetable of activities or reporting. A timetable of activities, reporting and inspections should be prepared by the Property Office for existing open space areas and new areas included as they are completed.

## 1.1 The Need for this Landscape Management Plan

Due to its high quality landscape setting, Macquarie University is recognised as a ‘Campus in the Park’. The ongoing management of the campus landscape is therefore fundamental in reinforcing the experience of the University into the future.

The Macquarie campus contains examples of biodiversity under threat from past extensive habitat loss. Around four hectares of the endangered Sydney Turpentine Ironbark Forest (STIF) community occurs as remnant bush around the University grounds, particularly to the northwest of the Mars Creek Lake.

In addition the University maintains the whole campus as an Arboretum comprising all trees and plants on the campus. These trees, growing in natural and planted habitats, provide a valuable resource for teaching and research and a pleasing and relaxing environment for the enjoyment of staff, students and visitors to the university. Where appropriate the university provides interpretive material throughout the campus which describes the arboretum, trees and ecological processes. The arboretum also provides habitat for many native birds and animals.

## 1.2 Where This Plan Applies

This LMP applies the entire open space network of the campus and includes landscape areas over podium or roofs, streetscapes and the sports fields. It includes all precincts. These are;

—**Precinct A** Academic Core

—**Precinct B** University Housing

—**Precinct C** University Open Space and Playing Fields

—**Precinct D** Macquarie University Research Park (MURP) and Private Hospital

—**Precinct E** Station South

—**Precinct F** Epping Road West

—**Precinct G** Epping Road Precinct Expansion

—**Precinct H** Talavera Road North

Refer to figure 1 showing the extent the area covered by the plan.


Figure 1 Extent of the campus covered by this LMP

## 1.3 Landscape Maintenance Responsibility

The Macquarie University Property Office will hold the first level of responsibility for the implementation of the Landscape Management Plan. The on-going, day-to-day implementation, monitoring and reviewing of the LMP will be undertaken by the by the Assets Manager, Campus.

## 1.4 Landscape Management Principles

The following landscape management principles have been identified as being consistent with the Concept Plan:

Minimise environmental impacts that may result from landscape management activities and utilise environmentally sustainable practices

Preserve, enhance and promote the bushland character of the university

For new and replacement plantings, consider the use of endemic plant species in the first instance. Next consider the appropriateness that the species selection may have in enhancing the character of the precinct or space in which it is to be planted and whether the species can enhance the Arboretum collection

Use specimen trees to unify and define the landscape character of particular outdoor spaces

Provide a safe environment, minimising potential risks to people, buildings and property

Incorporate water sensitive urban design (WSUD) techniques to manage stormwater, slow runoff, recharge groundwater, store for re-use and to passively irrigate landscape areas

Apply best practice bush regeneration in bushland areas and best practice landscape maintenance in landscaped areas

Provide a continuous and legible high quality path network that provides for safe, equitable and efficient movement. Give precedence to pedestrians over vehicles and improve access to all areas of the campus

Ensure that all new works comply with the requirements of AS 1428 Access and Mobility Design

Target noxious weeds and feral animals through the use of integrated pest management approaches

Integrate building and landscape design to provide external meeting and teaching and learning spaces

Provide opportunities for Aboriginal, environmental and informal learning and study in the landscape

Maintain high quality outdoor spaces, precincts and streetscapes

Maintain high quality sports precincts

Maintain high quality passive recreation areas

Manage bushfire risk in accordance with recognised guidelines

Provide opportunities for greater community involvement

Appropriately fund, plan and manage landscape maintenance to provide a measurable improvement of the campus landscape appearance, safety and amenity.

## 1.5 Report Structure

This report is to be read in conjunction with the:

- Macquarie University Campus Masterplan 2014 (Cox Richardson Architects and Planners 2014)
- Design Excellence Strategy and Urban Design Guidelines 2015 updated 2017, prepared by Cox Richardson Architects and Planners in conjunction with CONTEXT
- Vegetation Management Plan (VMP) 2015 for Macquarie University, prepared by Lesryk Environmental Consultants in conjunction with this LMP.

Section 1.0 provides an introduction to the LMP

Section 2.0 describes the general site conditions

Section 3.0 describes Specific Landscape Types

Section 4.0 describes management activities common to all landscape areas of the campus

Section 5.0 describes specific landscape management activities for specific areas of the campus

Section 6.0 describes Protective Measures for trees and vegetation

Section 7 Monitoring and Reporting

The report is structured to avoid duplication by separating maintenance activities into two categories:

1. Specific Landscape types – Those maintenance activities that are specific to particular landscape types. The specific landscape types are:
    a. Specimen Trees. These may be planted in lawn areas or in paving areas, as avenues and as street trees or in groupings
    b. Mass Planting Areas. These may be composed of single species plantings or mixes which may include trees shrubs and groundcovers
    c. Planting on Slab.
    d. Lawn Grasses and Sports Turf Grasses
    e. Native Grasses

2. All areas of the campus – Those maintenance activities that apply to all areas of the landscape within the University. These activities include:
    a. Disease and Insect Control
    b. Irrigation

3. Specific landscape management activities for specific areas of the campus. Specific areas of the campus are required to be managed in particular ways in order to preserve and enhance their unique landscape integrity. The specific areas are:

    a. Herring Road Gateway
    b. Balaclava Road Gateway
    c. Gymnasium Road Gateway
    d. Talavera Road Gateway
    e. Wally's Walk
    f. Macquarie Walk
    g. Sir Christopher Ondaatje Avenue

h. The Central Courtyard
i. The University Common
j. The Library Forecourt
k. Arts Lawn (West Common)
l. The Grove (East Common)
m. Mars Creek
n. University Creek
o. Culloden Creek
p. Mars Creek Plaza
q. Wally's Walk Open Space
r. Macquarie Theatre Courtyard
s. Cochlear Forecourt
t. Jim Rose Earth Science Garden
u. Talavera Park
v. Frank Mercer Biological Sciences Garden
w. University Avenue
x. Research Park Drive
y. Eastern Road
z. Western Road
aa. West Precinct Road
bb. Innovation Drive
cc. East-West Pedestrian Connections
dd. North-South Pedestrian Connections
ee. Sports Fields
ff. Residential Colleges

## 1.6 Intensity of use

A key factor in the frequency and types of landscape maintenance activities required for particular areas is the intensity of their use.

### High Intensity Open Spaces

High intensity spaces occur throughout the campus and are places which provide pedestrian linkages to buildings within the University as well as being spaces that encourage social and leisurely activities. They are mixed use zones.

High intensity spaces include Streetscapes such as University Ave near the train station, The Central Courtyard, The University Common, The Library Forecourt, The Arts Lawn and The Grove.

Figure 2 High intensity open space – Central Courtyard

### Passive Open Spaces

Passive areas include smaller, informal spaces which cater for outdoor learning opportunities, breakout areas and recreational uses and larger areas which see occasional use by small numbers of people.

These spaces on the campus include Mars Creek Plaza, Wally's Walk Park, Macquarie Theatre Courtyard, Jim Rose Earth Science Garden, Talavera Park and Frank Mercer biological Sciences Garden, Mars Creek and University Creek.

Figure 3 Passive open space – Mars Creek Lawn

### Sports Fields

Located on the corner of Talavera Road and Culloden Road in North Ryde the Macquarie University Sports Fields comprises of seven hectares of playing areas. Sports fields have short periods of intense activity and long periods of low activity.

The Sports Fields include Jim Campbell Sportsfield, Ross Gwilliam Sportsfield, Northern Oval and Roger Sheeran Oval.

### Riparian Corridors and Bushland Areas

The riparian corridors on the Macquarie University campus run along Mars Creek and University Creek. The riparian areas are generally areas of low activity although recent riparian rehabilitation upgrades may encourage greater activity. Bushland areas should be managed using bush regeneration techniques that have a low environmental impact.

Bushland management zone relates to bushland areas within the campus. Bushland on the North-west corner of the campus is mapped as Bushfire Prone land Vegetation Category 2 and is to be managed with a 30 metre perimeter vegetation buffer.

Areas of mass planting are not generally susceptible to compaction from pedestrian usage therefore heavier textured soils can be used.

Figure 4 Mars Creek Riparian Zone showing regeneration of the 20m riparian corridor

## 1.7 Arboretum

The arboretum at Macquarie University is unique in being the only arboretum in Sydney that is located on a university campus. It contains trees that are remnant to the native plant communities as well as recent landscape planting. The arboretum is a resource for teaching and research and provides habitat for native birds and other animals. The campus contains a series of walks and gardens, some themed, which display a range of interesting plant species.

The University was established in the 1960's. Prior to this time, the main use of the area was for market gardens. During that time pockets of remnant vegetation were retained. These pockets are still evident and have increased in size over the last 4 decades. As a result of the changes in land use in the surrounding suburbs, there is an increase in the importance of the native vegetation within the campus. Located on the north-western corner of the campus and to the west of the lake

is the main area of remnant Sydney Turpentine Ironbark Forest vegetation community, however smaller pockets are located near the railway station and scattered throughout the campus.

When undertaking planting or replanting at the University, consider the introduction of rare and unusual native and exotic species to increase the arboretum's collection.

Macquarie University is located near areas of native vegetation in Christie Park and Lane Cove National Park. A key goal of the campus landscape management is integrate the campus with the natural surrounding areas and to encourage biological diversity.


Figure 5 Arboretum interpretive signage

A Bushcare Group has recently been established at Macquarie University to preserve the natural environment in particular the native vegetation and the watercourses. The activities of this group will be focussed around the restoration of the riparian zones with native vegetation. There is also a focus around improving the natural flow and water quality of Mars and University Creeks and improving the connectivity between areas of remnant native vegetation.

Figure 6 Bushcare interpretive signage

# 2.0 General Site Conditions

## 2.1 Soil

Macquarie University is located at the geological boundary between Hawkesbury Sandstone and Ashfield Shale of the Wianamatta Group. The gently undulating topography, remnant shale/sandstone transition forest communities (Sydney Turpentine Ironbark Forest, Sandstone Ridgetop Woodland) and occasional loose sandstone boulders in the creek line reflect this characteristic landscape typology.

As noted in the Geomorphologic Assessment conducted by Coffey Geotechnics, 'the geological profile typically consists of topsoil or pavement overlying residual clay. The Bedrock is generally shallow throughout the site, with the depth of overlying clay generally decreasing with elevation'.

## 2.2 Existing Vegetation

### 2.2.1 Cultural Plantings

The predominately native landscape at Macquarie University is the result of over 40 years of continuous planting, transforming the site from its previous use an orchard and market garden into

a ‘Campus in a Park’. It was the intention of Professor Clough, the original landscape architect for the campus, to create a gradual landscape journey from the urban streetscapes outside the campus through the transitional campus building zone to the natural landscape of Mars Creek and its densely planted native backdrop beyond.

Historical aerial photography (refer Figure 7, 8 and 9) illustrates the previous clearing of large tracts of existing vegetation for cultivation as an orchard and market garden. The 1943 view was taken after a bushfire and illustrates the reduced canopy that resulted.

Figure 7 2014 Aerial view. Source: SIX Maps

Figure 8 1943 Aerial view. Source: SIX Maps

Figure 9 1930's Aerial view. Source: Macquarie Uni Archives

Over 14,000 trees and shrubs were planted by Macquarie University throughout the campus between the late 1960s and 1970s, of which some 10,000 have matured and still exist on site. It was the intention of Professor Clough, the University planner at that time, to create a gradual 'landscape journey' from the 'urban streetscape' outside the campus into a natural core.

The earlier streetscapes are defined by informal plantings of *Corymbia, Eucalyptus* and *Syncarpia* species; mainly *Corymbia maculata, Corymbia citriodora* and *Eucalyptus saligna*. The tree planting is often in clumps and form part of the greater open space layout rather than the definition of the roadway. Due to the consistency of size and species, most of the trees within the streetscape would have been planted during the 60s and 70s, however there are a number of naturalized trees in the vicinity of the road reserves.

More recent plantings, for example on University Avenue, are laid out in a formal boulevard arrangement with regular spacing providing shade for the length of the road.

### 2.2.2 Mars Creek Vegetation and Riparian Corridor

Mars Creek is located at the northern extent of the Macquarie University campus. Land use of the creek corridor incorporates remnant bushland, planted exotic and native woodland, mown exotic grassland, teaching & research facilities and animal enclosures. The restoration of vegetation along Upper Mars Creek through the implementation of the two VMP's has been a success. Ideally, similar rehabilitation, including the possible removal of underground culverts, should be adopted downstream of Gymnasium Road.

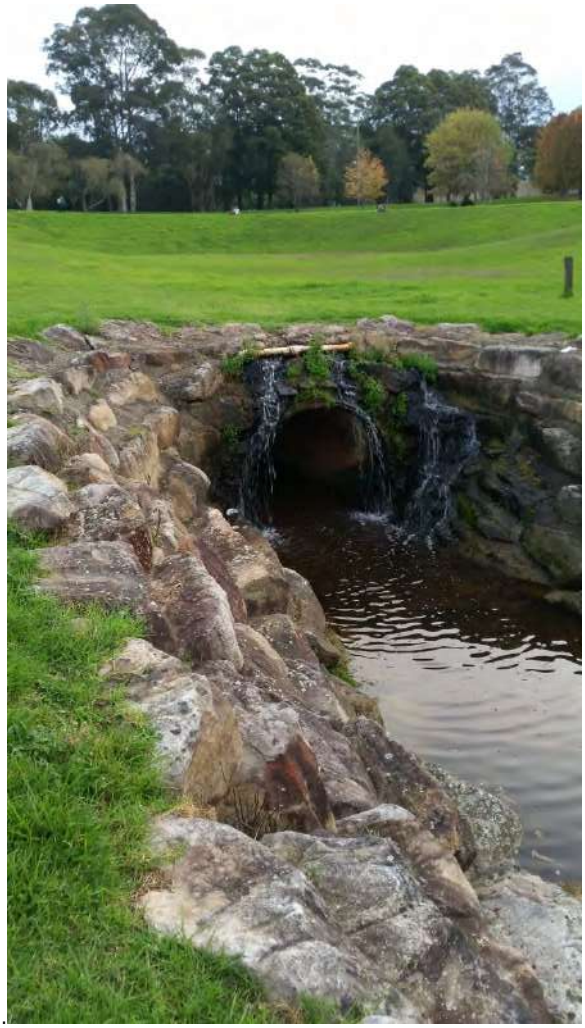

Figure 10 Underground culverts on Mars Creek should be considered for removal. This pipe travels in a direct line under the ampitheatre so the creek may need a slight diversion if the pipe is removed. Note that very little water is actually flowing in the pipe.

Mown lawns with planted Eucalyptus spp. and exotic deciduous trees form an open space perimeter in the south west of the creek corridor. Generally, Mars Creek is situated in a highly modified urban landscape with adjacent development including education facilities, medium density housing and commercial complexes, with Lane Cove National Park located to the north west of the creek corridor. (Total Earth Care, 2014)

A large, remnant stand of Sydney Turpentine Ironbark Forest (STIF) is located in the northern area of the creek corridor, with a smaller remnant stand of STIF located in the central area of the corridor south of the existing gymnasium building.

Refer to the Vegetation Management Plan (Lesryk, 2015) for additional information regarding the ongoing management of vegetation within the Mars Creek riparian corridor.

### 2.2.3 University Creek Vegetation and Riparian Corridor

University Creek is located in the southern area of the Macquarie University campus. Although a 'natural' watercourse, University Creek has been substantially altered over the past 50 years, with culverts, storm water inlets, constructed creek beds and banks contributing to its current flow and

flood regime. The south-eastern area of the creek zone and downstream is subject to periodic flooding.

The riparian corridor has been physically defined and limited by the development of the campus buildings, infrastructure and recreation zones over the last four decades and is often less than the desired 20m in width from the top of the bank. The current planting defines the creek line and creates a range of landscape experiences from the more open parkland landscape in the south west to a more ‘structured’ landscape past Research Park Drive to the north east.

The existing landscape in the riparian corridor of University Creek comprises open parklands and mown lawns set within rising topography on either side of the creek. The majority of the trees within the riparian corridor are native and are believed to have been planted in the late 1960’s and early 1970’s. Some remnant stands of STIF and Sydney Sandstone Ridgetop Woodland occur within the riparian zone. Recent plantings in conjunction with the University Avenue roadworks have re-introduced a balance of lawn, native lawn and STIF understorey to accommodate and balance biodiversity with passive recreation within the creek environs.

Refer to the Vegetation Management Plan (Lesryk, 2015) for additional information regarding the ongoing management of vegetation within the University Creek riparian corridor.

# 3.0 Specific Landscape Types

## 3.1 Specimen Trees

The existing trees on the Campus help to define spaces and provide character, shade, screening, wind protection, habitat, and a sense of scale. As each mature tree could be considered to have a commercial value ranging from several hundred to several thousand dollars (depending on the age, species, size and valuation method), it can be considered that the existing tree-scape is valuable in financial terms and is a major and physical asset.

In principle any tree with a trunk diameter of more than 150mm should be assessed by a qualified arborist prior to removal. This should not apply if the tree has major structural faults, is clearly senescent, an environmental weed or poses a health and safety risk.

Underground works, including excavation and service trenching, are frequently the major cause of damage to existing healthy trees. Consideration must been given to protection of the critical root zones of existing trees.

Tree selection for replacement and new tree plantings will be subject to individual designs however some key considerations for both landscape architects and landscape staff are to select endemic trees that contribute to local biodiversity first, then to consider whether the species can contribute to the character of the precinct in which it is planted (for instance, does it complement existing trees or contribute to a proposed theme for the space). Finally trees should be considered for their contribution to the goals of the University Arboretum.

All tree management on campus should refer to the *City of Ryde DCP 2010 Part 9.6 Tree Preservation* and the *City of Ryde Urban Forest Technical Manual and Application Guide.*

Refer to Section 6 for Tree Protection Measures.

All existing trees on Campus have been surveyed.

Avoid whipper-snipping grass at the base of trees because this can cause ring-barking and tree death. Clip around tree bases by hand or instead plant low groundcovers or mulch at the base of trees. Where trees are planted in paved areas, adjacent to the trunk use:

1. Gravel
2. resin-bonded gravel
3. permeable paving surrounds
4. proprietary tree grate or
5. a combination of the above

Figure 11 Specimen trees - *Liquidamber styraciflua* - in the Macquarie Theatre courtyard

### 3.1.1 Soil Management for Trees

Wherever trees are to be planted it is important to understand wether the existing in situ topsoil can be used as backfill, wether new topsoil,  soil mix, soil conditioner or amendments needs to be imported, or if a mix of the above is best.

In general, the greater the soil/subsoil depth (the effective root depth) - the larger the tree that can be supported with minimal maintenance. The ideal soil profile for trees will have at least 3 horizons where the “A” horizon is the topsoil, the “B” horizon is Subsoil and the “C” horizon is the Subgrade. The minimum recommended topsoil depth for trees is 250mm with a minimum subsoil depth of 200mm. This will provide the tree with the minimum moisture/nutrient reserve and anchorage capacity.

In addition to a physical inspection of the soil to be used to assess field texture and structure and drainage capability, soils should also be analysed by a soil laboratory for the following properties at a minimum:

- pH
- Salinity (electrical conductivity)
- Cation exchange properties and exchangeable cations
- Major and minor nutrients
- Organic matter (%)

Where tree specimens in container sizes 25 litres or larger are to be planted, the subsoil should also be tested for:

- pH
- Salinity (electrical conductivity)

- Cation exchange properties and exchangeable cations
- Aggregate stability.

The most common amendments used to bring soils up to a standard suitable for plant growth are:

- Lime or dolomite to make acid pH soils more alkaline.
- Lime or Gypsum to enhance exchangeable calcium and eliminate sodicity
- Gypsum to make clay soils more friable
- Composts and/or manures to improve organic matter and nutrients levels
- Single or complete fertilisers often with trace elements to correct a particular deficiency or multiple deficiencies.

it is important that the backfill soil is returned in the layers in which it was excavated so that topsoil with organic content is placed back near the top 300mm of the backfill. Where the existing site topsoil backfill is unsuitable or insufficient it can be made up with:

| | | |
|---|---|---|
| Sandy loam or site won topsoil mixed with;<br>Composted soil conditioner conforming with AS 4454 | 70-100% by volume<br>0-30% by volume | Eg. 8 parts washed sand/2 parts sandy loam/1 part compost.<br>Amendments as reported by the soil test results. |

(Leake and Haege 2014, p.87)

Where the tree pit is deeper than 300mm (usually for trees in containers over 45 litres) and the existing site subsoil is unsuitable or insufficient a topsoil medium low in organic matter is required so that the organic matter does not “sour” at depths where there is less oxygen, It can be made up with a sandy, well-drained medium which contains low organic matter An example of the components may be:

| | |
|---|---|
| Sandy loam | 60-80% by volume |
| On-site clay loam or clay topsoil or subsoil | 20-30% by volume |
| Composted soil conditioner conforming with AS 4454 | <10% by volume |

(Leake and Haege 2014, p.96)

### 3.1.2 Fertilising, composting and mulching

To ensure the health and vigour of trees are maintained.

All trees whether native or exotic will perform better when the soil conditions are healthy. Building healthy soils is the key to achieving the long term maintenance goals of mass-planted landscape areas. Soil health is primarily achieved with regular applications of organic soil conditioners such as animal manures, decomposed green waste or proprietary blends of compost.

Fertilising and composting are not critical maintenance activities except where there are obvious deficiencies but should be assessed on an annual basis by observation and leaf analysis.

Maintain an adequate level of mulch maintained in planter beds in order to maximise water conservations and to supress weeds.

Note: NPK ratios listed are for native trees. Increase P above >=5 for exotic trees.

| Maintenance Action Required | Frequency |
|---|---|
| Where obvious deficiencies are evident 60 grams/plant (trees) Controlled Release fertiliser such as Nutricote Total TE 360 Day - 17.6: 2.9:6.9 per plant.<br>Or: | Only to be applied if the plant is noticeably under stress and the plant will benefit from the application of the fertiliser Inspect annually; however apply in late Spring if required. |
| 3 x 20 gram slow release fertiliser tablet per plant . N:P:K ratio – 18:3:10 | Only to be applied if the plant is noticeably under stress and the plant will benefit from the application of the fertiliser Inspect annually; however apply in late Spring if required. |
| Where soils are dry, hydrophobic and as a regular maintenance procedure, top up all garden beds with 30-50mm depth of Soil conditioner as composted animal manure, decomposed green waste or proprietary blends such as “Botany Humus” as available from Australian Native Landscapes. For extreme cases use a proprietary soil-wetting agent. | Bi-annually, applied at any time of year. |
| Maintain mulch to a depth of 75mm, through periodic applications. Use same mulch as originally specified in each planting | As required, however should not be necessary more than once per year |

### 3.1.3 Pruning

Carry out all tree pruning in accordance with AS 4373 Pruning of amenity trees. Prune trees to maintain driver sight lines; to remove dead wood from over hanging paths, cycle-ways and roads, to maintain vegetation health and to remove branches or trees that are likely to pose a risk to public safety. Prune to an extent where this will not re-occur as a problem in the period to next routine maintenance without compromising overall form and growth potential of the tree.

Suitable timing for pruning should be determined by the arborist so as to maintain vegetation health, however all trees should be inspected regularly and especially after high winds to determine any action required.

Of particular note are recent avenue tree plantings on University Avenue. Refer to Figure 12. The *Tristaniopsis laurina* will eventually require underpruning to 4 metres to accommodate passing buses. This should be achieved over a period of time with the first pruning 12 months after establishment to “lift” the crown and provide a clear trunk to one metre. The following year the trunk should be lifted to 2 metres and so on until the tree is mature enough to have a velar trunk to

4m with a well-balanced crown.

Figure 12 Recently planted avenue of *Tristaniopsis laurina* in the central median of the recently upgraded University Avenue. These should be progressively underpruned to "lift" the canopy to four metres to allow for passing large vehicles.

Suitable timing for pruning should be determined by the arborist so as to maintain vegetation health.

Dead limbs containing hollows should not be removed unless there is a risk to public safety; limbs with hollows that are trimmed from trees should be left in a suitable location on the ground to provide habitat.

The installation of nest boxes should be considered if tree hollows are removed.

Removed timber and native vegetation, unless diseased, should be considered for reuse on-site either as habitat logs in bushland areas where appropriate, or mulched in garden beds.

Prune to reduce continuous canopy within the APZ.

Remove dead or dying trees from the campus as required. This may be necessary when trees mature, after damage or adverse environmental conditions.

| Pruning - Work Required | Frequency |
|---|---|
| Prune to remove split leaders, remove dead and heavily damaged limbs. As maturity permits prune lower branches to collar to 2.5 metres min. above ground level. (note; this is a general rule only as some trees have low branches which are essential to the form of the tree, and some trees will be sued for screening purpose where low foliage is required.) | As required |
| Prune all trees when limbs and branches hang lower than 4 metres over a roadway or parking | |

| | |
|---|---|
| space and 3 m over a walkways, path or cycleway | |

### 3.1.4 Replacement Plantings

To ensure that the density, species and design intent of established tree plantings is maintained. In figure 5 illustrates the *Liquidamber* tree planting at the graduation statues, a tree has died and snapped mid-trunk. This should be replaced immediately with the largest specimen that can be reasonably procured and practically handled into position.

| Replacement Plantings - Work Required | Frequency |
|---|---|
| Replace failed, senescent or damaged plantings. Densities, sizes and species used are to be in accordance with those specified in the original landscape plans. | As required |
| Water replacement plantings for a minimum of 12 weeks after planting | As required to ensure survival. |

Figure 13 The dead tree in the background should be immediately replaced as this is a high profile location used for graduation photos.

### 3.1.5 Tree Guards, surrounds and Stakes

Replace tree guards/stakes when damaged and/or remove them when no longer required.

Remove tree surrounds where there is the danger that trunks will outgrow the diameter of the surround. Refer to figure 14.

| Work Required | Frequency of Work |
|---|---|
| - Replace tree guards or stakes for trees and shrubs if they are damaged or removed prior to the establishment of the plant. Replace with the same or equivalent guard/stake. | As required until final removal at 12 months |

| | |
|---|---|
| - Remove tree guards and stakes | after planting |

Figure 14 The metal surround should be removed well before the trunk outgrows the circumference.

## 3.2 Mass Planting Areas

Mass planting areas can vary in appearance from mass plantings of single species (eg. *Lomandra sp., Dianella sp. Liriope sp.*) to more complex beds containing advanced trees, low and tall shrubs and ground covers. Planting sizes can include tubestock up to super advanced or semi-mature container sizes. In general, mass planted beds are either planted with native species or exotic species but may also include both.

Mass planted areas must balance design and aesthetics with the application of the principles of Crime Prevention through Environmental Design (CPTED). The highest priority for the management of mass planted beds should be given to areas that pose a security risk or are currently high maintenance.

The key differences in the management of native plants are their requirement for low-phosphorous fertilisers and a lower fertiliser rate than exotic species generally (although this doesn't apply to Australian rainforest plants – some species of which are endemic to the locality). Plants of the Pea group (including *Acacias, Pultenaeas* and *Hardenbergias*) and *Casuarinas* are also able to fix their own Nitrogen.

Natives also have lower water requirements in comparison to exotics and are adapted to the harsher Australian conditions.

Endemic native plants will tolerate site soils without amendment better than exotics, and if no fertilisers are added there may be a lesser invasion by exotic weeds.

For the above reasons native plantings make a more sustainable option in respect of the long term landscape management and should always should be considered for use on the campus before exotic species. For ease of maintenance it may be beneficial to keep native and exotic species apart although this may not always satisfy design intentions.

Most native plants including native rainforest plants prefer free draining soils.

Exotic planting beds will generally require more frequent fertilising, watering in dry periods and will benefit from more frequent applications of soil conditioner.

The edges of the beds will be defined by appropriate means. Beds shall be weed free and mulched annually to suppress weed growth and retain moisture content within the soil. Where irrigation is not present, garden beds should be watered during dry spells to remove undue plant stress and the potential for die-back.

Pruning will be carried out on shrubs that require it according to species to remove the dead and damaged branches and to retain natural shape and encourage good flowering to improve health and vigour. Where die-back of plant material has been identified new plants will be planted as soon as possible, using species originally specified or that maintain the character and continuity of the planting.

Figure 15 Recent mass planting of natives - Lomandra, Westringia Leptospermum and Melaleuca. A lower Phosphorous component fertiliser should be used in areas of solely native planting.

The key management activities required for mass planting areas are:

### 3.2.1 Soil Management for Mass Planted Areas

Areas of native mass planting require a sandy loam to clay loam topsoil mix which is suitable for the planting of grasses, woody and herbaceous perennials and occasionally trees. The following mix is suitable for plants that do not have high nutrient requirements and are not susceptible to compaction. Note that if phosphorous sensitive natives are used, the phosphorous levels of all components must be checked for suitability. Additional drainage may be required depending on the situation.

| | | |
|---|---|---|
| Sandy loam or site won topsoil mixed with;<br><br>Composted soil conditioner conforming with AS 4454 | 70-100% by volume<br><br>0-30% by volume | *Eg. 8 parts washed sand/2 parts sandy loam/1 part compost.*<br><br>*Amendments as reported by the soil test results.* |

(Leake and Haege 2014, p.87)

Areas of exotic mass planting with higher nutrient requirements can have a higher compost component as below:

| | | |
|---|---|---|
| Sandy loam or site won topsoil mixed with;<br><br>Composted soil conditioner conforming with AS 4454 | 70-90% by volume<br><br>10-30% by volume<br><br>30-60% by volume for organic | *Eg. 8 parts washed sand/2 parts sandy loam/3 parts compost.*<br><br>*Amendments as reported by the soil test results.* |

| | | |
|---|---|---|
| | soil variant | |

(Leake and Haege 2014, p.89)

### 3.2.2 Fertilising, Composting and Mulching

To ensure the health and vigour of mass plantings are maintained.

All mass planted areas whether native or exotic will perform better when the soil conditions are healthy. Building healthy soils is the key to achieving the long term maintenance goals of mass-planted landscape areas. Soil health is primarily achieved with regular applications of organic soil conditioners such as animal manures, decomposed green waste or proprietary blends of compost.

Fertilising and composting are not critical maintenance activities except where there are obvious deficiencies but should be assessed on an annual basis by observation and leaf analysis.

Note: NPK ratios listed are for native plants. Increase P above >=5 for exotic mass planting beds.

| Maintenance Action Required | Frequency |
|---|---|
| 50-100 grams per square metre of Organic fertiliser such as Dynamic Lifter Composted chicken manure, Blood and Bone, fish meal and seaweed NPK ratio – 3.7:2:1.8 | Annually. Applied late Spring and again in autumn (higher rate for fast-growing plants). |
| Where obvious deficiencies are evident use10 grams/plant (groundcovers), 20 grams/plant (shrubs) and 60 grams/plant (trees) Controlled Release fertiliser such as Nutricote Total TE 360 Day - 17.6: 2.9:6.9 per plant. N:P:K ratio– 18:3:10 | Annually. Applied late Spring |
| Where soils are dry, hydrophobic and as a regular maintenance procedure, top up all garden beds with 30-50mm depth of Soil conditioner as composted animal manure, decomposed green waste or proprietary blends such as “Botany Humus” as available from Australian Native Landscapes. For extreme cases use a proprietary soil-wetting agent. | Bi-annually |
| All currently mulched areas should gradually be converted to groundcover where possible. Mulch should continue to be applied to a depth of 75mm to retain moisture and minimise weeds until groundcover is established. Mulch applied should be weed-free. | As required, however should not be necessary more than once per year. |

### 3.2.3 Pruning

Ground cover and shrubs should be maintained at a maximum height of 0.5 m along path edges for personal security. Appropriate species selection in these areas will reduce the need for ongoing maintenance.

Remove dead or dying plant material from mas planted areas on the campus as required. This may become necessary as plantings mature, after damage or adverse environmental conditions.

| Pruning Mass Planted Areas - Work Required | Frequency |
|---|---|
| For low shrub species as per appropriate type: Tip prune to encourage density to 50-100mm | As required after flowering |
| For low shrub species as per appropriate type: Prune evenly to a height of 500mm above ground along path edges. Prune away from paths where required | Every 4 years after flowering |

### 3.2.4 Replacement Plantings

To ensure that the density and species of established plant material within mass planted areas is maintained.

| Replacement Plantings in Mass Planted Areas - Work Required | Frequency |
|---|---|
| Replace failed, senescent or damaged plantings. Densities, sizes and species used are to be in accordance with those specified in the original landscape plans. | As required |
| Water replacement plantings for a minimum of 12 weeks after planting. | As required to ensure survival. |

### 3.2.5 Weeding

Weeding is listed under “Mass Planted Areas” because it is the area of greatest concern for weeds in the fabricated landscape, note however that weed control in bushland and other landscape types is also covered in this section.

A noxious weed is a plant declared to be noxious under the NSW Noxious Weeds Act 1993. Noxious weeds can be agricultural weeds, environmental weeds or have a direct impact on human health.

Environmental weeds are non-local plants that can invade and change natural areas and threaten the survival of native plants and animals. After land clearing, environmental weeds are considered to be the next greatest threat to our indigenous biological diversity.

Environmental weeds have the potential to readily invade garden bed areas and potentially impact on the adjacent areas of bushland and creek reserves.

In addition to the environmental hazard posed by weeds, weeds occurring in mass planted beds, growing from the base of trees and from pavement can be unsightly and presents an untidy appearance.

The Ryde Council currently has a defined list of noxious weeds in the City of Ryde: http://www.ryde.nsw.gov.au/Environment/Animals+and+Plants/Noxious+Weeds This list defines plants that are classified as weeds and should be removed from the Campus and not planted in any new works.

This list provides a good basis for management and includes many problem garden weeds. However there are further species that have been identified under the Weed Management Act (1999) that should be specifically excluded from the site. Many of these plants are commonly available in the nursery trade so their use needs to be broadly discouraged.

For control of weeds on the Campus comply entirely with the ***Noxious and environmental weed control handbook*** *a guide to weed control in non-crop, aquatic and bushland situations NSW D P I* Management Guide Sixth Edition. A copy of the handbook can be downloaded at the link:

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/123317/noxious-and-environ-weed-control-handbook.pdf

Figure 16 While not a noxious weed and more of a nuisance weed, the Portulaca species in this bed could be easily controlled if the garden bed were more densely planted.

To ensure that environmental and noxious weeds do not reproduce within or spread into mass planted areas and compete with plantings and spread to other areas or nearby bushland.

Weeding and weed control is considered to be a critical maintenance action.

| Maintenance Action Required | Frequency |
|---|---|
| Prevent reproduction of weeds by destroying seedlings and established weeds before seed set or other propagules form. Remove by hand in the first instance (where infestations are low). Ensure that the entire weed including all roots is removed. Dispose of the weeds off site. | Monthly |
| Remove by Herbicide application any weeds which cannot be controlled by hand removal. Herbicide application must occur before weed seed set. Non-target species and areas must be reinstated if damaged by herbicide application. | |
| Herbicide use to be in accordance with regulation rates and manufacturers recommendations. Herbicide use must comply with the requirements of the *Noxious and environmental weed control handbook. a guide to weed control in non-crop, aquatic and bushland situations.* NSW Department of Primary Industry Management Guide, Sixth Edition. | |
| After spraying, lop any dead weeds flush with the ground surface and dispose of the cuttings. | |
| Use of bio-degradable herbicide is mandatory | |

## 3.3 Planting on Slab

On slab planting areas require particular vigilance in terms of their landscape maintenance. On slab planting areas should be designed with excellent drainage characteristics, but this leaves them susceptible to rapid drying-out because they do not have the moisture buffering capacity provided by subsoils. On slab planting should incorporate sub-surface drip irrigation to prevent drying out On campus they are generally intensive areas and any lawn on slab will be subject to increased wear.

Figure 17 Planting and lawn over a concrete slab near the library. Note the shape of the garden bed results in an area too narrow and difficult to plant. A different resolution could have prevented this.

### 3.3.1 Soil Management for On Slab Planting

`On slab soil media 'A' horizon requires a well-drained growing media with a saturated density of under 2400kg/m$^3$. To maintain the structure and porosity of the soil over long periods of time and to avoid volume loss the formulation must include low density mineral components such as ash, perlite, scoria, pumice and diatomaceous earth or the artificial components of urea formaldehyde and Styrofoam.

Physically, the media has the properties of a potting mix and is assessed using the methodology of AS 3743.

The "A" horizon on-slab would typically be 300mm deep for all on-slab planter boxes, containers and garden beds and may be composed of:

| | |
|---|---|
| Sandy loam or site won topsoil | 20-40% by volume |
| Horticultural ash, perlite, or similar lightweight low-density mineral matter or mixtures of these | 30-60% by volume |
| Composted soil conditioner conforming with AS 4454 | 20-30% by volume |

(Leake and Haege 2014, p.100)

Where the soil profile is deeper than 300mm, an on slab soil media "B" horizon is required. The characteristics are an open granular well-drained growing media with a total saturated density under 2400kg/m$^3$. This growing media is to be used on the subsurface layer below the 'A' horizon soil.

To maintain the structure and porosity of the soil over long periods of time and to avoid volume loss the formulation must contain low-density mineral components including ash, perlite, scoria, pumice and diatomaceous earth, or artificial components such as urea formaldehyde and Styrofoam. (Leake and Haege 2014, p.102)

| | |
|---|---|
| Sandy loam or site won topsoil | 10-30% by volume |
| Horticultural ash, perlite, or similar lightweight low-density mineral matter or mixtures of these | 30-50% by volume |
| Composted 10mm pine bark | 20-40% by volume |
| Composted soil conditioner conforming with AS 4454 | <20% by volume |

## 3.4 Lawn Grasses and Sports Turf Grasses

Significant areas of the Campus are surfaced in exotic lawn, turf or pasture grass. These areas contribute to the character of the Campus, and are important to open space and passive recreation areas. However, they have high demands for maintenance, and require commitment of significant resources particularly in irrigation, fertilizing and mowing and the maintenance of a thick sward that does not wear readily.

The level of maintenance required for particular lawn areas should be considered within the context of their intensity of use.

Figure 18 The lawn in the Central Courtyard is underperforming due to wear, possibly poor construction and competition from tree roots. A larger raised lawn may be preferable.

The traditional European aesthetic determines that grass should be kept lush and green all year round. This is possible and appropriate for high use areas but this perception is gradually changing and it is now more acceptable that in the Australian climate, lawn areas may be subject to seasonal change and browning off in summer. This aesthetic is appropriate for low-use areas that will not be subject to year-round wear.

Specific issues with the existing lawn and grass on the Campus include:

- A range of grass varieties are used on campus. Has one variety been observed to perform better than others?
- In some high use areas, compaction and wear caused by pedestrian and service vehicle has caused grass to die with bare soil remaining.
- While maintaining a complete grass cover under mature trees is desirable, it can be difficult to maintain. A surface mulch or groundcover planting may be more appropriate.
- Maintenance and access for mowing of grass on steep is a potential occupational health and safety risk. Embankments steeper than 3:1 should be considered for planting treatments so that mowing is not required. Tractor drawn mowers should never mow slopes steeper than 3:1 and it is not advisable to use hand mowers on slopes between 3:1and 2:1 and never on slopes 2:1 or steeper.
- Restrict the provision of high quality, well maintained lawn to sports fields, high traffic areas and premium passive use areas. Aim to reduce the amount of resources dedicated to maintaining lawn and grass areas. Clippings should remain where they fall under most circumstances and should not be raked up and removed. In high traffic areas this may require more frequent mowing so that the clippings are smaller and fall into the turf more easily.
- Designate 'lawn maintenance zones' for Campus. Within these zones grass may be irrigated, mown, fertilized and otherwise maintained as necessary to provide high quality lawn, suited to its uses. Such is the case with the inner grassed areas of the central campus which is mown with a catcher.
- In low-use areas, irrigation, fertilization, mowing and maintenance should be reduced.
- Good drainage is essential to turf health. Identify prolonged wet spots and rectify with sub-surface drainage installation.
- Areas of “Grass-Pave” parking occur on campus – These may be replaced in the future. In the meantime to maintain adequate grass cover, lawn management practices such as watering during dry oeriods, fertilising and topdressing must be implemented.
- Outside the lawn maintenance zones, plant deep rooting, drought tolerant grass varieties and planting or seeding of "Mowless" type grasses. A *Microlaena* lawn has recently been sown on University Creek. The use of tufting type native grasses may be more appropriate in some areas.
- More sustainable grass and turf management practices should be explored across the Campus, including limiting the use of fertilizers and developing an irrigation masterplan to determine a strategic and water efficient approach to irrigation on the site.

Figure 19 The Ampitheatre is a special case but in most circumstances a slope such as this is too steep for safe mowing and should be planted. Note that the mowing regime has allowed the grass to grow long which is desirable in an area of occasional use.

### Compaction

On occasion where compaction of turf areas cannot be managed through prevention, and the quality of turf is declining (usually due to poor drainage), special machines that remove cores of soil, make slits or grooves or spike holes must be used. Perform all these operations as often as necessary when turf is in active growth in summer (but not when temperatures are extreme or there are drying winds). Following these procedures, turf may require more frequent watering to offset the increase in evaporation.

### Topdressing

Topdressing is a thin layer of growing media applied to turf. Components are usually sand but whatever is used it *must always be more free-draining than the growing media under the turf and should always have the same consistency over consecutive applications*. Topdressing over time and properly applied will fill hollows and provide a smooth finish. The addition of free-draining sand will also improve drainage and infiltration and therefore improve turf health. It is an operation suited to all High Traffic areas and less so to large expanses of passive recreation lawn.

### Thatch Management

Thatch – the decomposing dead parts of turf - builds up over time on the surface of the rootzone. Some thatch is beneficial and is normally decomposed by earthworms at a rate that keeps it at an optimal level, but as it gets too thick (for instance when pH is too high or when chemicals are applied – both of which kill earthworms), most of the turf ends up rooted in the thatch rather than in the topsoil which exposes it to rapid drying out during hot periods.

Thatch can be controlled by vertical mowing. The blades are set so they penetrate to the bottom of the thatch. If the thatch is thick, a second pass may be required at right angles to the first. Following vertical mowing remove the cut thatch.

### 3.4.1 Soil management and mowing for Turf in High Traffic Areas

Areas of high usage require soils that allow for a high resistance to compaction. A sandy, well drained turf underlay allows for fast drainage and a sufficient water holding capacity for turf growth. Example components are:

| | | |
|---|---|---|
| Medium grade clean sand<br>Sandy loam soil or site soil<br>Composted soil conditioner conforming with AS4454 | 60-80% by volume<br>10-30% by volume<br>10% by volume | e.g.7 parts washed sand/2 part sandy loam/1part compost |

(Leake and Haege 2014, p.82)

Base level requirements for turf fertilisers in high traffic areas are:

| | |
|---|---|
| Lime and/or dolomite | 2kg/$m^3$ at mixing |
| Balanced compound NPK turf starter fertiliser | 2.9kg/100$m^2$ after placement |
| Minor trace elements | 300g/$m^3$ at mixing |

(Leake and Haege 2014, p.82)

To ensure that the density of the grass sward and the height of the grass in high traffic areas is maintained:

| Turf in High Traffic Areas - Work Required | Frequency |
|---|---|
| Remove litter before mowing | At each mowing |
| Cut grass height must not be less than 40mm or greater than 60mm high. Do not remove more than 50% of the grass height at any one time. | Spring – every 5 weeks<br>Summer – every 4 weeks<br>Autumn – every 5 weeks<br>Winter – every 12 weeks |
| Clippings to be removed. Consider leaving clippings where they fall if acceptable. | At each mowing |

### 3.4.2 Soil management and mowing for Turf in Passive Recreation Areas

Soils in passive areas require the provision of moderate resistance to compaction. In these areas a sandy loam 'turf underlay' topsoil mix is suitable. This soil mix provides a high water holding capacity reducing the requirement for watering during dry periods.

Example components are:

| | | |
|---|---|---|
| Medium-coarse grade washed sand<br>Sandy loam soil or site soil<br>Composted soil conditioner conforming with AS4454 | 30-50% by volume<br>40-60% by volume<br>10% by volume | e.g.5 parts washed sand/4 part site soil or sandy loam/1part compost |

To ensure that the density of the grass sward and the height of the grass in passive recreation areas are maintained:

| Turf in Passive Recreation Areas - Work Required | Frequency |
|---|---|
| Remove litter before mowing | At each mowing |
| Cut grass height must not be less than 50mm or greater than 80mm high. Do not remove more than 50% of the grass height at any one time. | Spring – every 6 weeks<br>Summer – every 5 weeks<br>Autumn – every 6 weeks<br>Winter – every 12 weeks |
| Clippings to remain where they fall except when near drains or footpaths | At each mowing |

### 3.4.3 Soil management and mowing for Turf in in Sports Fields

Sports turfs require a sandy root zone soil for rapid drainage which contains a minimum amount of silt and clay to provide a reasonable cohesion and water holding capacity. The main requirement being that the rootzone allows for rapid removal of rain or irrigation water so that play is interrupted for the shortest time. The infiltration rate should vary between 150mm/hr (newly laid sports turf) to 50mm/hr after several years of play. An example of the components to use are:

| | | |
|---|---|---|
| Medium grade clean sand<br>Sandy loam soil or site soil<br>Composted soil conditioner conforming with AS4454 | 80-90% by volume<br>5-10% by volume<br>5-10% by volume | e.g. 8 parts washed sand/2 parts sandy loam/1 part compost |

(Leake and Haege 2014, p.84)

Base level requirements for sports turf fertilisers are the same as for High traffic areas.

#### Rolling

In addition to the management techniques listed for Turf in High Traffic Areas, sports field turf and specifically cricket pitches will require rolling during preparation of the pitch for a match. Prior to

rolling, the lower part of the rootzone must not be too wet or too dry. Rolling must be undertaken only by experienced greenkeepers.

Other sports turf types will require rolling from time to time during renovation.

### 3.4.4 Weeds in Turf

Many weeds in turf are controlled by regular mowing and others are encouraged when lawns are cut too low, as is Bindii – the most common and unpleasant weed in turf. Where Bindii *(Soliva pterosperma)* occurs in the lawn raise the mowers cutting height. Bindii also prefers acidic, low-nutrient soil, so apply dolomite at the rate of one handful per square metre in autumn and fertilise turf with a handful of poultry manure per square metre in spring, summer and autumn.

## 3.5 Native Grasses

Native grasses are a viable alternative to lawn grasses where areas are only used occasionally. Many native grass species are capable of being mown infrequently and just as mowing helps to increase the sward of lawn grasses, it has the same effect on native grasses.

A distinction must be made between native grass areas on campus that are intended to be walked and sat upon (as these may require mowing) and those which are purely ornamental. Where native grasses are for ornamental purposes only, a larger selection of species can be used.

The advantages of native grasses over exotics grasses are that they require less water and fertiliser and less frequent mowing.

Figure 20 A native grass (*Themeda triandra*) intended for an ornamental purpose only, but with infrequent mowing can be used as a lawn for occasional use.

Suitable species are:

*Microlaena stipoides* (Weeping Grass) and cultivars

*Themeda triandra (*Kangaroo Grass) and cultivars

*Bothriochloa macra* (Red Grass)

*Rytidosperma spp*. (Wallaby Grass)

*Zoysia macrantha* (Prickly Couch) and cultivars

*Echinopogon caespitosus* (Tufted Hedgehog Grass)

*Poa affinis* (Poa)

Figure 7 A *Microlaena* lawn. *Microlaena Stipoides* has recently been sown via hydromulching in the University Creek corridor.

Native grasses can be grown on those soil mixes listed for turf in section 3.4.1 and 3.4.2 depending on the intensity of use. Note that fertilisers should be decreased in areas planted to native grasses because it degrades native grasses in favour of exotic grasses and annual weeds.

To ensure that native grasses are maintained in a way that supports their survival and persistence in the landscape:

| Native Grasses - Actions Required | Frequency |
|---|---|
| Mow all areas of native grasses flatter than 3H:1V.<br><br>Do not mow during flowering and seeding. Where mowing is required at this time, mow in a pattern that allows sections of at least 50% of any given area to persist with flowering seed heads. Maintain length not less than 200mm. | Minimum of once per year to a maximum of two times per year |
| Native Grass Areas steeper than 3H:1V (and including all other areas where burning may replace mowing as a management tool) may be maintained by controlled / planned fire according to ecological and catchment requirements; in some communities, no planned fire will be applied, but in other areas fire will be applied within a defined fire frequency range and prescription. The action must be co-ordinated with Roads and Maritime, Rural Fire Service and Local Council. | As required during the controlled burn season as established by the Rural Fire Service |

# 4.0 All Areas of the Campus

## 4.1 Disease and Insect Control

Always consider biological and non-chemical controls in favour of chemical controls in the first instance because the margin for error is far greater with chemicals. For example most insecticide will also harm beneficial insects as well as the target species.

For a comprehensive reference to the identification, diagnosis and control of of pests and diseases refer to "*What Garden Pest or Disease Is That? Organic and Chemical Solutions for Every Garden Problem" by Judy McMaugh 2000 New Holland*

## 4.2 Irrigation

Water sensitive urban design principles must be applied in order to minimise the use of potable water. This may include:

- Falling pavements to landscape or grass areas or by introducing permeable pavements
- Harvesting stormwater from nearby buildings for storage and later use for the irrigation of the sports fields
- The use of sub-surface irrigation in order to reduce the use of water.
- The use of bio-retention vegetated swales to slow and polish runoff and recharge groundwater

Water Sensitive Urban Design principles should be incorporated into the surrounding landscape to slow and filter runoff for the improvement of the water quality of the catchments of Mars Creek and University Creek.

Figure 21 "Castellated kerb" allows water into the central median where it is "polished" by vegetation and slowed from entering the stormwater system. Planting benefits by being passively watered.

Figure 22 A partially planted drainage swale in the Cochlear Forecourt.

New building works require detention tanks and/or infiltration retention systems for storing stormwater. Tank storages should be considered as a source of irrigation water for gardens in the vicinity. Plantings on slab will almost certainly require an automatic irrigation system, usually delivered by a sub-surface drip network.  Ensure that irrigation valve boxes are located in convenient and logical locations and set flush with the ground. Ensure enough garden taps are also provided so that all areas of the garden can be watered if automatic irrigation fails. Assume 30 metre length hoses to be used so 60-65 metres between tap locations is a good general rule.

The irrigation system to be designed, supplied and installed by an experienced specialist irrigation sub-landscape contractor, nominated by the Landscape Contractor and approved by the University or their landscape consultant. After selection they will be required to prepare detailed irrigation plans and specification for approval by the University prior to commencing work. The Landscape Contractor will co-ordinate the irrigation installation to the Universities approval. Ensure completion of the irrigation system before the commencement of any other landscape works, so as to provide a readily available supply of water to planting areas.

Upon completion of the installation of irrigation works the Landscape Contractor is to run through the system to ensure that it is operating correctly and instruct the client's representative in the correct operation and maintenance of the system. Manuals, warranties, and a minimum of two programs, summer and winter are to be provided to the client's representative at the time of completion.

At the completion of the installation the landscape contractor must provide complete dimension drawings, based on the approved design plan, of the entire irrigation system as executed, clearly indicating the type and location of all sprinkler lines, heads, etc. This is essential to ensure that the irrigation lines and valve boxes can be located for repair and replacement.

The University has an all of campus drawing prepared by David Buckle and Associates titled; *"Macquarie University Hydraulic Services Potable Cold Water and Fire Hydrants".* This drawing should be referred to when new tap points and irrigation is to be installed and Work as Executed irrigation drawings should be kept with this document.

# 5.0 Specific Landscape Management Activities for Specific Areas of the Campus

Each of the following specific areas of the campus has been identified in the Macquarie University Design Excellence Strategy and Urban Design Guidelines and a series of landscape principles for each has been described with the objective of retaining and enhancing the identity of each.

The following maintenance issues for each specific area are highlighted with a view to improving the management of the spaces in order to achieve these principles.

## 5.1 Primary public domain spines

### Wally's Walk

Character

Wally's Walk is characterised by an avenue of Plane trees running for the full length of the Walk. Not all trees are uniform in size and some trees are suffering due to overshadowing and close proximity to buildings. The understorey is varied throughout its length, there are occasional large weedy gaps in the understorey, but the predominant understorey plant is *Hedera Helix* (English Ivy).

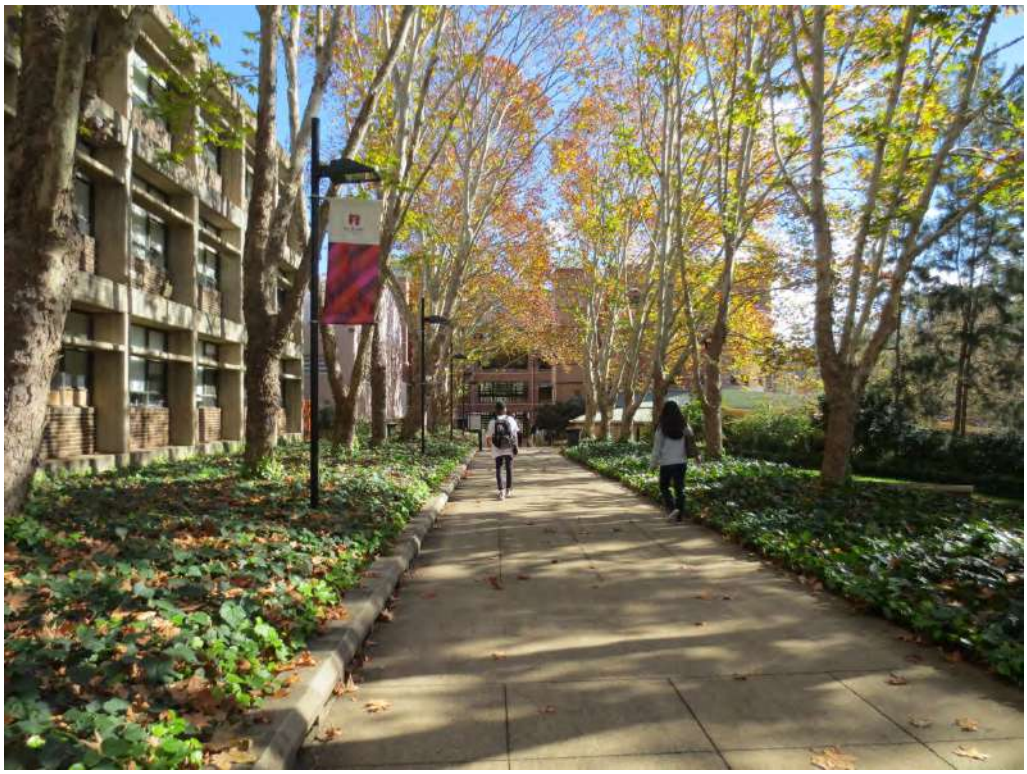

Figure 23 The western end of Wally's Walk - Plane Trees with Ivy below.

Comments

- Consider the introductions of *Platanus* (Plane Tree) hybrids when making replacements and choose types that are suited to shaded situations. Infill bare areas with understorey planting.

- Consider replacement of the *Jacaranda* at the Corner with Christopher Ondaatje Ave with a Plane Tree
- Infill bare understorey areas with new groundcovers to match existing.
- Use a limited understorey palette with *Hedera Helix* as the dominant species

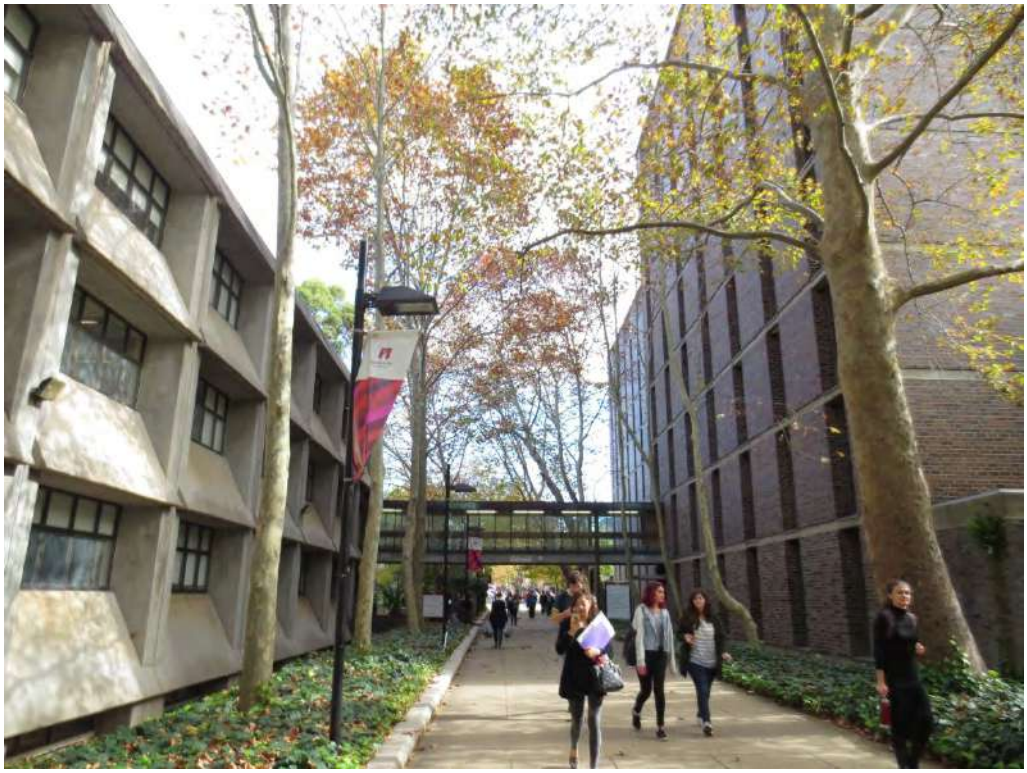

Figure 24 Plane trees adjacent to the building are stunted due to shade and proximity to the building

Wally's Walk Replacement Tree Schedule

| Botanical Name | Common Name | Mature Size (H x W) | Notes |
|---|---|---|---|
| *Platanus x acerifolia* | London Plane | 14 x 10m | Plane trees form an Avenue for the full length |
| *Platanus improved cultivars* | | | |

**Macquarie Walk**

Character

Macquarie Walk is currently a road but will eventually be pedestrianised and will be the key pedestrian link due to its connection in the east with the railway station. The current Herring road "Gateway" and University Creek "Crossing" projects will establish strong landscape themes for the Walk.

Comments

Starting in the east, an avenue of Queensland Kauri (*Agathis robusta*) is proposed. This will provide an iconic entry where Macquarie Walk meets University Avenue. The Walk will then traverse

University Creek via a proposed 9 metre wide bridge. The landscape surrounds in this section of the walk will be viewed from the bridge and will consist of the existing riparian trees with proposed endemic understorey planting and native grass lawns accessible to the University population. Where the bridge" lands" to the western side of the creek there is a significant clump of existing Tallowoods (*Eucalyptus microcorys*) which are to be retained.

Figure 25 The "Crossing" bridge over University Creek will "land" behind the clump of Tallowoods shown in the centre of the picture and will connect with Macquarie Walk.

The creek transition zone of the walk terminates where the walk intersects with Christopher Ondaatje Ave after which a Plaza Zone commences adjacent to the proposed University Common.

Figure 26 Looking West down the Axis of the proposed Macquarie Walk. The Creek transition Zone ends where it intersects with Christopher Ondaatje Walk at the pedestrian crossing in the middle ground.

The planting will transition here from the informal planting of the Creekside to formal streetscape planting which will continue to the west. Exotic deciduous trees should be used to delineate the "Plaza".

The current precedent for streetscape planting occurs at the library and the Australian Hearing Hub where Grey Gums (*Eucalyptus punctata*) have been planted as a street tree. It is suggested that over time the full length of the Walk with the exception of the Plaza Zone, riparian zone and the intersection with University Avenue to the south should be planted with an avenue of Grey Gums.

The landscape management goals of the Macquarie Walk will be to strengthen each of these planted landscape zones – use riparian trees and planting in the Creek Zone, use exotic deciduous trees in the Plaza Zone, use Pyrus "Chanticleer" to match those on University Avenue at the intersection and use Grey Gums as the street tree for the length of the Walk. The underplanting on the south-eastern edge of Macquarie Walk opposite the Common should be bold and dense to form an edge to the plaza and to visually terminate the common.

Figure 27 Grey Gum street trees outside the library -the precedence for future streetscape planting along Macquarie Walk. Note stakes and metal collar should be removed.

Existing street trees along Macquarie Drive have a galvanised metal collar around the base of the trunk to keep the gravel surround in place. This should be removed over time to prevent trunk girdling. Timber stakes on existing street trees should also be removed.

Suggested Macquarie Walk Replacement Tree Schedule

| Botanical Name | Common Name | Mature Size (H x W) | Notes |
|---|---|---|---|
| *Agathis Robusta* | Queensland Kauri | 14 x 10m | Gateway Entry street trees |
| *Anetholea anisata* | Aniseed Tree | | Creek Zone tree planting |
| *Angophora costata* | Smooth-barked Apple | | |
| *Allocasuarina littoralis* | Black She-oak | | |
| *Ceratopetalum apetalum* | Coachwood | | |
| *Synoum glandulosum* | Scentless Rosewood | | |
| *Syncarpia glomulifera* | Turpentine | | |
| *Tristaniopsis laurina* | Water Gum | | |
| *Eucalyptus punctata* | Grey Gum | | Street trees from University Common to the South |

| | | | |
|---|---|---|---|
| *Nyssa sylvatica* | Black Gum | 11 x 6 m | Plaza trees delineating University Common |
| *Pyrus ussuriensis* | Manchurian Pear | 9 x 7 m | |
| *Ulmus parvifolia* | Chinese Elm | 10 x 11 m | |
| *Pyrus "Chanticleer"* | Ornamental Pear | 9 x 7 m | Intersection with University Avenue in the South |

Figure 28 When traffic is removed, the southern edge of the Walk can be converted to a formal avenue. The existing Flooded Gums shown can be retained in the background.

**Sir Christopher Ondaatje Avenue**

Character

Sir Christopher Ondaatje Avenue runs North-south and takes in several campus spaces along the way. As a result it takes on the character of the spaces that it passes through – notably the University Common and the Central Courtyard. This is compatible with the landscape principles which seek to reflect Asian sensibilities of enclosure and openness. Ultimately the Avenue will connect Mars and University Creeks.

Figure 29 The edge of the University Common from Sir Christopher Ondaatje Avenue planted with Liquidambers

Comments

To reinforce these principles with the landscape planting the existing garden beds in front of buildings should be reinforced with dense plantings that create an edge. Where new trees are required use screening trees against buildings such as Lilly Pilly (where sunlight access to buildings is not affected), and use deciduous trees in open areas to increase the sense of contrast between openness and enclosure. Pruning should be undertaken to "lift" the canopy of deciduous trees and evergreen native trees should not be under-pruned to maintain bushiness to the ground.

Where there is space; for instance where the Walk passes the Common and the Grove, consider planting double rows of avenue trees.

The existing under-planting has large gaps which could be infilled to improve delineation. The Avenue is also used for interpretive plantings along its length. This should be continued but with consideration for denser planting within interpretive planting areas to achieve a consistent look along the length of the walk and to exclude weeds.

Sir Christopher Ondaatje Avenue Replacement Tree Schedule

| BOTANICAL NAME | COMMON NAME | MATURE SIZE (H X W) | NOTES |
|---|---|---|---|
| *Flindersia australis* | Crows Ash | 10 x 8 m | Other species may be used eg; for interpretive gardens. |
| *Arytera lautererana* | Corduroy Tamarind | 10 x 8 m | |
| *Toona ciliata* | Red Cedar | 20 x 10 m | |

| | | | |
|---|---|---|---|
| *Brachychiton discolor* | Pink Lacebark | 10 x 5 m | |

## 5.2 Primary parks and plazas

**The University Common and Library Lawn**

Character

The University Common is a very large open space with a large expanse of lawn, planted and paved areas.

Comments

Various tree species are used throughout the Common. No particular extant species is seen as a precedent for further planting. Consider extending the range of species to more unusual selections to improve the arboretum collection. Generally frame outside extent of the space with evergreen native trees and use deciduous trees to delineate plaza areas.

The central feature of the Common is the large expanse of lawn for passive recreation. The lawn requires attention due to invasion by Clover and other weeds. The Clover advantages the lawn by reducing the amount of nitrogen fertiliser the lawn requires, but does not wear well. Observe the lawn as the warm season returns and observe whether the turf increases and the Clover decreases. If not, apply a single application of a proprietary spring lawn fertiliser followed at six to eight-week intervals by an application of sulphate of ammonia at 15g per sq m. The nitrogen content encourages grass growth and acts as a deterrent to the clover. Other weeds such as Bindi's may require chemical control before seed set.

The open vista across the library lawn should be retained.

Figure 30 Clover in lawn. The Clover adds nitrogen but does not wear well. Take remedial action if the lawn does not increase in vigour as the weather warms.

Shrub garden beds to the north and south of the Common require replanting. A strong planting theme should be developed that includes tall shrubs/small trees not commonly used in landscape plantings to improve the arboretum collection. A visual connection to the central courtyard can then be achieved with lower under-planting.

Figure 31 Shrub beds between the Central Courtyard/Wally's Walk and the University Common. Replace with plantings that allow a visual connection between the spaces – small trees with clear trunks and low under-planting.

Suggested University Common Replacement Tree Schedule

| BOTANICAL NAME | COMMON NAME | MATURE SIZE (H X W) | NOTES |
|---|---|---|---|
| *Angophora costata* | Smooth-Barked Apple | 15 x 10 m | |
| *Pyrus ussuriensis* | Manchurian Pear | 9 x 7 m | |
| *Arytera lautererana* | Corduroy Tamarind | 10 x 8 m | |
| *Rhodoleia championii* | Hong Kong Rose | 5 x 5 m | Replacement small trees for north and south shrub beds |
| *Tabebuia argentea* | Silver Trumpet Tree | 5 x 5 m | |
| *Barklya syringifolia* | Crown of Gold | 5 x 5 m | |

**The Central Courtyard**

Character

The Central Courtyard is dominated by a grid planting of nearly 100 Lemon-scented Gum (*Corymbia citriodora)* planted to represent a Phalanx of the Roman Army.

The courtyard was once mostly grassed, now only a smaller central lawn, broken up by paths, remains. The lawn is worn and not conducive to use for sitting.

The surrounding buildings are concrete, the paving and the trunks are grey and the furniture is silver.

Comments

Wherever Gums are damaged or die they should be replaced immediately to maintain the integrity of the original plan. The lawn should be raised and the paths that dissect it removed to make it more useful and to improve the condition of the lawn. Colourful furniture, some sections of brighter paving and some judicious under-storey planting would all help to brighten up the space.

Figure 32 Dead Lemon Scented Gum should be replaced.

Figure 33 The existing lawn should be raised and the intersecting paths removed.

Central Courtyard Replacement Tree Schedule

| BOTANICAL NAME | COMMON NAME | MATURE SIZE (H X W) | NOTES |
|---|---|---|---|
| *Corymbia citriodora* | Lemon-scented Gum | 30 x 10 m | Replace dead or dying trees immediately |

**The Grove (East Common)**

Character

The Grove is an informal space with a forest atmosphere created by a grove of Eucalypts with a sensitively fitted sinuous path and picnic settings.

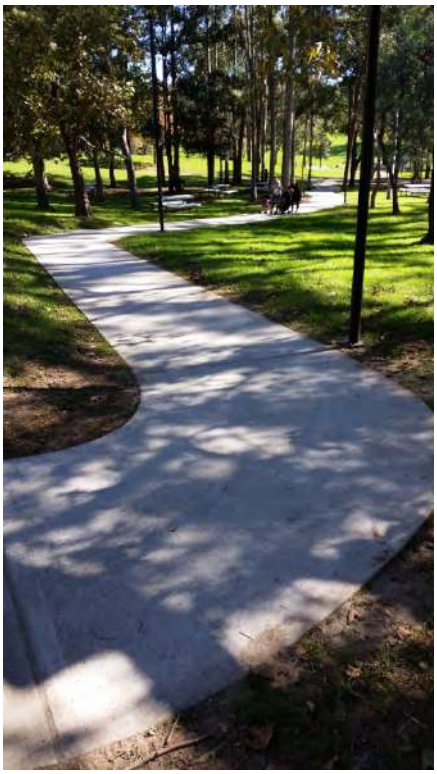

Figure 34 Path through the Grove

Comments

The Grove requires attention to the lawn area under the trees to ensure that a thick sward is maintained. Where turf is to be replanted, shade tolerant varieties could be introduced.

To the East of the Grove adjacent to the paved forecourt of Building E7b and to the west Adjacent to the Campus Hub Building there is the opportunity for deciduous shade tree planting with preferably interesting species to add to the Arboretum collection.

**Arts Lawn (West Common)**

The Arts Lawn will be built on land that is currently a car park. Some existing Eucalypts occur at the edges of the car park. These should be retained where possible in any future development. The landform should step down towards Mars Creek and planting should not prevent a visual link to the Creek.

## 5.3 Secondary Parks and plazas

**Frank Mercer Biological Sciences Garden**

The diversity of plantings should be maintained and enhanced in the spirit of the teaching garden for which it was envisaged. A landscape maintenance audit should be undertaken to ensure that the objectives of the garden and the cultural requirements of all plantings are being met.

**Jim Rose Earth Science Garden**

The diversity of plantings should be maintained and enhanced in the spirit of the teaching garden for which it was envisaged. Currently there are many bare spots in the garden. A landscape maintenance audit should be undertaken to ensure that the objectives of the garden and the

cultural requirements of all plantings are being met. The courtyard is divided into two sections, with the gardens on the north and west planted with Laurasian (predominantly) northern hemisphere species while the gardens on the eastern and southern sides are planted with Gondwanan (predominantly) southern hemisphere species. The path between the two is referred to as the "Wallace Line". The audit should identify further replacement plantings that continue the biogeographic story and which also contribute to making the garden a pleasant retreat.

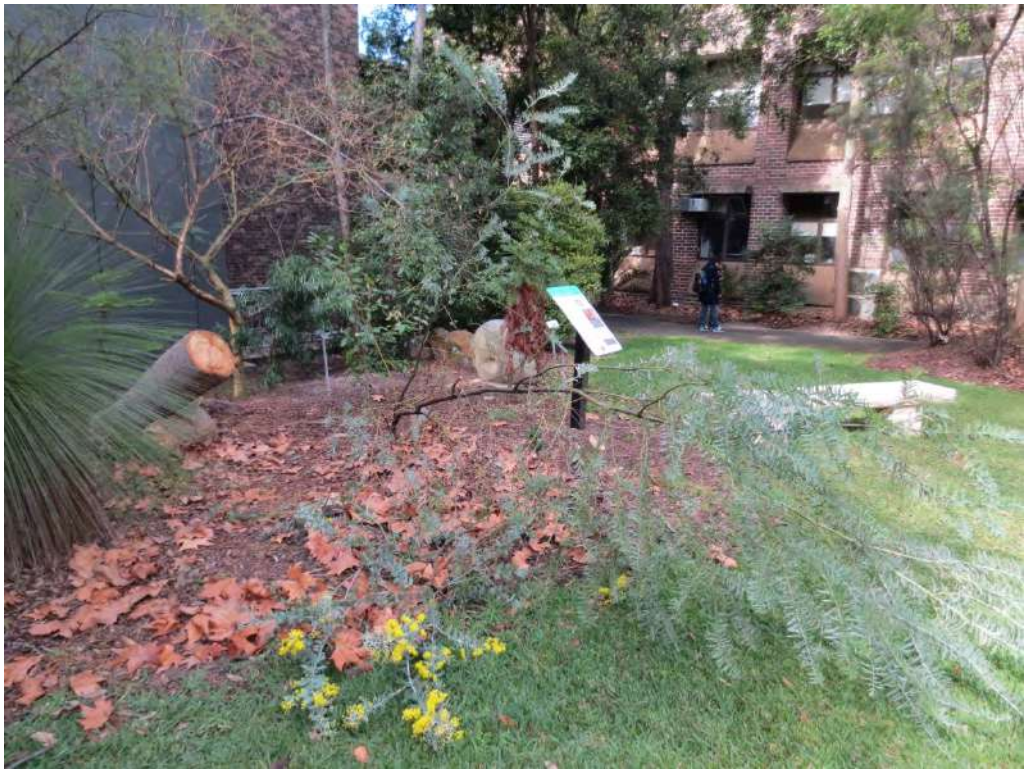

Figure 35 Bare spots could be replanted with appropriate species. Watering requirements should be checked.

**Mars Creek Plaza**

Mars Creek Plaza is a proposed plaza which will terminate the future extension of Macquarie Walk. Ensure that any future planting does not screen views to Mars Creek or prevent solar access. The Plaza will mediate between the more formal Macquarie Walk and the natural area down to Mars Creek.

Figure 36 Potential view from the proposed Mars Creek Plaza

**Wally's Walk Park**

The lawn is a popular passive recreation space as it slopes to the north with views to the Mars Creek corridor.

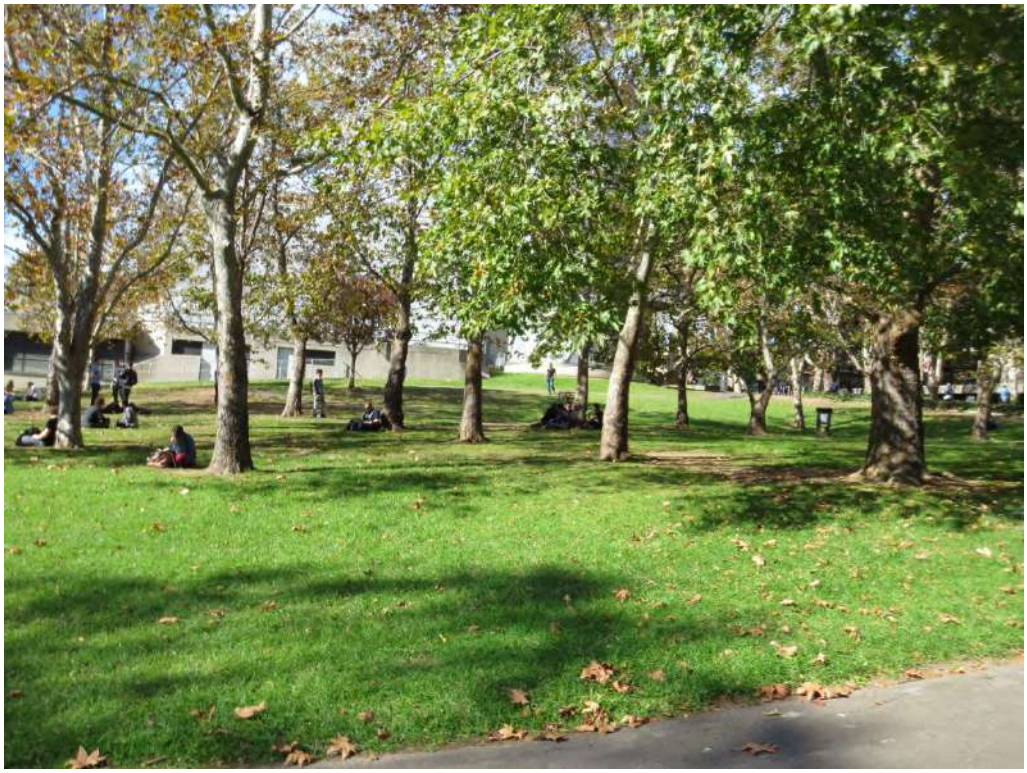

Figure 37 Wally's Walk Park

There are a few spots where the lawn has worn or is underperforming and also gaps in planting. These should be reviewed for any remedial action that can be taken.

**Western Road Park**

The recently completed Western Road Park is a roof garden (refer to section 3.3). The landscape maintenance schedule accompanying the construction documentation should be reviewed for inclusion into the ongoing maintenance and inspection checklist and as-built drawings should be reviewed and updated for location of irrigation.

**Macquarie Theatre Courtyard**

Character

The Macquarie Theatre Courtyard is a fairly recent landscape wrapping around two sides of the building - east and south - with large areas of gravel and concrete pavement.

There are patches of Mondo Grass missing at the entrance which should be replaced immediately. A steeply sloping lawn to the south of the building is planted to lawn. This area is difficult to access for maintenance and should be replanted in its entirety with a low maintenance, drought-tolerant groundcover such as *Lomandra* (already planted at the top of the bank)


Figure 38 Mondo Grass bed requiring replacement planting

Figure 39 Steeply sloping lawn should be replaced with low maintenance groundcovers such as *Lomandra* shown at the top of bank.

On the grassy bank leading up to building W3A there are sections of the slope too steep for grass to succeed. Consider replacement with low-maintenance, drought-tolerant garden beds.

**Cochlear Forecourt**

The Cochlear Forecourt landscaping is now well-established. There are some bare areas on the University Avenue frontage which require replacement landscaping and denser plant spacing.

Figure 40 Cochlear Building frontage to University Avenue requires replacement planting.

## 5.4 Creek corridors and parklands

### University Creek

A Landscape Rehabilitation plan has been prepared for University Creek. For management purposes the Creek has been divided into a number of reaches. The reaches are currently being rehabilitated in association with roadworks along University Avenue. For further maintenance issues relating to the creek, refer to the Plan prepared for Mars Creek (below) and also the Vegetation Management Plan 2015.

### Mars Creek

A Mars Creek Environmental Plan prepared by Storm Consulting was commissioned in 2010/11 by the University. Habitat restoration has been an overwhelming success. Over time further sections of the highly modified creekline may be naturalised, changing the maintenance priorities in the zone. For further maintenance issues relating to the creek, refer to the Plan and also the Vegetation Management Plan 2015.

### Culloden Creek

Culloden Creek corridor provides opportunities for the restoration of the Sydney Turpentine-Ironbark Forest and passive open space. Refer to the Vegetation Management Plan 2015.

## 5.5 Primary roads and pedestrian connections

Each of the universities internal roads and pedestrian connections are characterised by unique street tree planting. The length of the roads are not necessarily planted with a single species, making the most important aspect of landscape management the height to which each species is under-pruned of lower branches to make clearance for pedestrians and vehicles, but also to suit the species type and to achieve a relatively consistent canopy. For each road below the street tree under-pruned height has been noted.

**University Avenue**

University Avenue is changing to accommodate future uses. Parts of its length have been upgraded with formal street tree planting of *Pyrus "Chanticleer"* where adjacent to buildings, and *Tristaniopsis laurina* where alongside University Creek. The final section up to Herring Road is proposed to be planted with an avenue of Kauri Pines (*Agathis robusta*). Each of these trees has a distinctive form different from the next.

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Agathis robusta* | Kauri Pine | 5 |
| Pyrus calleryana "Chanticleer" | "Chanticleer" | 3 |
| *Tristaniopsis laurina* | Water Gum | 3 |

**Research Park Drive**

Research Park Drive will terminate at University Creek where Water Gums make a connection with the creek landscape and Crow's Ash and Red Cedar will provide tall and imposing avenue from the Talavera Road.

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Flindersia australis* | Crow's Ash | 5 |
| *Toona ciliata* | Red Cedar | 5 |
| *Waterhousia floribunda Cv.* | "Green Avenue" Weeping Lilly Pilly | 3 |

**Innovation Drive**

Innovation Drive street trees reinforce the University Creek Crossing with Weeping Lilly Pilly and Turpentine, and acknowledges the sandstone Geology at its interface with Herring Road with Smooth-Barked Apple and Grey Gum

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Angophora costata* | Smooth-Barked Apple | 5 |
| *Eucalyptus punctata* | Grey Gum | 5 |
| *Waterhousia floribunda* | Weeping Lilly Pilly | 3 |

**Eastern Road**

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Eucalyptus paniculata* | Grey Ironbark | 5 |
| *Eucalyptus punctata* | Grey Gum | 5 |
| *Syncarpia glomulifera* | Turpentine | 5 |

**Western Avenue**

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Angophora costata* | Smooth-Barked Apple | 5 |
| *Eucalyptus paniculata* | Grey Ironbark | 5 |
| *Eucalyptus punctata* | Grey Gum | 5 |

**West Precinct Road**

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Cupaniopsis anacardiodes* | Tuckeroo | 3 |
| *Tristaniopsis laurina "Luscious"* | Water Gum | 3 |
| *Waterhousia floribunda Cv.* | "Green Avenue" | 3 |

**Secondary East-West Pedestrian Connections**

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Pistacia chinensis* | Chinese pistachio | 3 |
| *Pyrus ussuriensis* | Manchurian Pear | 3 |
| *Ulmus parvifolia* | Chinese Elm | 3 |

**Secondary North-South Pedestrian Connections**

| BOTANICAL NAME | COMMON NAME | Underprune lower branches to a height of; (m) |
|---|---|---|
| *Backhousia myrtifolia* | Grey Myrtle | 3 |
| *Elaeocarpus eumundii* | Blueberry Ash | 3 |
| *Flindersia pimenteliana* | Maple Silkwood | 3 |

## 5.6 Sports field and facilities

**Macquarie University sports fields**

Macquarie University maintains approximately seven hectares of high quality specialist playing areas at high standard, suitable for a range of intended uses. Resource use in maintaining the sports fields should be environmentally sustainable due to their location in proximity to The Lane Cove River Catchment and sensitive bushland. Runoff from irrigation and excess fertiliser should be minimised and turf areas should be managed for minimum disease by providing good growing conditions. Chemical use should be discouraged. Amenity of spectators should be enhanced.

Sports ovals will continue to be maintained by a contractor who has expertise in this type of landscape management. This approach has worked well in recent years. To assist the contractor maintain the ovals to a high standard, the university should consider upgrading grounds maintenance equipment. An audit of the type and condition of existing equipment is needed to determine priorities for future.

One of the goals is to 'adopt further water sensitive urban design practices to minimise potable water consumption'. It recommends that current irrigation practices for the sports ovals are reviewed to identify water efficiency and drought proofing strategies.

Sporting Fields – Suggested Replacement Tree Schedule - species from the broader Sydney Sandstone Ridge-top Woodland community to provide shade for spectators at the perimeter of fields where space is available:

| BOTANICAL NAME | COMMON NAME | MATURE SIZE |
|---|---|---|

| | | (H X W) |
|---|---|---|
| *Angophora costata* | Smooth-Barked Apple | 15 x 10 m |
| *Corymbia gummifera* | Red Bloodwood | 25 x 10 m |
| *Eucalyptus haemastoma* | Broad-leaved Scribbly Gum | 15 x 10 m |
| *Eucalyptus piperita* | Sydney Peppermint | 20 x 10 m |
| *Eucalyptus sclerophylla* | Hard-leafed Scribbly Gum | 20 x 10 m |
| *Eucalyptus squamosa* | Scaly Bark | 7 m |

# 6.0 Protective Measures

## 6.1 Protection of Existing Vegetation

Existing vegetation and newly planted areas need protection during construction and establishment. During construction and establishment periods, temporary fencing should be placed at the extent of area to be protected, preferably beyond the drip-line of trees to be protected.

The fencing methods should include flagging tape, stakes and temporary fencing, clearly identifying the area to be protected and restricting pedestrian and vehicular access to the protected zone.

Following completion of the construction period (including establishment), all temporary works should be removed when they are no longer required.

## 6.2 Tree Protection

Tree protection on all development sites within the City of Ryde must comply with *Australian Standard 4970 – 2009 Protection of trees on development sites.*
Refer also to the *City of Ryde DCP 2010 Part 9.6 Tree Preservation* and the *City of Ryde Urban Forest Technical Manual and Application Guide.*

The relevant Australian Standards are:

- *AS 4970 Protection of trees on development sites.*
- *AS 4687 Temporary fencing and hoardings*

## 6.3 Erosion, Contamination and Sedimentation Control

During construction, all precautions necessary should be undertaken to prevent erosion, contamination, and sedimentation of the site, surrounding areas and drainage systems, including but not limited to the following:

- Progressive restoration of the riparian corridor (refer to Landscape Restoration Plan incorporating Vegetation Management Plan)

- Construction of temporary drains and catch drains
- Diversion and dispersal of concentrated flows to points where the water can pass through the site without detrimental impacts
- Construction and maintenance of silt traps to prevent discharge of scoured material to downstream areas
- Stabilisation of exposed soil surfaces (e.g. through sterile grass seeding, erosion control meshing, or mulching using vegetative material removed from the study area)
- Use of erosion and sediment control measures to collect sediment and to reduce flow velocities
- Construction of temporary fencing
- Regular monitoring and maintenance of all erosion and sediment control structures throughout the construction and operational phases of the development to ensure their effective function.

## 6.4 Tree Removal and Disposal of Vegetation on Site

All significant trees removed as a result of construction works are to be replaced by the same species and planted in a suitable location corresponding with the relevant vegetation community within the riparian corridor. Refer to the Landscape Rehabilitation Plan incorporating Vegetation Management Plan for University Creek.

For any significant trees removed for construction works, consideration should be given to retaining the woody parts whole or in sections, and placed on the ground in the riparian corridors of Mars Creek and University Creek to provide habitat for native fauna.

All other native vegetation that is identified for removal should be chipped for use as mulch. All weed material is to be separated and removed from the cleared material prior to chipping. Mulch should be stockpiled at approved locations around the site and be used in locations from where it was derived to ensure any seed stock located within the mulch will be located in appropriate site conditions.

Any vegetation, topsoil or other materials not identified for re-use shall be either disposal of off-site or in an area where the material will not wash into existing vegetation, Mars Creek or University Creek.

# 7.0 Monitoring and Reporting

Regular inspections of all landscape areas should be undertaken by the Campus Assets Team to ensure that maintenance is carried out according to the plan. The inspections should not be less frequent than three (3) monthly (or immediately after high rainfall/wind/heat events) with the objective that all areas are visited at least once within that period and an inspection checklist prepared and filled out during each inspection and a Three Monthly Maintenance Audit Form Submitted. (Refer to Appendix F). As well as open space currently in use, the inspection should include the ongoing protection of all existing vegetation and new revegetation works during its establishment period.

Maintenance staff should receive the audit form and carry out any remediation work required.

# Appendix A – Illustrative Masterplan

# Appendix B – Three Monthly Maintenance Audit Form

This form is to be completed by the Campus Asset Manager responsible for landscape assets.
Two copies of this completed form are required. One is to be issued to maintenance staff for action. The second is to be maintained for records.
Extra pages can be attached to the electronic record if needed

Date of Inspection: _____

Inspected by: _____

| Location | Landscape Type / Area | Issue | Remediation Works Required | Cost Estimate | Date to be completed | Variation/ Defect? |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Signed: _____ Date: _____

Issued to: _____ Date: _____

# Appendix C – Reference Documents

The following Australian Standards are referred to in this report:

- AS 1319 Safety signs for the occupational environment
- AS 4373 Pruning of amenity trees
- AS 4454 Composts, soil conditioners and mulches
- AS 4687 Temporary fencing and hoardings
- AS 4970 Protection of trees on development sites
- AS 1428 Access and Mobility Design

The following documents are referred to in this report:

- Macquarie University Campus Masterplan 2014 (Cox Richardson Architects and Planners 2014)
- Design Excellence Strategy and Urban Design Guidelines, prepared by Cox Richardson Architects and Planners in conjunction with CONTEXT
- Vegetation Management Plan (VMP) for Macquarie University, prepared by Lesryk Environmental Consultants 2015 in conjunction with this LMP.
- Precinct E Landscape Management Plan, prepared by CONTEXT 2010.
- University Creek Landscape Rehabilitation Plan (Incorporating Vegetation Management Plan) prepared by CONTEXT 2010.
- Mars Creek Environmental Plan (Storm Consulting 2011)
- Noxious and environmental weed control handbook. a guide to weed control in non-crop, aquatic and bushland situations. NSW Department of Primary Industry Management Guide, Sixth Edition.
- Soils for Landscape Development. Selection, Specification and Validation. Simon Leake and ELke Haege. CSIRO Publishing 2014.
- the City of Ryde DCP 2010 Part 9.6 Tree Preservation
- City of Ryde Urban Forest Technical Manual and Application Guide 30th September 2014
- Coffey Geotechnics, 2009, Geomorphological Assessment of University Creek, North Ryde.
- What Garden Pest or Disease Is That? Organic and Chemical Solutions for Every Garden Problem. Judy McMaugh 2000 New Holland.