

# MAINTENANCE GUIDELINES FOR AUSTRALIAN GREEN ROOFS



**GREEN CITIES  
FUND**

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# PREFACE

Maintenance Guidelines for Australian Green Roofs has been developed to provide advice on the planning and delivery of high-quality maintenance for Australian green roofs and synthesises knowledge from academic and industry experts.

This work forms part of a broader Hort Innovation (Hort Frontiers Green Cities Fund) project, *Researching the benefits of demonstration green roofs across Australia* (GC16002), which aims to overcome barriers to green roof construction and encourage the establishment of more green roofs in our cities.

Green roof maintenance involves issues that differ from general landscape and horticultural maintenance. The role of these guidelines is to help with this complexity by providing a better understanding of green roof maintenance to ensure they continue to deliver intended aesthetic and functional outcomes. The guidelines are designed for those in planning, design, maintenance and management roles. It includes details on specific maintenance activities and tasks as well as examples of maintenance schedules for four different types of green roof.

These guidelines comprise four sections:

## INTRODUCTION

Covers the importance of green roof maintenance in ensuring green roof design objectives are met, the need to consider safe access to, and on, the roof for maintenance personnel, and the need to tailor maintenance schedules for each green roof. Establishment maintenance and routine maintenance are defined.

## GREEN ROOF MONITORING AND MANAGEMENT

Monitoring is an essential part of green roof maintenance. This section includes a visual inspection checklist to aid in early identification of issues so that pre-emptive actions can be taken. It also provides details on items to include in maintenance reports and maintenance plans.

## MAINTENANCE PLANNING

Provides a comprehensive list of green roof maintenance tasks with suggested scheduling and desired outcomes. It covers safe work practices, monitoring and horticultural tasks as well as maintenance of infrastructure and hard landscape elements.

## SAMPLE MAINTENANCE SCHEDULES

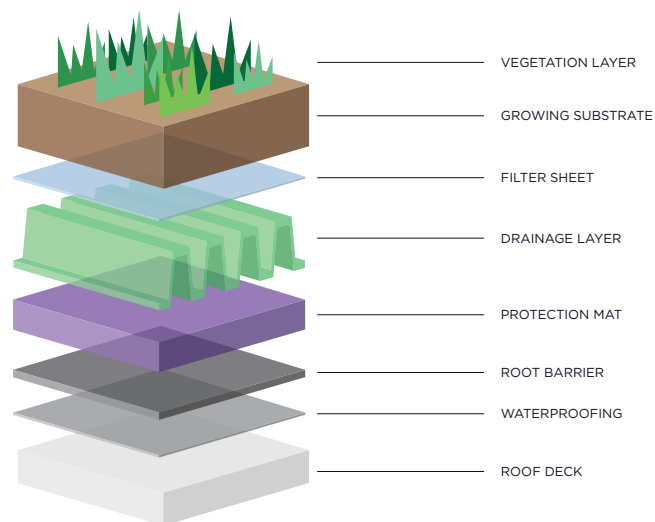
Examples of maintenance schedules are provided for four different types of green roofs typical of those built in Australian cities.



# 1. INTRODUCTION

A green roof is a vegetated landscape built entirely above a structure, generally a roof, that is designed to deliver environmental, economic and social benefits. There are many different configurations and types of green roofs, so maintenance needs to be adjusted accordingly. All green roofs have some form of layering across the profile to provide functions such as waterproofing, protection and drainage and to support a growing substrate and vegetation; an example can be seen in Figure 1.

Traditional definitions of green roofs are based around two extremes, with lightweight shallow-substrate profiles generally termed ‘extensive green roofs’ and heavier, deeper substrates termed ‘intensive green roofs’ or ‘roof gardens’. These definitions are becoming less useful as a modern green roof may contain a range of different spaces, vegetation types and substrate depths.



**Figure 1.** An example of the typical layers used in constructing a green roof. Increasingly, manufacturers are combining functions into a single layer – for example a layer that serves both as a protection mat and root barrier. Source: *Growing Green Guide* 2014.

Green roof maintenance includes specific, sometimes unique tasks requiring different knowledge and skills to ground-level landscape maintenance. For these reasons, maintenance personnel must have all relevant training and ideally some practical experience in green roof maintenance before working unsupervised, including the use of specific tools, materials, equipment and machinery.

Green roof maintenance contracts should specify the scope, duration and responsibilities for maintenance, and provide a schedule of required tasks, performance outcomes or standards, record-keeping, as well as any handover tasks on conclusion of the contract. An important component of many maintenance contracts is regular monitoring and reporting of green roof conditions and functions, including checking critical parts and components.



Green roof maintenance includes a range of horticultural tasks including replanting as needed. Burnley demonstration green roof, University of Melbourne. Image: J. Rayner



## 1.1 DESIGNING FOR MAINTAINABILITY

High quality maintenance is critical to successful green roofs and must be considered during design of a project. This includes designing the roof for safe access, including access for maintenance tasks, personnel, equipment and materials. The ease of access will determine how maintenance is conducted, (and at what frequency) and influence the overall maintenance costs. Designing for safe access also needs consideration of safe movement across the roof, including the installation of fall protection through either a fall arrest or fall restraint system. Fall restraint systems use guardrails or balustrades as protection, sometimes incorporating walkways and static line anchorage, away from any direct fall hazard. Fall arrest systems are more specialist applications for working at height, including dedicated personal protective equipment (PPE). These protect an individual from injury in the event of a fall from a roof and include use of a full body harness, lanyard, rope lines and secure roof anchor points. Fall arrest also involves a rescue plan to be actionable during maintenance, requiring additional personnel and specific training needs, and is therefore more costly and has higher risk than fall restraint systems. The other key aspect of designing for maintenance is in vegetation design and materials selection. These should be based around the available maintenance budget and required resources to ensure that they can be sustained over the lifecycle of the green roof.

Designing a green roof for maintenance can also minimise the risk of costly remediation works. This ensures that the level of maintenance provided can sustain the quality and function of the green roof over its lifetime. When planning for restoration of a failed or damaged green roof, the original design objectives should be reassessed to ensure that the available maintenance is able to deliver these objectives. If not, it may be necessary to modify or simplify the original design to suit the maintenance realities.

## 1.2 PLANNING FOR MAINTENANCE

Planning maintenance should be based around a range of green roof factors, including design and layout, components and materials (including any proprietary systems and components), access to and across the roof, fall protection systems, hard landscape components and any specialist skill or trade requirements. Green roof site conditions will also influence maintenance planning, including the local building topography, orientation and aspect, microclimate, vegetation both on and surrounding the roof and any fixtures or other equipment on the roof. Maintenance should be driven by objectives in a detailed maintenance plan, tailored for each green roof project. This helps to understand and sustain the design intent of the green roof, including aesthetic and functional outcomes. Determining the required maintenance for a green roof can be complex, and specialist advice, particularly horticultural advice, should be consulted wherever possible.

Proper maintenance helps sustain green roof outcomes and functions over time, functions that are increasingly factored into government and industry building policies, regulations and sustainability ratings tools. Some, like the Green Factor Tool (City of Melbourne) consider the maintenance plan in their assessments. Others, like Green Star (Green Building Council of Australia), require solid evidence that the proposed project outcomes are delivered before projects are given full accreditation. A maintenance plan that encompasses monitoring and reporting of green roof condition and function can contribute to this evidence base.



### 1.3 CLASSIFYING MAINTENANCE

Maintenance tends to be classified according to the phase or lifecycle of a landscape and the types of tasks and activities being undertaken and may be defined as 'recurrent', 'cyclical', 'rejuvenation', 'developmental' and 'reactive' maintenance, sometimes with quite different meanings. For the purposes of this guide, we are using the following two main categories of maintenance covering vegetation, hard landscape and infrastructure elements:

- **Establishment maintenance.** This includes the initial maintenance interventions following construction and planting of a green roof. It covers the period of landscape establishment and encompasses any treatments or interventions required to ensure the roof functions successfully as per the design. During establishment some maintenance activities, such as weed control and irrigation, may need to be more frequent to encourage good rates of plant growth and development. This period may also include replacement plantings or further treatments of hard landscape elements to ensure their functionality. Establishment maintenance can be as short as a few months up to two years post-completion and may be included by green roof installers as part of an integrated program of design, installation and establishment maintenance.

- **Routine maintenance.** These are the regular maintenance activities and tasks undertaken to ensure the green roof is functional, safe and meets the overall design outcomes. Some routine maintenance tasks will be cyclical or recurrent, based around seasonal or annual frequencies to sustain functionality or appearance. Tasks can include vegetation treatments, but also hard landscape and infrastructure maintenance activities.

In this guide, we provide a comprehensive list of monitoring and maintenance tasks and objectives, which can be tailored for specific green roof applications. We then provide examples of maintenance schedules for four common green roof types ranging from very low to very high maintenance requirements.



Skypark, Melbourne. Image: R. Bathgate



## SEVEN KEY CONSIDERATIONS FOR GREEN ROOF MAINTENANCE

1. Appreciate that green roofs are designed systems. They are discrete, engineered and unique installations that need appropriate maintenance to ensure they function as designed.
2. Provide for safe working at heights. Always plan to mitigate the risk of working at heights and ensure there is safe access for people, plants and equipment.
3. Maintain effective drainage. Drainage is crucial for water movement off the roof and to avoid leakage into the underlying building or structure. If you see standing water on a green roof it indicates more serious drainage problems that need urgent attention
4. Avoid damaging the waterproof membrane. It is critical that green roof layers, especially waterproofing, are not damaged during maintenance activities.
5. Manage irrigation effectively. Green roof environments can be hot and exposed, and the substrates used are lightweight and free draining. Irrigation systems are often key to successful outcomes - understanding them and operating them effectively is crucial.
6. Understand plant growth and performance. Green roofs are unique environments and plants grow differently on roofs compared to ground level. Understanding these differences is key to effective vegetation maintenance.
7. Know your weeds and how to control them. Weeds will always be on green roofs, but knowing what the different weeds are, their lifecycle features and how to control them is vital to managing them effectively.



Regular weeding is an essential maintenance task for achieving designed vegetation outcomes and green roof function. Burnley research green roof, University of Melbourne. Image: R. Bathgate

## 2. GREEN ROOF MONITORING AND MANAGEMENT

Managing a green roof effectively should commence during design, where specific objectives of the project are agreed to, and the maintenance implications discussed. The design team and client are obviously key to this, but other specialists may also need to be involved to ensure that design outcomes can be achieved during establishment and more broadly over the life of the green roof.

This consultation can include green roof installers, site facility managers and contract managers, but it may also involve horticulturists who can advise on the plant and vegetation maintenance inputs.

Monitoring is critical to successful green roof maintenance. It involves regular inspections, recording and reporting on the condition of vegetation, built infrastructure and hard landscape elements; and recording all activities and resources used during maintenance to inform future green roof maintenance planning.

### 2.1 DEVELOPING A GREEN ROOF MAINTENANCE PLAN

Green roofs need to have a detailed and tailored maintenance plan specific to the site. The maintenance plan should be goal or outcome focused, be current (i.e. reflect the existing and overall condition of the green roof), as well as identifying future maintenance or developmental needs.

Plans can also be split into establishment and routine maintenance phases of the roof, often with specific outcomes that are relevant to each phase (i.e. 80% vegetation coverage 6 months post-planting). These outcomes or targets can also be readily linked to or provide the basis for specifications and contract documentation for green roof maintenance.

A green roof maintenance plan should include the following components:

- Introduction to the green roof and site
- Details on the design intent and any specific maintenance objectives
- Planting plan and schedule
- Irrigation plan and specifications
- Drainage plan and specifications
- Maintenance schedule, detailing the tasks and frequency
- Required standards, performance targets or expected outcomes
- Any specific cyclical or periodic maintenance activities (i.e. not included in the regular maintenance schedule)
- The required resources, training and equipment
- Clear delineation of roles and responsibilities, including updated contact details
- Details of a handover process for maintenance staff
- All relevant component, equipment and machinery specifications, servicing and warranty information

Prior to each maintenance visit, all the necessary equipment should be available to complete any required works on the roof. Some maintenance contractors use a specialised green roofs toolkit, comprising frequently used and specific hand tools and materials for the tasks at hand.



## 2.2 VISUAL INSPECTION CHECKLIST

Regular visual inspection of green roofs ensures that problems can be readily identified and fixed. A visual inspection should be completed by a competent professional and include both observation and assessments of different aspects of the vegetated and constructed parts of the green roof. Images of the green roof should be taken at the time of the inspection, with image collection and location details recorded. Additional visual inspections are recommended after extreme weather events, such as heavy rainfall, strong winds and periods of prolonged drought and/or heat, or after any repairs or remedial works.

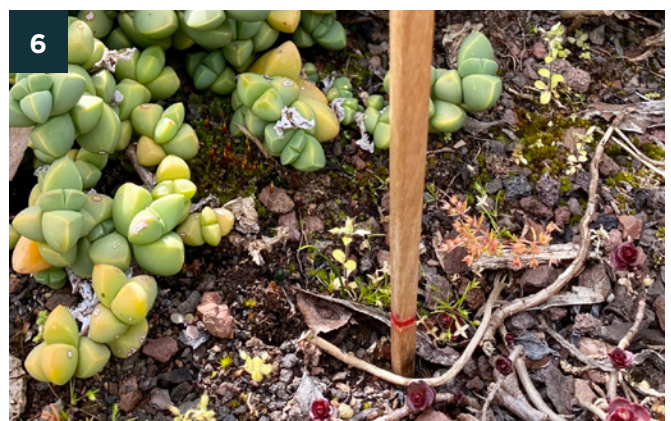
This is to identify any damage to plants, substrate, drains or other infrastructure on the green roof. The frequency of visual inspections will depend on the type of green roof, with more accessible and higher profile sites typically requiring more regular checks. Where permitted and accessible, drones can provide a rapid, effective and safe way to complete a visual inspection, particularly for larger, more inaccessible roofs. The use of drones requires a skilled operator, a consistent method and regular monitoring across the roof to ensure accurate interpretation of the results.

An example of a visual inspection checklist that could be used for most types of Australian green roofs is provided in Table 1.

TABLE 1. EXAMPLE OF A GREEN ROOF VISUAL INSPECTION CHECKLIST

ITEM	TASK
Safety systems	Look for damage/ deterioration of fall protection systems. Check clear and safe access to and across roof for maintenance personnel.
<b>VEGETATED AREAS</b>	
Plant coverage	Assess plant coverage noting unintended and/or persistent bare patches over consecutive visits. Take photos of any issues and file for future reference and training.
Plant health	Assess plant health and condition, noting signs of possible nutrient deficiencies, pests and diseases, damaged plants, pruning needs and any decline/deaths. Take photos of any issues and file for future reference and training.
Weeds	Assess the weeds present, noting the dominant species and if particular areas are more impacted than others.
Substrate	Check the substrate, noting any erosion or any obvious changes in substrate depth across the roof.
Planters	Check the planters, noting any roots emerging from bottom of planters, particularly at drainage points, or any surface damage of the planter profile.
Irrigation system	Check any damage/ deterioration of irrigation components, and any visual signs of over/under-watering, check water meter for usage and any other applications (e.g. moisture sensors and remote monitoring devices).
Drainage	Check for functioning drainage, including for blockages, vegetation clearance, standing water.
Underlying layers	Check for any evidence of damage/deterioration of exposed layers, including around roof penetrations and edges. Care is needed during physical inspection to avoid damage to underlying layers, especially waterproofing membrane.
Hard landscape elements	Check for damage/deterioration of balustrades, edges, paving, decks, furniture and vegetation supports. Record and remove rubbish or other debris on the roof.





A comprehensive maintenance checklist ensures all required tasks are undertaken and helps to identify and anticipate any horticultural, drainage or structural problems. Checks are required for 1. Plant health and coverage 2. Condition of hard landscaping elements such as grates and raised planters 3. Drains 4. Rectifying poor drainage issues as indicated by the presence of standing water. 5. Position and function of irrigation components such as drip lines 6. Substrate levels e.g. using a blunt probe to assess depth. 7. Condition of fixed services and infrastructure such as solar panels. 8. Insect biodiversity elements such as bee hotels. Images: 1-2, 4-7 J. Rayner, 3. E. Snodgrass, 8. N. Williams



## 2.3 MAINTENANCE REPORTS

A maintenance report should be completed after every maintenance visit, a copy of which should be included in a maintenance manual for the site. This could also be through use of a computerised maintenance management system (CMMS). The maintenance report should include the following:

- Date and time onsite
- Person/people performing maintenance and completing report
- Summary list of all tasks completed
- Visual inspection records and notes, including images, site plan annotations and further actions/recommendations
- Identification of potential hazards or problems that may impact next maintenance visit
- Details of all vegetation maintenance tasks, including new plantings (species, location, plant supplier), plant deaths, plant removals (dead or alive), plant health interventions (pests/disease treatments, fertiliser application - types, rates, locations)
- Details of any hard landscape or facility maintenance completed, including irrigation testing and routine maintenance, substrate testing (e.g. pH, Electrical Conductivity) including sample location and results, hard surfaces, balustrade, structure or perimeter drainage treatments, cleaning, rubbish removals and any other interventions on the roof
- Follow-up tasks for completion in next maintenance visit and items requiring specialist input



Wonthaggi desalination plant green roof. Image: [Fytogreen](#)

## 3. MAINTENANCE PLANNING

A comprehensive list of maintenance tasks for green roofs is outlined below, together with notes on scheduling. Where available, reference to relevant standards has also been noted.

Maintenance planning, including preparation of a maintenance schedule, should always be customised to an individual green roof, ideally in consultation with a specialist horticulturist. Sample maintenance schedules for four different types of green roofs are provided in Section 4.

### 3.1 SAFE WORK PRACTICES

Green roofs can be hazardous places and safe work practices are critical to minimising risk. All documentation related to safety, including staffing, training, certification, procedures and any other relevant details, should be current and be stored in an accessible and secure location.

#### 3.1.1 SAFETY PROCEDURES

All maintenance activities are to be conducted in accordance with applicable Australian and State-based workplace safety regulations, including compliance with relevant Australian standards, local Occupational Health and Safety (OH&S) requirements and manufacturers' specifications. Safety procedures start with the use of work

method or safe operating procedures (SOP) and where relevant, the preparation of risk assessments for specific tasks and activities, and incident reporting. The use of appropriate personal protective equipment (PPE) is critical and will generally form part of a SOP.

The implementation of maintenance works will frequently require the placement of appropriate signs and barriers, consideration of falling objects, and incident reporting procedures. Where fall arrest systems are being used, the appropriate procedures and rescue plans must be in place. Safety procedures also include clear communication to all maintenance staff prior to any access to, or work proceeding on, the green roof. All 'Working at Heights' requirements must be met and recorded for all maintenance personnel, including evidence of relevant certification and dates of expiry where applicable. The procedures for safe handling of equipment, materials and chemicals must be in place with maintenance staff having the required licences and/or training.

Further information can be gained from Safe Work Australia

[www.safeworkaustralia.gov.au/heights](http://www.safeworkaustralia.gov.au/heights)

- **Frequency:** Every maintenance visit.



Fall arrest systems require dedicated personal protective equipment (PPE) to protect an individual from injury in the event of a fall from a roof and include use of a full body harness, lanyard, rope lines and secure roof anchor points. Image: S. Hardgrove



### 3.1.2 MAINTAINING SAFETY SYSTEMS

The maintenance of safety systems is essential for safe work practices. This includes checking safe roof access and equipment, including where applicable, inspection of fall-prevention systems as per Australian standard AS/NZS 1891.4:2009. Other required maintenance includes local OHS regulations, such as tagging of electrical equipment for irrigation and power outlets, and regulatory testing of irrigation system components such as backflow prevention device certification where applicable.

- **Frequency:** Annually or more frequently if regulated.

### 3.1.3 STAFF TRAINING

In addition to any required training for safe working procedures and licences (see 3.1.1), maintenance personnel and others completing works (e.g. tradespeople) may require targeted training to ensure that work operations do not damage the green roof system and components (i.e. vegetation, underlying layers, drainage and irrigation). Training should cover safe access to, and on, the roof and specific work practices, including the use of appropriate tools and equipment. Training may also extend to the maintenance of infrastructure and hard landscape elements. Staff undertaking horticultural maintenance should have a minimum of a Certificate IV in Horticulture and other certification related to maintenance activities (e.g. the application of pesticides: Agricultural Chemical Users Permit). All staff training certification should be filed and readily available, with records routinely reviewed and staff training kept up to date.

- **Frequency:** Training is required for every new maintenance personnel and contractor before completing any green roof works; additional annual training is recommended to ensure compliance. All new staff required to do a site induction prior to commencing work.

## 3.2 MONITORING

### 3.2.1 VISUAL INSPECTION

Use a visual inspection checklist to monitor the green roof (see Section 2.2), including identification of any problems present (particularly relating to the vegetation and hard landscape components). Visual inspection reports should be documented within 3 business days of the inspection.

- **Frequency:** Visual inspections are required during every maintenance visit, either monthly or quarterly, depending on the green roof type.

### 3.2.2 MAINTENANCE REPORT

All tasks performed and detailed in a comprehensive maintenance report that flags issues requiring action. Report filed in maintenance manual or computerised maintenance management system (CMMS) within three business days of visit (see Section 2.3) and follow-up tasks completed within agreed timeframe. The maintenance schedule should be kept up to date.

- **Frequency:** Every maintenance visit.

### 3.2.3 REVIEW MAINTENANCE PLAN

Ensure maintenance plan is consistent with design intent, reflecting current roof requirements and future maintenance needs (see Section 2.1).

- **Frequency:** Annually.

### 3.3 HORTICULTURAL MAINTENANCE

#### 3.3.1 WEED CONTROL AND MANAGEMENT

*‘One year’s seeding makes seven years’ weeding’* is a commonly used phrase to describe the importance of weed control in the landscape and this is particularly the case with green roofs. Weeds can compete with, and overgrow, planted vegetation and can also compromise components and functions. Woody weeds can quickly produce strong tap roots that can damage under-surface layers and drainage systems while vigorous grassy weeds can quickly overrun planted vegetation and perimeter drains. Annual weeds can be problematic long-term if they are allowed to grow and set seed. Mineral-based substrates used on green roofs and in non-vegetated spaces, such as perimeter drains, can provide ideal conditions for weed emergence, making weed control during the establishment of a green roof crucial. Accurate weed species identification and an understanding of weed biology and lifecycles are also important and may need to be specified clearly in the skills requirements for green roof maintenance. The use of a good weed field guide to assist in identification of weeds at different lifecycle stages can be invaluable for this work.

Consideration of weeds should start at the design and planting stage. A good quality site analysis process will identify any adjoining vegetation, particularly tree species, that may become a source of weeds in the future. Green roof plant selection also plays a part in weed control. This includes assessment of a species ‘invasiveness’ to ensure they do not become weedy when established on the green roof. This is particularly important for low-input green roofs or roofs with complex vegetation designs, such as biodiversity green roofs. In these types of roofs, vigorous and spreading species can quickly dominate planted vegetation and over time reduce diversity. By contrast some design approaches can aid in weed suppression, for example using ground cover species planted at high density, which in turn limit the space and opportunity for weeds to germinate and grow. The types of substrates used also influence weeds on a green roof. Using weed free growing substrates at the start of a project and whenever topping up a green roof will reduce weed emergence. While weeds can grow under any conditions, more fertile substrates and/or deeper soil profiles can create ideal conditions for weeds to thrive, particularly as a green roof matures over time. Understanding that greater interventions will be required when these conditions change should form part of maintenance planning.



1. Woody weeds can be particularly problematic on green roof as roots can penetrate underlying layers, requiring care when removing to avoid further damage and removal of substrate. Image: E. Snodgrass 2. Regular weeding of the non-vegetated perimeter on green roofs ensures that drainage functions properly and reduces further problems caused by weed ingress into drains and flashing. Image: J. Rayner



Some of the best ways to reduce weeds on green roofs are through prevention and good hygiene practices. Using high quality and weed-free stock at planting will reduce weed emergence. If there is any concern of the quality of the nursery-supplied plants, removing the top 1-2 cm of the container media prior to planting can stop weed seeds in this media germinating and then spreading on the roof. Good hygiene practices during maintenance visits, including cleaning footwear, tools and equipment

prior to access, can also help to reduce weed problems on green roofs. During maintenance visits all weeds should be removed carefully from the site, including removal of any plant propagules (e.g. stolons, seeds, bulbs, etc.) to minimise spread. Maintenance staff should also observe good hygiene practices when moving from one green roof site to another to ensure that they don't spread weeds unknowingly.



Uncontrolled weeds compete with planted species and can alter the aesthetic and functional outcomes of green roofs. Excessive weed growth may also require costly and time-consuming remediation of the entire green roof including replacement of substrate to remove the weed seed load. The two examples here in Melbourne, 1. the Venny Green Roof and 2. Monash City Council Green Roof, both show uncontrolled weeds overtaking planted vegetation. Images: J. Rayner



Weeds can also change the vegetation diversity on green roofs over time as this example at the Emporia Shopping Centre in Malmö Sweden shows from (3). 2012 to (4). 2019. There is a loss of most of the original herbaceous perennials planted in 2012. Images: J. Rayner

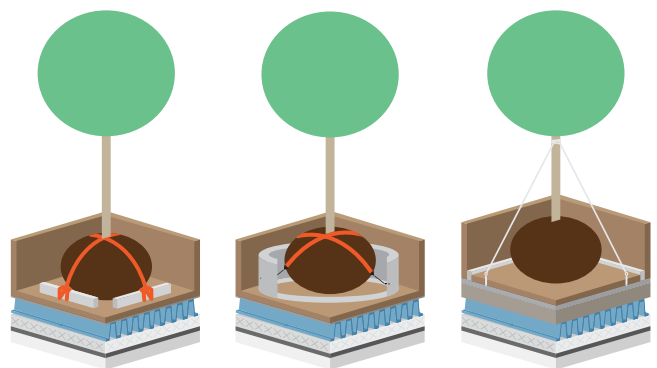
Physical control of weeds on green roofs relies on hand removal, with early weeding of small weeds the most effective approach. In situations where heavy infestations of weeds are present, hand control is best focussed on removing any flowers, fruits and seeds and working to control smaller patches of weeds first, before moving to control larger patches. Residual herbicides are generally not recommended for use on green roofs due to persistence of the active chemical in the substrate. Care is needed in the use of hand tools - avoid those with sharp points or edges to reduce the risk of damage to underlying layers. Care is also needed in the removal of any woody or stoloniferous weeds, particularly if their roots or stolons have penetrated lower layers (i.e. filter fabric or drainage layer). While chemical use on green roofs should be minimised, spot applications with contact herbicides, including 'cut and paint' treatments of woody weeds, can be an effective control. Exercise caution when removing large biomass weeds from a green roof as this may also result in loss of substrate still attached to the plant roots.

Biodiversity green roofs require special attention for weed control and specialist advice should be sought to assist with maintenance planning. While some level of seedling recruitment of target plant species may be desirable, this needs to be managed to sustain a diverse vegetation community over time. Weed control should be based on cultural controls during establishment with routine maintenance focussed on interventions to manage plant communities (e.g. removal of excessive seed loads of dominant species or potential weedy plants).

- **Frequency:** Routine maintenance ranges from biannual for very low maintenance roofs through to fortnightly in spring and summer for very high maintenance roofs. The frequency will also depend upon the green roof's location and surrounding vegetation, particularly the risk of weed infestation from the surrounding landscape. Increased frequency is required during establishment and after any replanting or renovation works.

### 3.3.2 PRUNING, STAKING AND SUPPORT

Pruning is undertaken to manage plant form and shape, to maintain plant productivity and to control plant biomass. On roof gardens and higher maintenance green roofs, perennials, grasses, climbers, shrubs and trees are all commonly pruned. Tasks can range from structural and formative pruning to maintain plant density, shape and flowering, through to deadheading to remove seed set, improve appearance and encourage repeat flowering. After pruning, plants should have no dead wood evident and retain an appropriate form or shape. In some cases the trimming of vegetation for safety reasons (e.g. clear access to services and building fixtures) may also be required. Specialist horticultural advice should always be sought in pruning on green roofs and where relevant added to the maintenance plan.



**Figure 2.** A range of tree anchor systems may be used to secure trees on green roofs. Stakes and supporting frames may also be required for a range of vegetation including young trees, climbers and productive plants. Tree anchors should be checked at least once a year. Source: *Growing Green Guide* 2014.



For trees a qualified arborist may need to be consulted with any required tree works compliant with relevant standards, particularly *AS 4373-2007 Pruning of Amenity Trees*. Any local policies and/or guidelines pertaining to tree management should also be followed. Green roof access should be designed to enable safe and easy removal of plant biomass generated by pruning. The pruning requirements of specific plants should be a factor in green roofs plant selection to ensure that the pruning requirements can be sustained by the available maintenance inputs. Some trees will be supported on a green roof through use of staking and support systems, including guys and anchors. Many of these are sub-surface systems (e.g. Deadman anchors) but they should be checked to ensure they are fixed safely and securely.

- **Frequency:** Pruning is dependent on specific plant requirements, growth rates and seasonality. For high and very high maintenance green roofs, some species may require more frequent pruning. This includes scheduling annually (e.g. shrubs post-flowering), scheduling 2-3 times per annum (e.g. hedges with regular trimming) or seasonally (perennials deadheading during/post flowering). For low maintenance extensive-type green roofs, there are likely to be minimal pruning needs. Tree anchors should be checked annually.

### 3.3.3 TURF MAINTENANCE

These guidelines apply to small to medium-sized areas of functional or display turf but are not designed for sports turf on green roofs in large stadia. Turf cover (height of grass and extent) should be maintained using small hand-operated machinery and equipment, such as hand mowers (rotary or cylinder depending on the turf species), line or grass trimmers and lawn edgers. Operators using this equipment should follow safe operating procedures. Turf height may be varied during conditions of drought stress or high use but should be maintained in a good condition, with a dense sward and no bare patches evident.

Turf health, particularly nutrition, should be managed carefully through monitoring of substrate fertility and the use of suitable soluble and inorganic fertilisers. The use of pesticides and broad leaf or pre-emergent herbicides, used widely in turf maintenance, is not recommended due to the increased risk of damage to non-target species and human health.

Turf renovation, such as coring and dethatching, may be required but should be completed with hand-held tools or equipment. Specialist horticultural advice should always be sought for maintaining turfgrass health and performance on green roofs.

- **Frequency:** Varies with grass species (i.e. cool season vs. warm season), site conditions and climate. In temperate climates turf cutting frequency ranges from weekly or fortnightly (spring and summer) through to monthly (autumn and winter). In tropical climates turf will generally be cut weekly. Fertiliser application should be guided by the monitoring of substrate nutrition but is frequently undertaken bi annually. Turf renovation works will generally be completed annually.



The frequency of turf maintenance varies with the type of grass being used (i.e. cool season vs. warm season), the site conditions and climate. Freshwater Place, Melbourne. Image: J. Rayner

### 3.3.4 PLANT HEALTH

Plant health issues on green roofs need to be promptly identified and managed. Some plant health issues may relate to nutrition (see 3.3.4), or from the effects of abiotic stresses, such as elevated heat, drought and wind exposure. Pests also cause physical damage to plants while pathogens such as viruses, fungi and bacteria can introduce disease and damage plant growth. Some intervention may also be needed for other pests including mice, rats, possums and birds where there is evidence of plant damage or grazing.

Integrated pest management approaches will be most effective at long term pest control and includes the use of biological, cultural and physical controls such as barriers, repellents and traps, along with the application of low-toxicity pesticides such as soap sprays. Possum and rodent control is best undertaken by removing entry points to the roof, rather than the use of poisonous baits that may harm other fauna. Specialist horticultural advice will often be needed for managing plant health where there are severe pest and disease problems or in some applications such as productive green roofs where food is grown for human consumption.

- **Frequency:** Biannual detailed vegetation inspections, even for very low maintenance extensive-type green, with more frequent inspections for more intensive green roofs. Vegetation should be healthy with even growth and no evidence of pest and disease infestation or damage. Any pests and diseases must be identified and attended to promptly. Scheduling of control measures may depend on the species planted as well as seasonal considerations.



Green roofs can experience 1. high winds causing damage to vegetation, and 2. extreme temperatures leading to plant desiccation and death, particularly during heat waves. This can be addressed through proper species selection and to some extent can be minimised through pre-emptive or reactive maintenance – for example by increasing irrigation before, during and after a heatwave. Image: J. Rayner



### 3.3.5 PLANT NUTRITION

Managing plant nutrition on green roofs should be based around good plant establishment and then regular monitoring of plant growth and substrate properties. Visual symptoms such as low vigour, stunting, leaf yellowing or chlorosis may indicate nutrient deficiency, but further analysis may be required. Assessing the substrate pH and soluble salt concentration helps identify problems with nutrient availability, deficiency or toxicity, but these tests will not provide a complete nutrient analysis. In some situations, particularly for productive green roofs, a more complete and detailed chemical analysis of the substrate will be needed.

Fertilisers on green roofs need to be used carefully, especially to avoid ‘dumping’ of nutrients and/or leaching of nutrients into stormwater and receiving waterways. Synthetic, controlled-release fertilisers (CRF) or organic, slow-release fertilisers (SRF) tend to be preferred for most green roofs. Most CRF products release plant nutrients in response to substrate temperature and moisture, and given the elevated heat found in many green roofs, application rates tend to be lower than those used in most other horticultural or landscape settings. SRF fertilisers are also used widely and can be preferred as their release rate is not as influenced by elevated temperatures. In some cases, the method of fertiliser will also need consideration of the irrigation system in use (i.e. sub-surface drippers vs. micro-sprays). Fertiliser practices are particularly important where the nutrient needs of the vegetation are already very low (e.g. succulents, biodiversity green roofs) or alternatively where more detailed nutritional management is needed to support crop species (e.g. productive green roofs). When in doubt, specialist horticultural advice should be sought to properly manage plant nutrition in green roof settings.

- **Frequency:** At a minimum, there should be a detailed vegetation inspection bi annually, even for very low maintenance extensive-type green roofs, with more frequent inspections for more intensive green roofs. Vegetation should be healthy with no evidence of deficiency or toxicity symptoms following fertilisation. Analysis of substrate properties should be completed annually or as required (productive green roofs) and meet the recommended values for performance (i.e. satisfactory for pH and soluble salts). In many extensive-type green roofs, one fertiliser application per annum should be adequate; while in other green roofs, including roof gardens and productive green roofs, more frequent application may be needed.



Fertilisers should be used carefully on green roofs and may be required to treat specific nutrient deficiencies such as low nitrogen. Image: J. Rayner



Integrated pest management will always be the most effective approach for pest control. Image: J. Rayner

### 3.3.6 MULCHING

Mulches can be used to assist with weed control and reduce evaporation but are not widely used on green roofs as they add mass (e.g. mineral aggregates) or provide a seed bed for weed emergence (e.g. organic materials). Most mineral-based green roof substrates have ‘self-mulching’ properties, providing some of the benefits a mulch layer would provide. If mulches are used, they should be high quality, long-life, aggregate materials and applied to a consistent depth (i.e. typically 50 to 75 mm deep). Organic mulches should comply with the Australian Standard for composts, soil conditioners and mulches (AS 4454 - 2012). Specialist horticultural advice on mulching should be sought for productive green roofs. Heavier mulches, such as some mineral aggregates, will add mass and should always be included in dead load calculations for a green roof.

- **Frequency:** Mulches should generally be applied annually and after replanting or any renovation works and should be spread evenly and uniformly at a consistent depth. On higher maintenance green roofs, such as roof gardens and productive green roofs where organic mulches are more likely to be used, mulching may need to be more frequent.

### 3.3.7 BIOMASS REMOVAL

Most green roofs will require regular removal of plant biomass, including weeds, prunings, dead plant matter, leaf litter and other organic materials. The accumulation of plant matter can block drains, while dead and dry plant materials can become a fire hazard, particularly over summer. Such biomass should be removed from all parts of the roof, including non-vegetated areas such as hard surfaces and perimeter drains. Green roofs designed for biodiversity need to be treated a little differently as some will require retention of undisturbed plant materials to support habitat and food values. Note that adjoining vegetation to a green roof may impact maintenance, particularly the presence of trees and leaf fall seasonally or during the year.

- **Frequency:** For higher maintenance, intensive-type green roofs biomass removal should be scheduled monthly, while in low maintenance extensive-type green roofs an annual or biannual allocation should be allowed for. Further biomass removal may be required under conditions of excessive plant growth.



Regular and seasonal biomass removal allows for new plant growth, a decrease in the weight load on the roof and removal of dead, potentially flammable plant material. Here *Miscanthus sinensis* ‘Kleine Fontaine’ is pruned to the base in spring. Burnley demonstration green roof. Images: R. Bathgate



### 3.3.8 REPLANTING

Plant failure should be monitored through regular inspections of the green roof. In all cases an investigation should be undertaken before plant replacement. This may include evaluating the original plant selection and examining any localised problems. Replanting with suitable species should seek to maintain the design intent of the project. Any replanting activities should be scheduled seasonally to maximise plant growth outcomes (e.g. winter/spring).

- **Frequency:** Plant replacement is scheduled to maximise new plant establishment and performance in situ. The timing for these interventions would generally be in winter, but this is very site dependent. For example, there will be more frequent replanting required on a productive green roof throughout the year. Adequate establishment maintenance post-replanting is crucial, including irrigation. Replanting may be required more frequently during the establishment phase if there are early plant failures.



Planting in productive green roofs, such as this one growing vegetables and herbs, should be scheduled to the growth cycles of selected crop species. Image: J. Rayner

### 3.3.9 SUBSTRATE DEPTH

Maintaining adequate substrate depth is important, particularly on shallow green roofs and should be checked regularly. In these green roofs, depth can be measured using a blunt measure (a chopstick is ideal), while in deeper green roofs the required substrate depth can be noted by a fixed marking (e.g. internal planter wall). Depending on roof size, a transect approach to depth sampling may be required. While some slumping of substrate and a slight reduction in depth is to be expected over time, a more detailed inspection may be needed where significant reductions in substrate depth have been observed. This may be due to the use of a poor quality and/or inappropriate substrate. Testing the substrate properties, particularly saturated bulk density and air-filled porosity, can also help determine if the substrate has changed composition over time. Topping-up of substrate to original depths should only be needed every few years (i.e. 3-5), but in some cases may be required annually (e.g. high organic substrates). New material should match the original specifications and must be integrated into the existing substrate to avoid problems with 'layering' and water infiltration. Substrate should never be piled around the base of woody plants on a green roof as this can lead to further problems (e.g. collar and root rot). Dead load limitations always need to be adhered to when adding substrates.

- **Frequency:** For most green roofs substrate depth should be checked annually or biennially with the depth kept within a range limit of the designed depth (e.g. 2.5 cm range). For green roofs with higher organic substrates, such as productive green roofs, more frequent checking may be needed (i.e. six-monthly). For biodiversity green roofs only check substrate depth if there is an observable issue, so as to minimise habitat disturbance.



Substrates can compress and slump over time. Small areas may be filled by hand (1, 2) while larger roofs may require substrates to be delivered through machinery such as blowers (3). Scalping the top 3-4 cm of existing substrate prior to application of new material may help reduce the weed seed mass and remove any impermeable surface crust. Hand excavation allows a visual inspection of the substrate profile as seen during renovation of a Sydney green roof. (4) This sandy loam substrate has remained largely stable over time due to its low organic content. Images: 1 & 2. Burnley research green roof, University of Melbourne, J. Rayner 3. Monash green roof, Melbourne, Junglefy. 4. Readers Digest green roof, Sydney, J. Rayner

## 3.4 INFRASTRUCTURE AND HARD LANDSCAPE

### 3.4.1 IRRIGATION

Given the many possible irrigation designs, only general maintenance issues are discussed here with particular reference to microspray and drip irrigation systems, as these are used widely on green roofs across Australia. All irrigation operations should follow manufacturer specifications which should be documented in the maintenance manual along with a plan of the irrigation configuration and component settings.

The documentation required should include design drawings, showing layout and location of components, the water source (potable, harvested or grey water), scheduling instructions, power supply and connections (battery or mains) and technical aspects such as controllers, fittings, filters, and valves.



Irrigation maintenance involves regular monitoring during operation and testing of performance, particularly during different irrigation programming (i.e. summer vs. winter) and across different zones on the roof (i.e. turf vs. garden beds). Monitoring includes checks for blockages, leaks, wear, corrosion, and application that is uniform and consistent. Inspection may extend to checking substrate moisture levels and wetting patterns, particularly surface drip irrigation, to ensure there is even distribution. Less frequent but essential irrigation maintenance includes regular flushing of irrigation lines and applicators to reduce blockages and checking systems with remote monitoring to ensure they are functioning successfully and that alarm response times are accurate. Installation of a water meter aids in detecting any issues, as does the use of substrate sensors.

All power supplies and any electrical components should be tested, including timers, sensors, connections to weather stations; some devices may need batteries replaced regularly. Specialist advice may be needed to assist with irrigation operations and maintenance, particularly if non-potable water sources are being used.

Occasional testing is also required for the functionality and performance of irrigation systems. This includes a more detailed inspection of components: pipes, connections, driplines, filters, emitters/ spray heads, pumps, backflow prevention devices, sensors and valves (master, solenoid, flush, air, pressure, etc.). Irrigation testing also includes checking the application performance (i.e. emitters, spray heads, etc.) to ensure that irrigation is as per specifications, particularly flow rate and frequency (flow sensor or manually).

- **Frequency:** Inspection of irrigation system operations can range from monthly, in low maintenance green roofs, through to weekly in high use or higher maintenance green roofs especially over spring and summer. Flushing of irrigation lines and components should be completed monthly when in use. Undertake annual testing for irrigation function and performance and after irrigation systems have been idle for a period of months.



Microspray and drip systems are the most widely used irrigation systems on green roofs across Australia. 1. Inline drippers using purple pipe (non-potable water source) on the Burnley demonstration green roof. 2. Microspray emitters. 3. Irrigation controllers are critical in managing irrigation systems. Images: 1. & 3. J. Rayner, 2. E. Snodgrass

### 3.4.2 MAINTENANCE OF DRAINS, GUTTERS AND FLASHINGS

Drainage is a critical component of green roof infrastructure. Blocked drains can cause leakage to the underlying structure and localised flooding or saturation, creating further problems with substrates, plant growth and weeds. Drainage areas should be free of any vegetation and plant debris, with regular monitoring of drainage pits, inspection chambers, gutters, and downpipes. Underlying buildings should be inspected for cracks, infiltrations and water stains on walls and ceilings underneath the green roof. Electronic leak detection systems should be checked for performance based on manufacturers, specifications. Any leak observed should be reported immediately and a qualified roof plumber called in to respond to the problem. Green roof flashings should be in good condition with solid fixings and no corrosion evident.

- **Frequency:** Quarterly inspections for drains and associated infrastructure. In some sites, more frequent inspection may be needed (e.g. where there are deciduous trees on/near the roof). Annual checking and inspection of flashings and internal walls and surfaces. No ponding of water should be evident on roofs or in perimeter drains and no leaks observed from overflowing gutters externally or internally. Any required repairs are dealt with promptly and recorded.

### 3.4.3 SURFACE CLEANING

Hard surfaces on green roofs, particularly decking or paving areas, need to be kept free of any plant debris and rubbish. Other spaces and facilities, such as furniture and barbecue areas should be cleaned regularly. Surface pressure-washing equipment must be used with care on a green roof to minimise damage to vegetation, both from physical damage and from the cleaning chemicals.

- **Frequency:** Dependent on the type and use of the green roof. Can range from quarterly/biannually for a very low maintenance roof, through to weekly for accessible and high maintenance green roofs.



Drainage is a critical component of green roof infrastructure. Drainage areas should be free of any vegetation and plant debris, with regular monitoring of drainage pits, inspection chambers, gutters, flashing and downpipes. Images: 1. & 3. J. Rayner, 2. E. Snodgrass



### 3.4.4 MAINTAINING HARD LANDSCAPE ELEMENTS

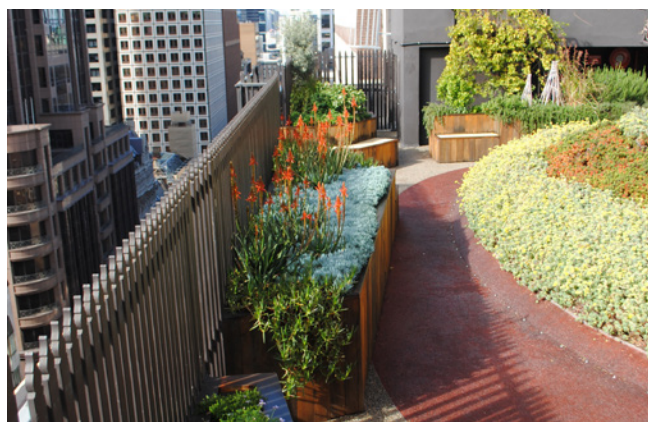
Hard landscape elements on a green roof typically includes edges, balustrades, paths, decking, furniture, shade structures, planter surfaces and any temporary equipment. All maintenance activities and repairs should follow manufacturers' guidance and specifications. Walkable and trafficable areas, including timber and masonry surfaces, encompassing supports and fixtures, will need maintenance to ensure safety of use. This may include the application of solvents, oils and paints - all of which should be used following safe operating procedures. During treatment the surrounding vegetation should be protected from any damage. Other components, such as lighting, should also be inspected regularly with repairs and replacement completed as needed.

- **Frequency:** Annually (at a minimum), depending on the wear and tear and use of the hard landscape. Repairs completed as required.

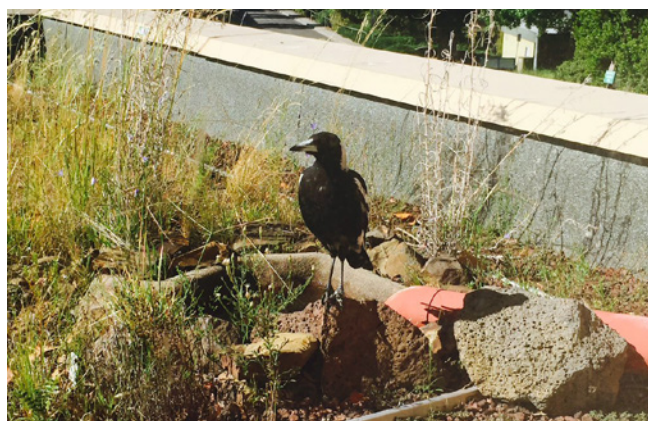
### 3.4.5 MAINTAIN HABITAT PROVISION

Green roofs designed for biodiversity may have other elements, aside from the plants used, that provide for habitat, nesting, forage and food resources. This includes natural materials such as timber, dead wood, sands and gravels, and designed elements such as ponds and 'bee hotels'. Maintenance of these elements should ensure that habitat provision is provided with replacement and/or addition of elements undertaken as required. Features such as ponds and ephemeral water features should be cleaned regularly to ensure they are clear of debris and in good condition.

- **Frequency:** Dependent on the type of green roof and elements present but generally annually. The timing/season for scheduling will depend on the type of habitat provision and the target species for biodiversity.



All hard landscape elements that form part of a green roof, such as this one at 131 Queen Street Melbourne, will require maintenance. They should be inspected regularly to ensure they are safe and fit for purpose. Image: J. Rayner



Green roofs designed for biodiversity may have other elements, aside from the plants, including natural materials such as timber, dead wood, sand and gravel and designed elements such as ponds and 'bee hotels'. Images: J. Rayner and N. Williams



### 3.5 CASE STUDIES

#### 3.5.1 MAINTENANCE NEEDS A PLAN: BURNLEY BIODIVERSITY GREEN ROOF

The Burnley biodiversity green roof, completed in February 2013, is planted with indigenous plants from Victoria's endangered grassland communities and has additional features designed to attract and provide habitat for wildlife, insects and birds. Over time there has been a gradual loss of the planted flora across the roof and a significant increase in weeds, some of which have now become well established. Remediation works to restore the original biodiversity functions will be time-consuming and expensive. These problems could have been avoided through regular maintenance interventions, guided by a maintenance plan specific to the objectives needed to sustain these functions. The green roof has also had ongoing problems with a drainage outlet and water leakage. These were first detected in 2015 and despite several repair efforts, were not finally rectified until 2020 with assistance from a leak detection expert and a dedicated roof plumber. Green roofs frequently require specialist expertise; making sure that these experts are engaged in any problem solving is key to successful maintenance.



Planting of the Biodiversity Green Roof was completed in 2013.



Persistent weed problems have developed on the green roof as these examples from 2020 demonstrate.



Drainage problems on this corner of the green roof took many years to be resolved (Nov 2020).

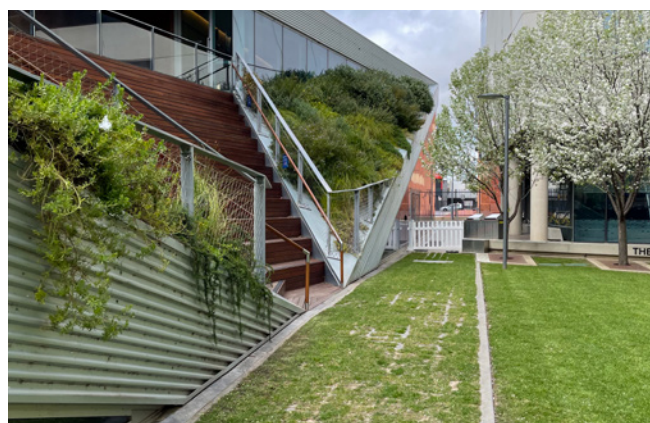


The corner of the green roof following roof repairs and remediation works (Sept 2021). Images: J. Rayner and A. Smith



### 3.5.2 QUALITY DESIGN REDUCES MAINTENANCE: UNI SA GREEN ROOF

Pridham Hall, a sports and conference building on the UniSA City West Campus, has four sloping green roofs of varying grades from 18° to 42°. Completed in 2017, the project has been designed with several features to assist with green roof maintenance. Each roof is fitted with an ILD leak detection system®, providing easy detection of the waterproofing membrane without disturbing the roof profile. Safe access is provided through a 'raptor rail' installed along the highest edge of each roof with an anchor point that slides along the rail. Maintenance staff wear a harness that is then attached to the raptor rail on an extension rope, enabling full and safe access. High density planting has been used successfully to reduce weed growth, although one species (*Westringia* sp.) has been removed due to excessive vigour. Much of the monthly maintenance is focussed on reducing the biomass of the shrubs and grasses that dominate the planting on each roof. The main maintenance problem has been rodents chewing through irrigation lines. This has resulted in multiple repairs with rodent baiting now becoming part of the routine maintenance schedule, as the pest operators do not have Working Safely at Heights certification.

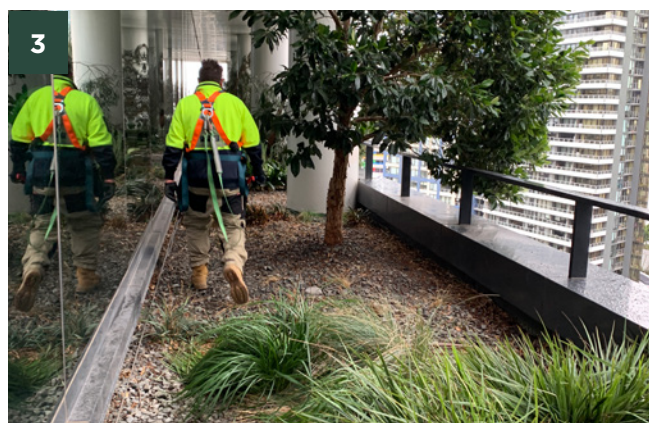
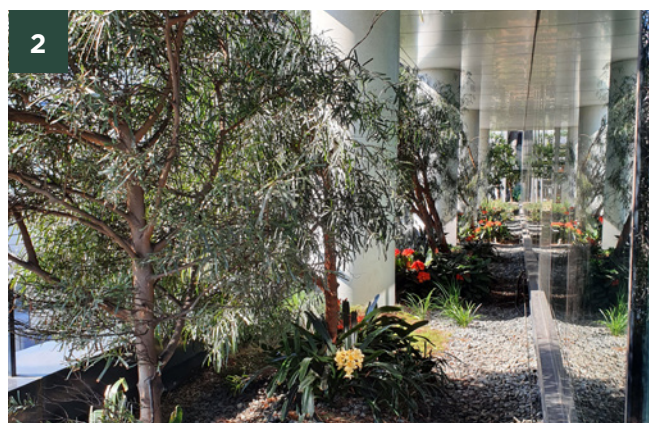


The UniSA green roof has been designed with maintenance in mind and includes several features to facilitate maintenance including an electronic leak detection system and 'raptor rail' that crews can attach to for full and safe access. Images and text: [Fytogreen](#)



### 3.5.3 PLANNING FOR MAINTENANCE OVER TIME: MEDIBANK BUILDING

The Medibank Building in Melbourne has 16 green roofs located on the east, west and north facades of the building. Completed in 2014, the green roofs vary in size from 9 m<sup>2</sup> to 400 m<sup>2</sup>, and all have 600 mm substrate depth to accommodate the growth of ground covers and trees (1). The green roofs are exposed to elevated temperatures and high winds, the latter requiring all trees to be root anchored to the building. Maintenance is based on a bi monthly schedule and weeds are not a major issue because of the height, use of engineered media and location of the green roofs. As the trees have matured some of the ground covers have been slowly shaded out, resulting in poor growth and some deaths (2), requiring some minor design modifications and new plant selections. Every green roof was installed with a protective balustrade to meet original safety requirements but new static lines for safe access were installed three years later (3). This was because the green roof surfaces had become uneven over time, with the balustrades then being deemed too low and unsafe, requiring additional safety requirements for access.



Medibank green roofs span levels 2 to 15 of the building and are subject to challenging conditions with periodic high winds and elevated temperatures. Images and text: [Fytogreen](#)



## 4. GREEN ROOF MAINTENANCE SCHEDULE EXAMPLES

The four templates provided here apply to green roofs in south-east Australia which experience warm-hot dry summers and cool, wet winters. For green roofs in other Australian climates maintenance schedules should be adapted accordingly. Climate influences the frequency of maintenance, decreasing during dormant periods and increasing during the more active growing phase of both planted species and weeds. The timing of maintenance in a schedule should therefore reflect these seasonal variations.

Tasks in these examples are divided into both establishment and routine maintenance phases of a green roof (see 1.3 Classifying Maintenance). More frequent monitoring may be required during the establishment phase, particularly in relation to weed control, plant replacement and irrigation. Tasks are also grouped according to category and readers are encouraged to refer to the relevant section within this guide for more detail.

SAFE WORK PRACTICES	SECTION 3.1
MONITORING	SECTION 3.2
HORTICULTURAL MAINTENANCE	SECTION 3.3
INFRASTRUCTURE AND HARD LANDSCAPE	SECTION 3.4



The Wonthaggi desalination plant green roof, Victoria. Image: E. van Zuilekom, [Fytogreen](#)

## 4.1 LIGHTWEIGHT, RESTRICTED ACCESS GREEN ROOF

<b>DESIGN AND FUNCTION</b>	A shallow, lightweight (extensive) green roof dominated by low-growing succulents that may be viewed from surrounding buildings and designed to provide ecological and aesthetic benefits (visual interest, stormwater mitigation, building thermal insulation).
<b>MAINTENANCE OBJECTIVE</b>	Flourishing plants that provide at least 90% coverage across the roof at all times (post-establishment). Plant communities retain the diversity of species or forms of the original design, are largely self-generating and weed levels are low, with weeds not competing with, or overgrowing, plants. Substrate depths should remain consistent across the roof. Roof perimeters are weed free, drains are free of blockages and guttering and flashing are in good condition. Roof waterproof membrane and green roof layers are intact with no leakage into underlying structures
<b>MAINTENANCE INPUTS</b>	Very low maintenance: quarterly or biannual schedule
<b>SUBSTRATE DEPTH</b>	150 mm mineral-based substrate
<b>ACCESSIBILITY</b>	Access for maintenance purposes only, use of a fall-arrest system
<b>VEGETATION TYPE</b>	Predominantly low-growing succulents
<b>IRRIGATION SYSTEM</b>	Hose provided for establishment and emergency irrigation only
<b>INFRASTRUCTURE AND HARD LANDSCAPE ELEMENTS</b>	<ul style="list-style-type: none"> <li>• External walkway</li> <li>• Drains, gutters and flashings</li> <li>• Safety harness attachment points</li> <li>• Non-vegetated zones</li> <li>• Retaining edges</li> </ul>

### ESTABLISHMENT MAINTENANCE

Establishment maintenance for this green roof would typically be around 3 months on a fortnightly schedule; longer (up to 6 months), if the seasonal conditions post-planting requires additional inputs such as irrigation. The critical tasks during establishment include irrigation (fortnightly/weekly), particularly over the summer months, weed control and early re-planting to ensure plant coverage targets are met at the end of the period.

### ROUTINE MAINTENANCE SCHEDULE

A lightweight, restricted access green roof is very low maintenance and can be maintained on a quarterly or biannual schedule.



Low-growing succulents are the main plant type on this shallow green roof in Stuttgart, Germany. Image: J. Rayner



TASK	ROUTINE (FREQUENCY/YR)
<b>Safe work practices</b>	
Safety procedures	Every visit
Maintain safety systems	2 and as required
Staff training	1 and as required
<b>Monitoring</b>	
Visual inspection	Every visit
Maintenance report	Every visit
Review maintenance plan	1
<b>Horticulture</b>	
Weed control	2
Pruning	1 and as required
Fertilisation	1
Plant health	Every visit
Mulching	1
Biomass removal	1
Replanting	1
Check substrate depth	1
Manual watering	As required
<b>Infrastructure and hard landscape</b>	
Drains, gutters & flashings maintenance	Every visit
Surface cleaning	Every visit
Maintaining hard landscape elements	1



Image: N. Williams

## 4.2 BIODIVERSITY GREEN ROOF

<b>DESIGN AND FUNCTION</b>	A green roof designed primarily to enhance biodiversity using a largely indigenous plant palette and a range of features to create habitat and resources for invertebrates, birds and other wildlife.
<b>MAINTENANCE OBJECTIVE</b>	Plants and other habitat features provide ecological resources – primarily habitat and food – for a range of biota, including target species where appropriate. Biodiversity on the roof increases ensuring connectivity with ground-level populations. Plants are healthy and weeds do not negatively impact plants, habitat features or biota. Species diversity is maintained to 80% of original plant list in routine maintenance.
<b>MAINTENANCE INPUTS</b>	Low maintenance: bimonthly or quarterly schedule
<b>SUBSTRATE DEPTH</b>	200 mm with some variation in topography (+/- 100mm) to allow for habitat features
<b>ACCESSIBILITY</b>	Access for maintenance purposes only, use of a fall-arrest system
<b>VEGETATION TYPE</b>	A mixture of largely native/indigenous herbaceous plants, mainly grasses and forbs.
<b>IRRIGATION SYSTEM</b>	Yes – low pressure microspray system.
<b>INFRASTRUCTURE AND HARD LANDSCAPE ELEMENTS</b>	<ul style="list-style-type: none"> <li>• Drains, gutters and flashings</li> <li>• Safety harness attachment points</li> <li>• Non-vegetated zones</li> <li>• Retaining edges</li> <li>• Structures/elements for habitat provision such as logs and old wood, piles of sticks, native bee/insect hotels, bird/bat boxes, rocks, water provision e.g. ephemeral pond/other water feature</li> </ul>

### ESTABLISHMENT MAINTENANCE

Establishment maintenance for this green roof would typically be around 6 months. The critical tasks required during establishment are irrigation (fortnightly/weekly), adjusted to meet needs over the hotter and drier summer to early autumn period; weed control and vegetation management works, to maximise planted species success; and early re-planting to ensure that planting design targets are met at the end of the period. All areas across the roof should be disturbed as little as possible to minimise damage to microhabitats that might be colonised, leaving in place living and dead plant material that may be providing habitat, food or nesting resources.

### ROUTINE MAINTENANCE SCHEDULE

Biodiversity roofs are low maintenance and can be maintained on a bimonthly or quarterly schedule.



Burnley biodiversity green roof, University of Melbourne.  
Image: N.Williams



TASK	ROUTINE (FREQUENCY/YR)
<b>Safe work practices</b>	
Safety procedures	Every visit
Maintain safety systems	2 and as required
Staff training	1 and as required
<b>Monitoring</b>	
Visual inspection	Every visit
Maintenance report	Every visit
Review maintenance plan	1
<b>Horticulture</b>	
Weed control	Every visit
Pruning	1 and as required
Fertilisation	1
Plant health	Every visit
Mulching	1 and as required
Biomass removal	2
Replanting	1 and as required
Check substrate depth	1
<b>Infrastructure and hard landscape</b>	
Irrigation maintenance	1
Drains, gutters & flashings maintenance	4
Surface cleaning	1
Maintaining hard landscape elements	1
Check habitat provision (e.g. bee hotel, water feature)	1



PWC biodiversity green roof, London. Image: J. Rayner

### 4.3 ROOF GARDEN

<b>DESIGN AND FUNCTION</b>	A green roof primarily designed for passive recreation and amenity with distinct zones that include podium plantings, seating and a range of hard surfaces. A diverse assemblage of plant materials used, including trees, shrubs, herbaceous and climbing plants, plus a small area of amenity turf.
<b>MAINTENANCE OBJECTIVE</b>	Plants and hard landscape features are consistently maintained to a high standard for maximum visual benefits, functions and uses.
<b>MAINTENANCE INPUTS</b>	High maintenance: weekly to fortnightly schedule
<b>SUBSTRATE DEPTH</b>	Variable across roof, 300 – 1000 mm
<b>ACCESSIBILITY</b>	Fully accessible with balustrade to ensure safe access and use
<b>VEGETATION TYPE</b>	A variety of native and exotic succulents, annuals, herbaceous perennials, subshrubs, shrubs, turf and small trees.
<b>IRRIGATION SYSTEM</b>	Surface drip irrigation
<b>INFRASTRUCTURE AND HARD LANDSCAPE ELEMENTS</b>	<ul style="list-style-type: none"> <li>• Drains, gutters and flashings</li> <li>• Leak detection system</li> <li>• Non-vegetated zones</li> <li>• Retaining edges</li> <li>• Planters and cables and frames for climbing plants</li> <li>• Decking, furniture, barbecue area and shade structures</li> <li>• Paths and lighting</li> </ul>

#### ESTABLISHMENT MAINTENANCE

Establishment maintenance for this green roof would typically be around 6 months, longer (up to 12 months), if trees are planted as these can take longer to fully establish on site. The critical tasks required during establishment are irrigation (fortnightly/weekly), weed control and pruning to promote suitable plant form and growth. Any replanting during establishment should be undertaken when climatic conditions are the most suitable.

#### ROUTINE MAINTENANCE SCHEDULE

Roof gardens are high maintenance and can require maintenance on a weekly or fortnightly schedule.



Skypark green roof, Melbourne. Image: R. Bathgate



TASK	ROUTINE (FREQUENCY/YR)
<b>Safe work practices</b>	
Safety procedures	Every visit
Maintain safety systems	1 and as required
Staff training	1 and as required
<b>Monitoring</b>	
Visual inspection	Every visit
Maintenance report	Every visit
Review maintenance plan	1
<b>Horticulture</b>	
Weed control	Every visit
Pruning	26 or as required
Turf maintenance	26
Fertilisation	2
Plant health	12
Mulching	2
Biomass removal	12
Replanting	2
Check substrate depth	1
<b>Infrastructure and hard landscape</b>	
Irrigation maintenance	26
Drains, gutters & flashings maintenance	4
Leak detection test	1
Surface cleaning	26
Maintaining hard landscape elements	2
Check tall vegetation supports	1



MONA green roof, Hobart. Image: [Fytogreen](#)

## 4.4 PRODUCTIVE GREEN ROOF

<b>DESIGN AND FUNCTION</b>	A green roof designed for crop production and growing a variety of herbs, fruits and vegetables throughout the year. The green roof is designed around a configuration of connected specialist planters in a fully accessible space.
<b>MAINTENANCE OBJECTIVE</b>	The green roof should appear well-maintained with plants in optimal health throughout the year. Plants yield good quantities of high-quality produce fit for human consumption.
<b>MAINTENANCE INPUTS</b>	Very high maintenance: daily to weekly schedule
<b>SUBSTRATE DEPTH</b>	500 mm
<b>ACCESSIBILITY</b>	With balustrade to allow safe access and use
<b>VEGETATION TYPE</b>	Mainly a range of edible annuals and herbaceous perennials and some low-growing woody perennials
<b>IRRIGATION SYSTEM</b>	Micro spray irrigation, supplementary tap and hose
<b>INFRASTRUCTURE AND HARD LANDSCAPE ELEMENTS</b>	<ul style="list-style-type: none"> <li>• Drains, gutters and flashings</li> <li>• Leak detection system</li> <li>• Non-vegetated zones</li> <li>• Retaining edges</li> <li>• Paths</li> <li>• Support structures /frames for plants such as tomatoes, peas, climbing beans etc.</li> </ul>

### ESTABLISHMENT MAINTENANCE

Establishment maintenance for this productive green roof is directly linked to the growing cycles of the crop plants under cultivation. This will typically include woody perennials such as trees, shrubs and vines that require long periods for establishment (approx. 6 months); herbaceous perennials (e.g. Rhubarb, Asparagus) requiring moderate periods for establishment (approx. 1-3 months); and annual, herbaceous plants grown seasonally, by either seed or seedling, that have short periods for establishment (days or weeks). Because of the unique requirements for crop production on a green roof and the individual needs of different plant species under cultivation, specialist horticultural advice should be sought to plan establishment maintenance.

### ROUTINE MAINTENANCE SCHEDULE

Roof gardens have very high maintenance and can require maintenance on a daily and weekly schedule.



Burwood Brickworks urban rooftop farm, Melbourne. Image: E. Lumsden



TASK	ROUTINE (FREQUENCY/YR)
<b>Safe work practices</b>	
Safety procedures	Every visit
Maintain safety systems	1 and as required
Staff training	1 and as required
<b>Monitoring</b>	
Visual inspection	Every visit
Maintenance report	Every visit
Review maintenance plan	1
<b>Horticulture</b>	
Weed control	26
Pruning	12
Fertilisation	6
Plant health	26
Mulching	4 and as required
Biomass removal	12
Replanting	6
Check substrate depth	4
<b>Infrastructure and hard landscape</b>	
Irrigation maintenance	Every visit
Drains, gutters & flashings maintenance	4
Leak detection test	1
Surface cleaning	26
Maintaining hard landscape elements	1
Check tall vegetation supports	6



Productive green roof, Singapore. Image: J. Rayner

	LIGHTWEIGHT, RESTRICTED ACCESS GREEN ROOF	BIODIVERSITY GREEN ROOF
Duration of Establishment Maintenance	3 - 6 months	6 months
Routine Maintenance Frequency	Quarterly to biannual	Bimonthly to quarterly
TASK	FREQUENCY OF ROUTINE MAINTENANCE TASKS	
Safe work practices		
Safety procedures	Every visit	Every visit
Maintain safety systems	2 and as required	2 and as required
Staff training	1 and as required	1 and as required
Monitoring		
Visual inspection	Every visit	Every visit
Maintenance report	Every visit	Every visit
Review maintenance plan	1	1
Horticulture		
Weed control	2	Every visit
Pruning	1 and as required	1 and as required
Turf maintenance	-	-
Fertilisation	1	1
Plant health	Every visit	Every visit
Mulching	1	1 and as required
Biomass removal	1	2
Replanting	1	1 and as required
Check substrate depth	1	1
Manual watering	As required	-
Infrastructure and hard landscape		
Irrigation maintenance	-	1
Drains, gutters & flashings maintenance	Every visit	4
Leak detection test	-	-
Surface cleaning	Every visit	1
Maintaining hard landscape elements	1	1
Check habitat provision (e.g. bee hotel, water feature)	-	1
Check tall vegetation supports	-	-



	ROOF GARDEN	PRODUCTIVE GREEN ROOF
Duration of Establishment Maintenance	6 – 12 months	Dependent on crop, recurring
Routine Maintenance Frequency	Weekly to fortnightly	Daily to weekly
TASK	FREQUENCY OF ROUTINE MAINTENANCE TASKS	
<b>Safe work practices</b>		
Safety procedures	Every visit	Every visit
Maintain safety systems	1 and as required	1 and as required
Staff training	1 and as required	1 and as required
<b>Monitoring</b>		
Visual inspection	Every visit	Every visit
Maintenance report	Every visit	Every visit
Review maintenance plan	1	1
<b>Horticulture</b>		
Weed control	Every visit	26
Pruning	26 or as required	12
Turf maintenance	26	-
Fertilisation	2	6
Plant health	12	26
Mulching	2	4 and as required
Biomass removal	12	12
Replanting	2	6
Check substrate depth	1	4
Manual watering	-	-
<b>Infrastructure and hard landscape</b>		
Irrigation maintenance	26	Every visit
Drains, gutters & flashings maintenance	4	4
Leak detection test	1	1
Surface cleaning	26	26
Maintaining hard landscape elements	2	1
Check habitat provision (e.g. bee hotel, water feature)	-	-
Check tall vegetation supports	1	6

## 5. REFERENCES AND FURTHER READING

### WEBSITE RESOURCES

#### AUSTRALIA

Growing Green Guide: A guide to green roofs, walls and facades in Melbourne (2014) State of Victoria, Melbourne.  
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Minnesota Stormwater Manual – green roofs [https://stormwater.pca.state.mn.us/index.php/Green\\_roofs](https://stormwater.pca.state.mn.us/index.php/Green_roofs)

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### TEXTS, GUIDELINES AND STANDARDS

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Centre for Urban Greenery & Ecology (2012) *Guidelines on general maintenance for rooftop greenery*, CS E07:2012, Centre for Urban Greenery & Ecology, Singapore.

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MONA green roof, Hobart. Image: [Fytogreen](#)



# MAINTENANCE GUIDELINES FOR **AUSTRALIAN GREEN ROOFS**

## GET IN TOUCH

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