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CITY OF PORT PHILLIP

STREETSCAPE WSUD: Targeted Maintenance

Final Report

May 2014

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1 Maintenance types

This report provides targeted advice on how to undertake typical maintenance activities for street scale WSUD assets in the City of Port Phillip. It is based on findings from work undertaken as part of the 'Review of Street Scale WSUD' project and is therefore targeted specifically at maintenance requirements identified for streetscape WSUD within the City of Port Phillip. The project involved inspecting a large range of raingardens, including infiltration raingardens (no underdrain), street tree raingardens (no groundcover vegetation) and typical raingardens.

Two key areas of maintenance were identified as part of the 'Review of Street Scale WSUD'.

1. Planned maintenance tasks – these typically require minimal resources and primarily involve removal of debris and litter, minor maintenance of the filter media to ensure good drainage (levels and infiltration rate), and weeding/pruning. These tasks are generally predictable and can be undertaken within a planned timeline or framework of annual maintenance.
2. Corrective maintenance or rectification works – a large number of WSUD assets within the City of Port Phillip require some type of corrective maintenance. These assets require more comprehensive works to reconfigure some of the key features to ultimately reinstate the function of the asset. Reasons that rectification or resetting might be required included poor design or construction, inadequate establishment phase maintenance or altered/unforseen site conditions. These activities may require special equipment or skills, such as filter media installation or kerb alterations and reconfiguring outlets.

The two types of maintenance tasks (planned maintenance and corrective maintenance) have been addressed separately in this report. When designed, constructed and functioning appropriately, only planned maintenance should be required for street scale WSUD assets in the City of Port Phillip.

PLANNED MAINTENANCE

Rubbish removal
Leaf litter removal
Minor sediment removal
Mulch maintenance
Plant densities – infill planting
Weed removal
Pruning
Plant health check
Minor surface level adjustments
Blockage detection/removal
Repair minor vehicle or pedestrian damage

CORRECTIVE MAINTENANCE

Major sediment removal
Reinstatement of ponding depth
Drainage review (e.g. standing water present)
Extensive vegetation replacement
Low flow rerouting
Major scour or erosion repair
Preferential flow path repair (major)
Filter media reinstatement
Filter media replacement (major)
Algae or moss management
Significant damage repair (civil or landscape)
Gravel mulch removal

2 Maintenance objectives

The primary objectives for planned maintenance of street scale WSUD assets are to preserve:

- Aesthetics
- Water quality treatment objectives
- Drainage function

In order to achieve these objectives (i.e. long term function and aesthetics of a WSUD street scale asset) the following features must be maintained:

- Adequate ponding depth (extended detention)
- Even flow distribution across the surface of the raingarden
- Good vegetation cover
- Design infiltration rates
- Overflow capacity

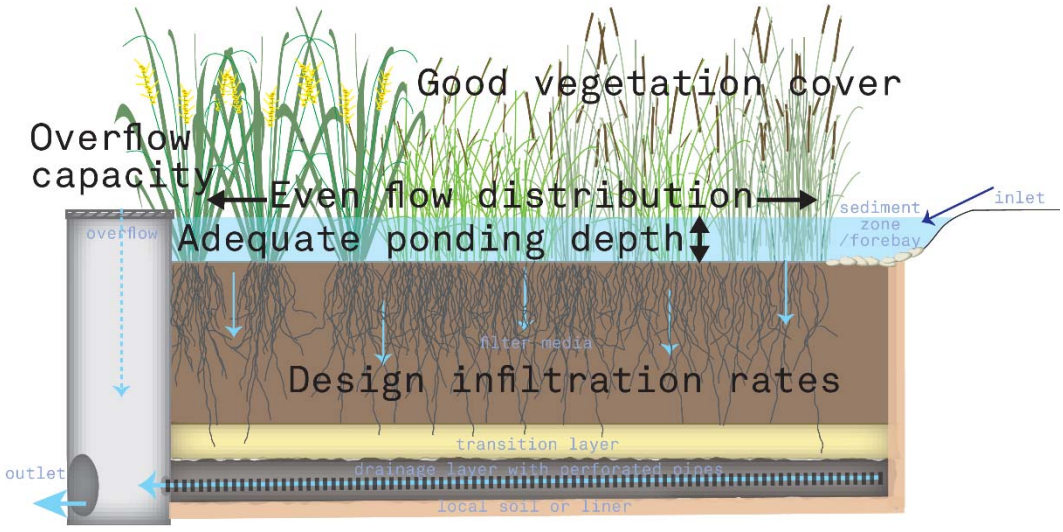


Figure 1. Elements of a well designed and constructed streetscape raingarden

For a well designed and constructed raingarden, planned maintenance can be separated into the following components:

- Landscape components – maintenance of a flat filter media surface with design infiltration rate and design ponding depth that is free of debris and supports dense stands of the appropriate plant species
- Civil components – maintaining free drainage through pipes and pits and kerbs etc.

3 Assessment procedures

The procedures for assessment of maintenance requirements for street scale WSUD assets are:

1. Inspect assets (as per inspection checklist)
2. Record maintenance requirements
3. Undertake Planned Maintenance (as identified during inspection)
4. Undertake Corrective Maintenance (as required)
5. Keep a record of maintenance performed

3.1 TIMING

TYPICAL

Typically, it is suggested that routine inspections and maintenance should be undertaken every 6 months to ensure the system is operating as required. However more frequent inspections are required for street scale WSUD assets in high profile or high traffic areas, or where specific site conditions necessitate (i.e. heavy leaf litter loads).

HIGH PROFILE OR UNUSUAL SITE CONDITIONS

For high profile sites (i.e. where aesthetics is a critical driver) or where individual site conditions necessitate (i.e. unusually heavy rubbish or leaf litter loads), it is recommended that inspections and maintenance be undertaken every 2 months.

MINIMUM

As a minimum, a full inspection of every WSUD system should be undertaken once a year and following large storm events. The 'Inspection Checklist – Planned and Corrective Maintenance' should be used as a guide when undertaking inspections on the streetscape WSUD system.

Schedule of Regular Inspections and Maintenance

Frequency	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Typical				✓						✓		
High profile site or unusual conditions (e.g. heavy leaf litter loads)		✓		✓		✓		✓		✓		✓
Minimum										✓		

3.2 RECORD KEEPING

Example inspection and maintenance forms have been prepared for City of Port Phillip's streetscape WSUD systems which can be used to record any maintenance activities required for the treatment systems. These forms

should be kept in an appropriate maintenance record file for future reference. A template is contained in Appendix A – Inspection Template.

Non-conformances are to be recorded in a log and a corrective action plan logged and undertaken. Repetitive non-conformances need to be thoroughly reviewed to understand the root causes and appropriate action taken.

3.3 CORRECTIVE MAINTENANCE

If corrective maintenance is required, this should generally result in a suspension of planned maintenance activities until the corrective maintenance has been undertaken.

Any issues identified for Corrective maintenance require additional investigation as per Section 5 of this report.

3.4 IMPORTANCE OF PLANTS

The management of the vegetation health is critical to the functional performance of raingardens, especially in terms of stormwater treatment performance. **High plant densities significantly reduce the impacts (and therefore maintenance requirements) of leaf litter accumulation, weed growth, and clogging.** High plant densities area also critical for long term raingarden aesthetics– an important factor for inner city and suburban streetscape raingardens.

3.4.1 General maintenance advice for plants

An establishment phase maintenance program should always be implemented when plants are installed into WSUD assets. Maintenance should predominantly involve some watering and weed removal once the vegetation is established. More information on maintenance activities for bioretention plants, in additional to other maintenance tasks, are provided in Section 4.

4 Planned Maintenance Tasks

4.1 RUBBISH REMOVAL

Rubbish was present in many WSUD assets that were inspected within the City of Port Phillip. The type and size ranged from cigarette butts to a discarded mattress. Maintenance is critical to ensure rubbish does not result in blockages, or impede flow across the surface of the filter media, and also to preserve aesthetics (especially in highly visible locations).

INSPECTION
Check the following locations for rubbish:

- On the filter media surface
- Surrounding kerbs and channels
- Inlet (where water enters the raingarden from kerb or pipe)
- Outlet/overflow structures

TRIGGER
- Visible blockage due to rubbish
- Diminished aesthetics

MAINTENANCE ACTION
Rubbish can be removed by hand or with hand tools such as tongs and shovels. Collected litter should be placed into bags or similar and transported to appropriate waste disposal facility.




4.2 LEAF LITTER REMOVAL

Leaf litter accumulation on a significant scale was observed at a number of sites within the City of Port Phillip. Where leaf litter posed a threat to WSUD asset function, it was primarily from Plane Trees (both overhead trees as well as from leaves washing in from the upstream catchment). Leaf litter can accumulate and become saturated within a WSUD asset. Breakdown of the leaves in saturated conditions can produce fine organic matter that can cause clogging of the filter media surface (eventually) and leach nutrients into waterways. A heavy leaf litter load can impede drainage through the filter media as well as restricting the growth and spread of desired plants in the WSUD asset.

INSPECTION

Check the following for leaf litter:

- On the filter media surface
- Across the canopy of the plants within the WSUD asset
- Surrounding kerbs and channels
- Inlet (where water enters the raingarden from kerb or pipe)
- Outlet/overflow structures

TRIGGER

- Wet and decaying leaf matter present
- Aesthetic issue
- Obstructing flow paths

MAINTENANCE ACTION

Remove leaf litter from the surface of the filter media (including around inlet areas and between plants) using rakes or other appropriate hand tools. Remove leaf litter from hard surfaces using appropriate hand tools. Leaf litter must be removed from the site and composted or disposed of appropriately.

4.3 SEDIMENT REMOVAL (MINOR)

The rate of sediment accumulation was observed to be highly variable, and dependant on a WSUD asset's catchment size and type. Most sediment was observed accumulating:

1. In the gutters and kerbs upstream of the inlet to the WSUD asset (see Section 4.11),
2. Within the gravel mulch located on top of the filter media (see Section 4.4), and
3. On the filter media closest to the inlet.

Sediment accumulating on the surface of the filter media can change the profile of the systems; clog the filter media or smother vegetation, reducing the treatment performance of the system. Sediment must be removed from any designated sediment fore bays (if provided) for long term protection of the filter media.

INSPECTION

Check the following locations for sediment accumulation:

- On the filter media surface
- Surrounding kerbs and channels
- Inlet (where water enters the raingarden from kerb or pipe) or in designated sediment fore bay
- Outlet/overflow structures

TRIGGER

- Fine clay or sediment across more than 10% of the filter media surface
- Sediment fore bay (if present) more than 80% full
- Sediment accumulation is impeding flows

MAINTENANCE ACTION

For minor sediment removal from the filter media surface (10 to 60 % coverage of the filter media, less than 50mm depth), or cleaning of sediment fore bay, use hand tools to remove/scrape clay and fine sediment from around the plants. Remove sediment from site and dispose of appropriately.

For sediment accumulation on hard surfaces use appropriate hand tools (broom, shovel etc) to collect and remove from site.

If sediment is predominantly amongst gravel mulch, see following section.

For removal of major sediment accumulation (more than 50mm deep or covering more than 60% surface area, see corrective maintenance in Section 5.11)

4.4 MULCH MAINTENANCE

Most WSUD assets across the City of Port Phillip contain gravel mulch, however the size and depth of the gravel varies between sites. The presence of gravel mulch has two key drawbacks as identified at some sites across the City of Port Phillip:

1. It can make sediment removal challenging. If fine sediment or clay washes in from the catchment, it accumulates between the gravel particles and then the task of sediment removal is more laborious because the gravel mulch must be removed and washed or replaced.
2. It restricts the growth and spread of the desired plant species (often due to heat trapped by the gravel, pressure on the plant stems and potentially through abrasion or cutting of stems).

INSPECTION
Check the following:

- Gravel mulch on the filter media surface and batters

TRIGGER

- Substantial loads of fine sediment or clay visible between the gravel particles
- Visible restriction of growth and spread of desired species observed

MAINTENANCE ACTION
Option 1 (preferred) – Remove gravel with hand tools from around plants. Do not replace gravel mulch. Provide infill planting to ensure at least 6-12 plants/m^2 (depending on species) coverage once established. Inspection and removal of weeds should occur every three months for the first year following plant establishment.

Option 2 – Remove existing plants and store appropriately. Use appropriate machinery to excavate gravel mulch. Dispose of or reuse mulch elsewhere (e.g. in regular garden beds). Replant existing plants and provide infill planting to ensure at least 6-12 plants/m^2 (depending on species) coverage once established.

Option 3 – Maintain gravel mulch of between 5 and 10mm diameter, to a MAXIMUM of 25mm depth.



4.5 PLANT DENSITIES (SMALL SCALE INFILL PLANTING)

Some raingardens within the City of Port Phillip require infill planting to fill gaps and replace weeds to ensure that design planting densities are maintained.

INSPECTION
Check the following locations for bare areas:

- On the filter media surface
- On the batters (if present)

TRIGGER

- Bare areas where filter media is visible due to vegetation loss
- Plant densities less than 6 plants per m^2. (For some plants, including many rushes and sedges, densities must be up to 12 plant/m^2 to achieve adequate vegetation cover.)

MAINTENANCE ACTION
Option 1 - Replant with species which are growing well in similar conditions in other areas of the raingarden (same proximity to the inlet and same drainage conditions/supporting soil). Commence establishment phase maintenance.

Option 2 - Refer to the original design specifications or natural vegetation communities for that region. Note: Do not replant original design species if reason for initial failure is not understood. Commence establishment phase maintenance.

Option 3 – Replant with Carex appressa, Melaleuca ericifolia, Ficinia nodosa, Juncus amabilis or Juncus flavidus (species that are wide-spread, easily available and have been shown to perform well in street scale WSUD settings, FAWB 2009). Commence establishment phase maintenance.

4.6 WEED/NUISANCE PLANT REMOVAL

An inspection of street scale WSUD assets throughout the City of Port Phillip revealed few assets where weeds were a significant maintenance issue, although a few weeds were present in many of the assets. Weeds and nuisance plants species can impact the aesthetics and function of a raingarden and ideally, these plants should be removed as soon as they appear.

INSPECTION
Check the following:

- Filter media
- Batters

TRIGGER

- Any significant quantity of weeds present
- Any specific invasive weed species present

MAINTENANCE ACTION
Option 1 (preferred) – Hand pull weeds (dispose of appropriately) and provide infill planting for any bare areas (if necessary) with design plants. Weeding should take place before the plants flower to reduce the likelihood of seed dispersal and further regeneration.

Option 2 – Herbicide application using spot spray, or similar targeted approach, only. Herbicide must be approved for use in proximity to waterways. This will minimise the potential impact on desirable species and reduce the likelihood of chemical residuals within the soil profile, or local waterways.

4.7 PLANTS - PRUNING

Pruning is required for vegetation within some of the WSUD assets that were inspected within the City of Port Phillip. Typically, pruning is required to improve aesthetics, promote new growth or manage footpath trip hazards (where vegetation is falling across footpaths). Pruning may also be required for plant health (to remove diseased sections, see next section).

INSPECTION

Check the following to determine pruning requirements:

- Plants on the filter media surface
- Plants on the batters (if present)

TRIGGER

- Unacceptable aesthetics (keeping in mind the profile of the site)
- Any safety hazard (plants overhanging footpaths)
- Any signs of disease

MAINTENANCE ACTION

Prune vegetation using hand tools according to individual species tolerances. In general, prune in early spring, removing 1/3 to 2/3 of the plant height.

4.8 PLANT HEALTH CHECK - DISEASE, PESTS OR POOR GROWTH

An inspection of street scale WSUD assets throughout the City of Port Phillip revealed very few assets where plants were showing signs of disease and pests. A number of WSUD assets contained plants that were in poor condition (or had been lost) due to poor growth, in most circumstances this was due to inappropriate species selection for the hydrology of the zone it was planted in.

INSPECTION
Check the following plants:

- Plants on the filter media
- Plants on the batters

TRIGGER
- Any sign of disease
- Any signs of pests
- Signs of poor growth in more than 10% of plants

MAINTENANCE ACTION
Disease and pests - Prune affected plant matter (or remove entire plants where necessary), treat if appropriate and replant any plants that have been lost or removed.

Plants showing poor growth – determine cause (e.g. environmental pressures such as inappropriate hydrology, inappropriate growing media or unsuitable location (shading etc).

Where there is poor growth in less than 10% of plants – monitor and replace lost plants with more suitable species.

Where there is poor growth in more than 10% of species – see Section 0 for details on rectification works around large scale plant losses.

4.9 FILTER MEDIA – MINOR SURFACE LEVEL ADJUSTMENTS

A number of WSUD assets throughout the City of Port Phillip had uneven surface levels across the filter media. This appeared to be predominantly a result of sediment build up. It is important that the surface of a WSUD asset has a profile that provides a flat surface area with no depressions, mounds or short circuit pathways between the inlet and outlet or overflow, as this can substantially reduce water quality treatment capacity.

INSPECTION
Check the following locations:

- Filter media surface

TRIGGER
- Visible depressions or mounds on the filter media surface

MAINTENANCE ACTION
Re-profile to achieve level surface across base of raingarden.

Minor depressions or mounds can be re-profiled with hand tools, limiting the damage to adjacent vegetation.

If **fill material** is required – use an appropriate raingarden filter media mix.

All affected areas require **replanting** with the design vegetation.

For raingardens, if appropriate, **add an inlet zone** (a small depression at the inlet to a raingarden compromising of large gravel, rocks or a depressed concrete/grassed storage area) to assist in flow velocity reduction (and also helping to concentrate sediment deposition – often making sediment removal simpler).

4.10 FILTER MEDIA - MINOR EROSION OR SCOUR

Erosion is typically caused by high velocity flows, poor vegetation cover, poor soil conditions or a combination. It is important to identify the cause of the erosion before undertaking maintenance works. The surface of a WSUD asset must have a profile that provides a flat surface area with no depressions, mounds or short circuit pathways between the inlet and outlet or overflow, as this can substantially reduce water quality treatment capacity.

INSPECTION
Check the following locations:

- Filter media surface

TRIGGER
- Short circuit pathways visible
- Minor scour or erosion visible

MAINTENANCE ACTION
Re-profile to achieve level surface across base of raingarden.

Minor erosion or scour can be re-profiled with hand tools, limiting the damage to adjacent vegetation.

Short circuit pathways must be re-profiled and revegetated.

If **fill material** is required – use an appropriate raingarden filter media mix.

All affected areas require dense **replanting** with design vegetation (or similar, see Section 4.5).

For raingardens, if appropriate, **add an inlet zone** (a small depression at the inlet to a raingarden compromising of large gravel, rocks or a depressed concrete/grassed storage area) to assist in flow velocity reduction (and also helping to concentrate sediment deposition – often making sediment removal simpler).

If major erosion or scour is observed see Section 5.8.

4.11 BLOCKAGE REMOVAL

Clearing blockages from pits, pipes, inlets & outlets. Blockages of the civil infrastructure components of WSUD assets were more often observed at inlets, and in kerbs and gutters immediately upstream of WSUD assets. Generally consisting of sediment accumulation, leaf litter and rubbish (addressed in earlier sections of this report). However, any blockage that impedes flows into a raingarden, across the surface or down through the filter media must be removed. Blockages result in low flows bypassing the system, substantially reducing the water quality treatment performance and may also result in nuisance flooding during larger event flows. In severe cases, blockage can prevent water reaching plants resulting in plant loss.

INSPECTION

Check the following locations for possible blockages:

- Inlets (kerbs or pipes) directing stormwater to the raingarden.
- Outlets and overflow structures
- Pits (typically associated with outlets and overflow structures)
- Drainage pipes (located under the filter media), blockage may be identified by extended ponding of water on the filter media surface

TRIGGER

- Visible blockage
- Ponded water in kerbs, pits or pipes >12hrs after rainfall

ACTION

Blockages should be removed manually, by hand or with hand tools such as tongs and shovels. Large blockages in pits may require vacuuming or other appropriate machinery.

4.12 VEHICLE DAMAGE

Vehicle damage was observed in a number of street scale raingardens within the City of Port Phillip. Typically, vehicle damage was observed where assets were located on tight street corners or in locations where vehicles were frequently pulling aside (e.g. taxis). If vehicle damage is an ongoing issue, then corrective maintenance is required (Section 5.12).

INSPECTION
Check the following locations for damage:

- Edges of filter media
- Batters
- Kerbs

TRIGGER

- Compaction of filter media
- Plant loss

ACTION
Ensure vehicle access is not an ongoing issue that requires traffic management (bollards etc). Loosen/till top 100mm of soil. Replant at densities >6 plants/m^2 and protect during establishment phase.

4.13 PEDESTRIAN DAMAGE

Pedestrian damage was observed in a few street scale raingardens within the City of Port Phillip. Pedestrian damage is typically due to foot traffic through the raingarden, causing compaction and plant loss. If pedestrian damage is an ongoing issue, then corrective maintenance is required (see Section 5.12).

INSPECTION

Check the following locations for damage:

- Filter media
- Batters

TRIGGER

- Compaction of filter media
- Plant loss

ACTION

Ensure pedestrian access is not an ongoing issue that requires corrective maintenance (preventing access through fences or redirecting natural pedestrian routes). Loosen/till top 100mm of soil. Replant with plants likely to deter access (tall, robust with dense foliage) at densities >6 plants/m^2 and protect during establishment phase.

5 Corrective Maintenance: Rectification & Re-setting

If the need for corrective maintenance is identified during regular inspections then further investigation (internally or externally) must be undertaken. In many instances, expert opinion should be sought to ensure appropriate remediation measures are implemented. In most cases, when appropriate remediation measures are implemented, corrective maintenance should not be ongoing and the asset will only require ongoing simple maintenance activities as set out in Section 4 – Planned maintenance.

The advice below is intended as a guide to assist in investigating causes, and likely remedies, for raingardens where major issues (requiring corrective maintenance) have been identified. The discussions below are principally based on what was observed during the site inspections of assets across the City of Port Phillip.

5.1 NO OR INSUFFICIENT PONDING DEPTH (OUTLET STRUCTURE TOO LOW, FILTER MEDIA TO HIGH, SEDIMENT ACCUMULATION REDUCING PONDING DEPTH)

ISSUE: Water quality treatment capacity is significantly affected if design ponding depth is not available. Designs vary but typically 200mm ponding is required.

LIKELY CAUSES: Design issue, construction error (pit constructed low or filter media installed too high), sediment accumulation.

POSSIBLE MITIGATION MEASURES:

- Install a lip around the outlet pit to increase the ponding depth before the outlet structure is engaged
- Reduce the depth of the filter media (providing this will not result in <500mm filter depth)
- Remove sediment accumulation (see Section 5.11)

5.2 STANDING WATER ON SURFACE >12 HOURS AFTER RAINFALL

ISSUE: Standing water indicates impeded drainage through the filter media and therefore reduced water quality treatment capacity.
LIKELY CAUSES: High groundwater in the area around the raingarden or poor sub-soil infiltration rate (if unlined and designed to infiltrate), blockage of the filter media (clay layer, fine sediment etc), blockage in the underdrain.

POSSIBLE MITIGATION MEASURES:
Mitigation measures must be tailored to individual sites after full investigation of the causes and possible solutions.

However, some solutions may include:

- Investigation of surrounding groundwater conditions (seasonally high groundwater should be at least 0.5 m below the base of the drainage layer)
- Redesign of drainage pathways and outlet structures
- If media is clogged, scraping and replacement of top 100 mm of filter media or complete replacement of filter media material (See 5.11 further details)
- High pressure cleaning of underdrain

5.3 LARGE SCALE PLANT LOSS

ISSUE: Plants are a critical component of the functional performance of raingardens, especially in terms of stormwater treatment performance. They are also critical for long term raingarden aesthetics – an important factor for inner city and suburban streetscape raingardens. High plant densities significantly reduce the impacts (and therefore maintenance requirements) of leaf litter accumulation, weed growth and clogging as a result of clay or fine sediment build-up.

LIKELY CAUSES: Unsuitable species selection, inadequate planting, poor establishment phase maintenance, unsuitable filter media material (low water holding capacity), monoculture design, poor quality plant stock.

POSSIBLE MITIGATION MEASURES:

- Replanting and providing establishment phase program including monitoring, weeding, infill planting and irrigation if required
- Amendment of filter media to increase water holding capacity where soil moisture is identified as being deficient (the most common cause of large scale plant loss)
- Redesign of outlet structures to create a submerged zone, increasing water available to plants
- Review of plant species selection for given site conditions and hydrology
- Increase plant species diversity to provide a more robust design.

5.4 SIGNIFICANT LOSS OF A PARTICULAR SPECIES

ISSUE: High plant densities across the entire filter media surface are critical for maintaining infiltration capacity of the filter media, reducing impacts of erosion and weeds, providing water quality treatment.

LIKELY CAUSES: Inappropriate species selection, poor quality plant stock

POSSIBLE MITIGATION MEASURES:

- Review species selection and replant with plants species more suitable for the inundation conditions (i.e. wet conditions near the inlet, and dry conditions near the outlet and on the batter slopes)
- Review suitability of species for raingardens in Victoria

5.5 TREE LOSS

ISSUE: Trees loss reduces the aesthetics of raingardens as well as compromising water quality treatment performance.

LIKELY CAUSES: Inappropriate species for the hydrologic conditions

POSSIBLE MITIGATION MEASURES:

- Select a tree species more appropriate for the wetting and drying conditions within the raingarden
- Review the placement of the tree within the raingarden.

5.6 LOSS OF ALL PLANTS IN A PARTICULAR ZONE/AREA

ISSUE: High plant densities across the entire filter media surface are critical for maintaining infiltration capacity of the filter media, reducing impacts of erosion and weeds and providing water quality treatment.

LIKELY CAUSES: Inappropriate species selection, changed hydrologic conditions

POSSIBLE MITIGATION MEASURES:

- Review species selection and replant with plants species more suitable for the inundation conditions (e.g. wet tolerant species for wet conditions near the inlet, and drought tolerant species for dry conditions near the outlet and on batters)

5.7 NO INFLOWS (INLET TOO HIGH, LOW FLOWS BYPASS RAINGARDEN)

ISSUE: Water quality treatment capacity is significantly affected if low flows are not directed onto the filter media surface.

LIKELY CAUSES: Design issue, construction error (levels)

POSSIBLE MITIGATION MEASURES:

- Reduce level of inlet if it presents a barrier to inflow
- Reduce the depth of the filter media (providing this will not result in <500mm filter depth)

5.8 SIGNIFICANT SEDIMENT BUILD UP OR SCOUR AT INLET

ISSUE: Significant sediment or scour at the inlet can reduce inflows by causing bypass or prevent water from spreading evenly across the raingarden surface (both of which reduce water quality treatment capacity).

LIKELY CAUSES: Large catchment, severe storm event, poor velocity control at the inlet, lack of grade at inlet

POSSIBLE MITIGATION MEASURES:

- Remove plants as needed and set aside. Remove sediment and gravel mulch, repair any erosion or scour, ensure filter media surface level provides design ponding depth (100 – 300 mm typically). Undertake hydraulic conductivity testing to confirm infiltration rates. Replace plants at 6-12 plants/m^2, providing infill planting if required.
- Consider installing sediment forebay (a small depression at the inlet to a raingarden compromising of large gravel or rocks, a depressed concrete area or grassed zone) to assist in velocity control and concentrating sediment deposition.
- Install rocks or concrete apron to dissipate flows through high velocity zone

5.9 MAJOR EROSION OR SCOUR OF THE FILTER MEDIA

ISSUE: Significant erosion or scouring of the filter media surface can reduce inflows by causing bypass or prevent water from spreading evenly across the raingarden surface (both of which reduce water quality treatment capacity).

LIKELY CAUSES: Poor velocity control, damage during a severe storm event, inadequate plant densities

POSSIBLE MITIGATION MEASURES:

- Provide velocity reduction at the inlet (i.e. install sediment forebay or split/disperse inflows by creating multiple inlet points)
- Plant erosion or scour area densely
- Split or disperse flow by creating multiple small inlets

5.10 PREFERENTIAL FLOW PATH DEVELOPING BETWEEN INLET AND OUTLET

ISSUE: Short circuit pathways (between the inlet and outlet) can prevent water from spreading evenly across the raingarden surface and result in bypass (both of which reduce water quality treatment capacity).

LIKELY CAUSES: Poor velocity control, damage during a severe storm event, inadequate plant densities

POSSIBLE MITIGATION MEASURES:

- Provide velocity reduction at the inlet (i.e. install sediment forebay)
- Remove any sediment build-up and re-profile any depressions in the filter media surface. Use hand tools to minimise damage to existing plants. Replant scour area with design plant species and high plant densities (6-12 plants/m^2).

5.11 FINE SEDIMENT OR CLAY ON FILTER MEDIA SURFACE (SUBSTANTIAL VOLUME)

ISSUE: Significant sediment or clay on the filter media can result in clogging of the filter media, leading to bypass or prevent water from spreading evenly across the raingarden surface (both of which reduce water quality treatment capacity). Significant build up is likely to require corrective maintenance if it is deeper than 20mm or covers more than 60% of the surface area of the raingarden.

LIKELY CAUSES: Construction in catchment, unusual catchment characteristics, spill or other one-off episode, long term accumulation of sediment or fine material imported with the gravel mulch.

POSSIBLE MITIGATION MEASURES:

- Remove existing plants and store appropriately. Use hand tools or appropriate machinery to scrape off the top 100mm of filter media. Undertake in-situ hydraulic conductivity testing. If underlying filter media retains design infiltration rate (or similar, hydraulic conductivity tests typically have an accuracy of ± 50%), replace top 100mm with appropriate filter media material. If drainage rate not adequate, determine whether complete reset is required (replacement of entire depth of filter media). Dispose of or reuse mulch elsewhere (e.g. in regular garden beds). Replant existing plants and provide infill planting to ensure at least 6-12 plants/m^2 (depending on species) coverage once established.
- Monitor sediment accumulation every three months after rectification to identify any ongoing high sediment loads.

5.12 VISIBLE COMPACTION DUE TO PEDESTRIAN OR VEHICULAR TRAFFIC

ISSUE: When WSUD street scale assets are persistently impacted by traffic or pedestrian damage (e.g. compaction of the filter media and plant loss) those areas of the asset are no longer functional.

LIKELY CAUSES: raingarden located in natural vehicular or pedestrian route, tight street corners

POSSIBLE MITIGATION MEASURES:

- Vehicles:
  - Redesign such as reshaping kerbs and rounding off corners of street scale assets to provide more room for traffic.
  - Installation of bollards to restrict access
- Pedestrians:
  - Preventing access (i.e. dense tall planting, installing fences or other barriers)
  - Redirecting natural pedestrian routes (wider footpaths, revising or clearly marking parking locations, installing boardwalks etc)

5.13 EXCESS GROWTH OF ALGAE OR MOSS (>20% OF THE SURFACE AREA)

ISSUE: Substantial algal growth on the surface of the filter media can form a crust and impede drainage through the filter media, subsequently reducing the water quality treatment capacity.

LIKELY CAUSES: shading from overhead trees, insufficient plant densities within the raingarden, poor drainage or continuous inflows.

POSSIBLE MITIGATION MEASURES:

- Reduce overhead shading
- Increase plant densities within the raingarden (i.e. 6 -12 plant/m^2)
- Improve drainage through the filter media (i.e. replace filter media, remove pipe blockages)
- Identify sources of continuous flows (such as regular irrigation overfill in catchment or basement pumping etc)

5.14 IRRIGATION PIPES PRESENT OR TREE STAKES REMOVED (CAUSING SHORT CIRCUIT PATHWAY)

ISSUE: Tree stakes are often used to support young trees planted into the filter media of raingardens or tree pits. Once the trees are adequately established the stakes are removed and the holes can create a short circuit pathway for stormwater (avoiding treatment that occurs as it filters down through the filter media and plant roots).

LIKELY CAUSES: Stakes removed after trees established

POSSIBLE MITIGATION MEASURES:

- Fill holes with suitable filter media (lightly compacted).

5.15 DAMAGE TO PITS, PIPES OR GRATES

ISSUE: Damage to civil infrastructure

LIKELY CAUSES: Vehicle impact, vandalism

POSSIBLE MITIGATION MEASURES:

- Identify likely cause of damage and opportunities to reduce re-occurrence, e.g. re-shape kerb corner to reduce likelihood of traffic impact if will not affect treatment function of WSUD asset
- Repair damage

5.16 LARGE GRAVEL MULCH >10MM DIAMETER OR GRAVEL MULCH >25MM DEPTH

ISSUE: Gravel mulch has two key drawbacks, as identified at some sites across the City of Port Phillip:

1. It can make sediment removal challenging. If fine sediment or clay washes in from the catchment, it accumulates between the gravel particles and then the task of sediment removal is more laborious because the gravel mulch must be removed and washed or replaced.
2. It restricts the growth and spread of the desired plant species (often due to heat trapped by the gravel).

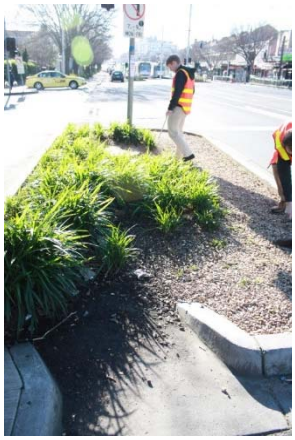
LIKELY CAUSES: Designed for weed control

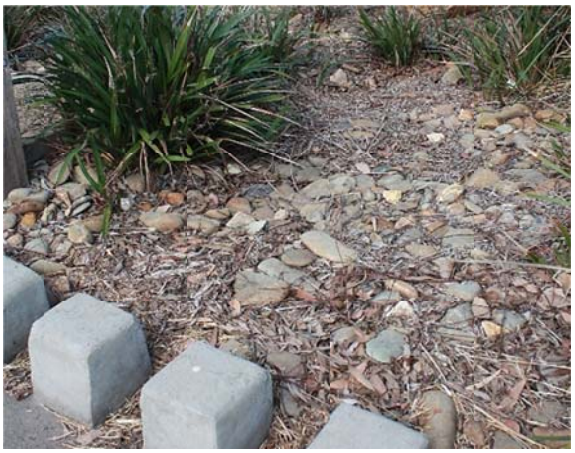
POSSIBLE MITIGATION MEASURES:

Option 1 (preferred) – Remove gravel with hand tools from around plants. Do not replace gravel mulch. Provide infill planting to ensure at least 6-12 plants/m^2 (depending on species) coverage once established.

Option 2 – Remove existing plants and store appropriately. Use appropriate machinery to excavate gravel mulch. Dispose of or reuse mulch elsewhere (e.g. in regular garden beds). Replant existing plants and provide infill planting to ensure at least 6-12 plants/m^2 (depending on species) coverage once established.

Option 3 – Maintain gravel mulch of between 5 and 10mm diameter, to a MAXIMUM of 25mm depth. Ensure desired planting densities are achieved and provide infill planting if necessary.





6 Safety and access

6.1 OCCUPATIONAL HEALTH AND SAFETY

Working on streetscape systems can potentially be a dangerous activity and personnel should therefore be appropriately trained before undertaking maintenance work. Weather forecasts should always be reviewed before undertaking maintenance activities. Maintenance staff should be wearing PPE equipment appropriate to their task or activity and consistent with Council Guidelines. Exposure to traffic should be avoided and traffic management measures used where appropriate. Staff should always face towards on-coming traffic when inspecting or working on assets in proximity to open traffic lanes.

Up-to-date "Dial Before You Dig" records should be sought and maintenance staff should be aware of the location of existing services (i.e. sewer mains, power, communications). These services need to be appropriately protected before maintenance commences.

6.2 PUBLIC SAFETY

If an activity is likely to pose a risk public safety then access to the work area should be appropriately screened to restrict public access.

7 Appendix A – Inspection Template

City of Port Phillip - Streetscape WSUD

Inspection checklist - Planned and Corrective Maintenance

Site location: Fitzroy Street | Asset name: Rain garden 9

Date | WSUD Type | Inspected by

Weather | Date of last rainfall

Maintenance type		Item	Performance target	Mark if observed				Inspected Y/N	Maintenance required Y/N	Additional comments
Planned Maintenance	Landscape	Surface and batters	*Free from sediment, rubbish or leaf litter that may alter flows, reduce drainage or reduce ponding depth*	4.1 RUBBISH (Trigger: blockage or aesthetic issue)	4.2 LEAF LITTER (Trigger: wet/decaying leaf matter or aesthetics)	4.3 SEDIMENT ACCUMULATION (Trigger: >10% of surface area, impeding inflows or forebay >80% full)	4.4 GRAVEL MULCH (Trigger: clay / fine sediment build up, restricting plant growth)			
		Plants	*Dense stands of healthy growing plants (6-12 plants/m2 - depending on species)*	5.4 PLANT DENSITIES (Trigger: visible bare areas or densities <6 plants/m2)	4.6 WEEDS OR NUISANCE PLANTS (Trigger: any present)	4.7 PRUNING (Trigger: unacceptable aesthetics, safety hazard or signs of plant disease)	4.8 DISEASE, PESTS OR POOR GROWTH (Trigger: signs of disease or pests, poor growth in >10% of plants)			
		Filter media (levels)	*Lightly compacted, level surface with no depressions, erosion/scour*	4.9 UNEVEN SURFACE LEVEL (Trigger: visible depressions, short circuiting)	4.10 MINOR SCOUR OR EROSION (Trigger: impeding flow)					
	Civil	Surrounding kerbs and channels	*Free from litter or sediment build up, undamaged*	4.11 RUBBISH OR LEAF LITTER (Trigger: causing blockage or aesthetic issue)	4.3 SEDIMENT ACCUMULATION (Trigger: impeding flow)					
		Inlet (entry from kerb or pipe)	*Free from litter or sediment build up, undamaged*	4.11 RUBBISH OR LEAF LITTER (Trigger: causing blockage or aesthetic issue)	4.3 SEDIMENT ACCUMULATION (Trigger: impeding flow)	4.10 SCOUR (Trigger: impeding flow paths)	4.3 SEDIMENT FOREBAY (Trigger: >80% full)			
		Outlet pits & Overflow structures	*Free from litter or sediment build up, undamaged*	4.11 RUBBISH OR LEAF LITTER (Trigger: causing blockage or aesthetic issue)	4.3 SEDIMENT ACCUMULATION (Trigger: impeding flow)	4.11 BLOCKAGE (Trigger: visible blockage, ponded water >12hrs after rain)				
		Bollards and kerbs	*Free from damage*	4.12 VEHICLE DAMAGE (Trigger: compaction, plant loss)						
		Under drains	*Freely draining, undamaged*	4.11 BLOCKAGE (Trigger: visible blockage, ponded water >12hrs after rainfall)						
		Batters	*Free from erosion or damage & typically densely planted*	4.12 VEHICLE DAMAGE (Trigger: compaction, plant loss)	4.13 PEDESTRIAN DAMAGE (Trigger: compaction, plant loss)	4.10 EROSION (Trigger: visible channels)				
Corrective Maintenance Corrective maintenance (including further investigation) is required if any of these conditions are observed.		**Checklist for corrective maintenance**								
				5.1 No or insufficient ponding depth						
				5.2 Standing water on surface >12 hrs after rainfall						
		Plants	*Dense stands of healthy growing plants (6-12 plants/m2 - depending on species)*	**5.3 Large scale plant loss**						
				5.4 Significant loss of a particular species						
				5.5 Tree loss						
				5.6 Loss of all plants in a particular zone/area						
		Inlet areas (entry from kerb or pipe)	*Low flows freely drain on to filter media surface*	**5.7 No inflows (Inlet too low/filter media surface level too high)**						
				5.8 Significant sediment build up or scour at inlet						
		Filter media	*Lightly compacted, level surface with no depressions, no litter, no damage, freely draining, no erosion/scour*	**5.9 Major erosion or scour of the filter media**						
				5.10 Preferential flow path developing between inlet and outlet						
				5.11 Fine sediment on surface (greater than 20mm depth or more than 60% surface area)						
				5.12 Visible compaction due to pedestrian or vehicular traffic						
				5.13 Excess growth of algae or moss (>20% of the surface area)						
				5.14 Irrigation pipes present or tree stakes removed (causing short circuit pathway)						
		Inlets, outlets, underdrain	*Free from damage*	**5.15 Damage to pits, pipes or grates**						
		Mulch	*No mulch or gravel mulch <50mm*	**5.16 Large gravel mulch >10mm diameter or gravel mulch > 25mm depth**						
									Priority ranking	
PRIORITY		Loss of WQ Treatment		HIGH / MEDIUM / LOW - Higher score assigned to systems where maintenance was needed to rectify issues impacting the water quality treatment function of systems (e.g. a blocked inlet would be a higher priority than litter scattered within a system)						
		Simplicity of Works		HIGH / MEDIUM / LOW - Higher score given to works that can be easily and/or cheaply completed						
		Safety Risk		HIGH / MEDIUM / LOW - Where a potential safety risk was identified this was given a high (significant risk) or medium (minor risk), all other sites were rated low						

Figure 2 Simplified Inspection Template