FAWB
Facility for Advancing
Water Biofiltration

Raingardens and Bioretention Tree Pits MAINTENANCE PLAN

EXAMPLE

June 2008

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1 RAINGARDEN AND BIORETENTION TREE PIT FUNCTIONS

This is a sample maintenance plan only. When preparing a maintenance plan for a specific site, consideration should be given to the individual site requirements to ensure all the elements within a particular design are incorporated in to the plan.

A sketch or drawing should be provided (as seen in Figure 1) to help maintenance personnel and asset managers understand the function and features of a particular asset. The drawing should provide enough information about the function of a system to enable appropriate management/maintenance decisions to be made.

Raingardens and bioretention tree pits are designed with the primary intent of removing pollutants from stormwater before the water is discharged to the local waterway or reused. Commonly, stormwater runoff enters the raingarden or bioretention tree pit through a break in a standard road kerb and is filtered through the soil media as it infiltrates. Treated stormwater is then collected at the base of the raingarden or bioretention tree pit via perforated pipes located within a gravel drainage layer before being discharged into conventional stormwater pipes or collected for reuse. In most designs the conventional stormwater pipes also act as an overflow, taking flows that exceed the design capacity of the raingarden or bioretention tree pits.

The inclusion of raingardens or bioretention tree pits into the stormwater drainage system does not affect other conventional drainage elements. Stormwater discharge that exceeds the capacity of the raingarden or bioretention tree pit may continue down the kerb to be collected in a conventional side entry pit or may overflow into a pit located within the raingarden that is directly connected to the conventional drainage system.

Raingardens and bioretention tree pits provide stormwater treatment as well as landscape amenity. An additional benefit is that the passive irrigation from stormwater reduces the demand for irrigation from other sources such as potable water.

The tree and/or understorey species need to be relatively hardy, tolerant of freely draining sandy soils and regular inundation. The filter media into which the trees are planted has a specified hydraulic conductivity (generally between 100 – 400 mm/hr depending on the local climate and the configuration of the system). The understorey (or groundcover) vegetation reduces the likelihood of clogging at the surface of the tree pit.

Figure 1 illustrates the intended flow pathways for stormwater through a typical raingarden/bioretention tree pit and shows some of the subsurface infrastructure that requires consideration for maintenance.

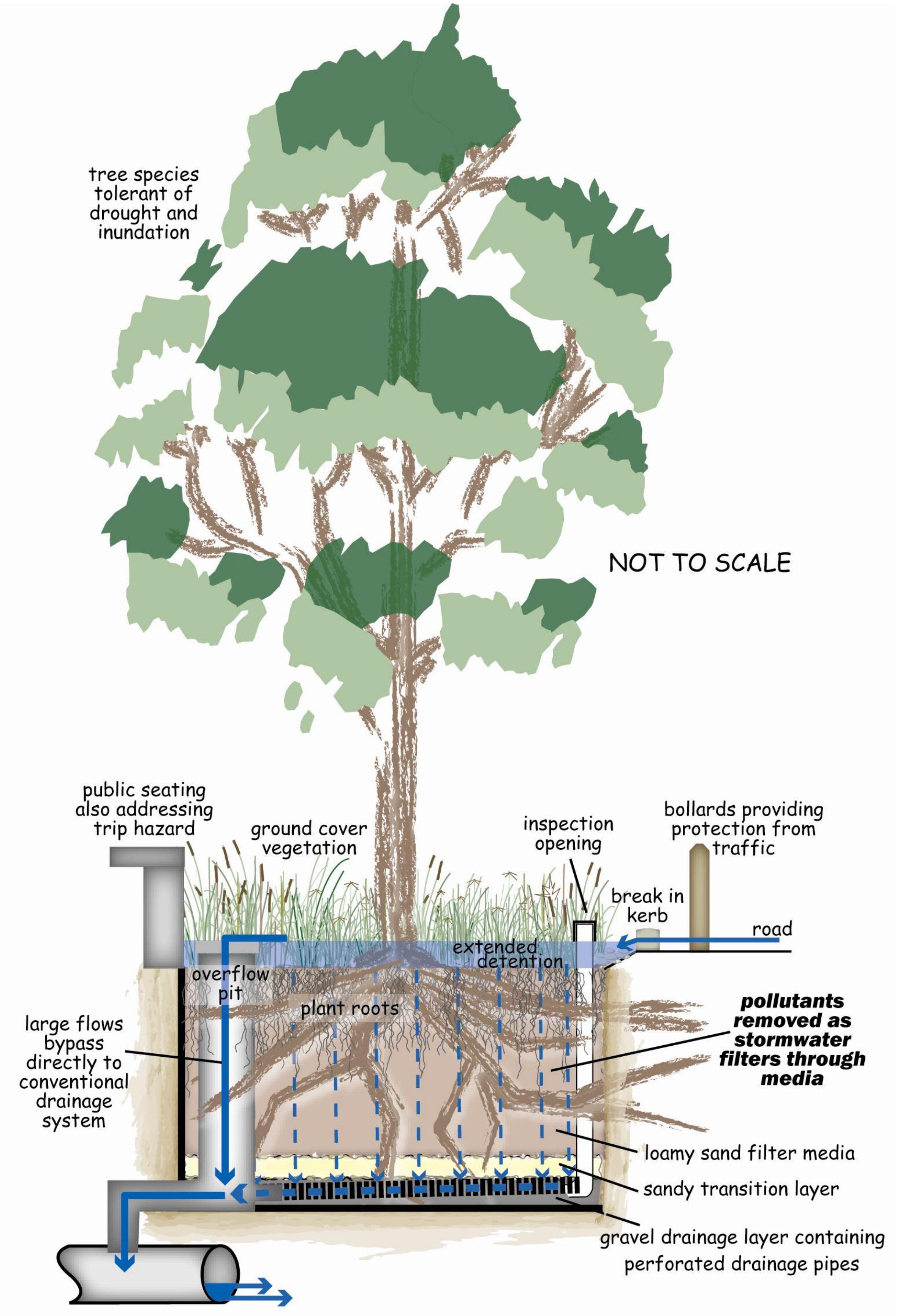

Figure 1. Concept illustration of a raingarden or bioretention tree pit illustrating stormwater flow pathways and subsurface infrastructure requiring maintenance

2 MINIMISING LONGTERM MAINTENANCE

Three key elements in the design and construction of raingardens and bioretention tree pits have been identified that strongly influence the amount of long term maintenance that is required. Adequately addressing these three key elements ensures that the long term maintenance of these systems is predictable, and therefore minimal. The elements are:

- Correct filter media specification and installation
- Dense vegetation cover
- Protection during construction phases

The importance of these key elements is described in more detail below.

2.1 Filter media

The filter media for the raingarden or bioretention tree pit must meet certain specifications. It is crucial that the filter media installed maintains its hydraulic conductivity (i.e. it's ability to pass water through the media) in the long term. When an inappropriate filter media is installed (e.g. it contains high levels of fine silt + clay materials) it may result in compaction or even structural collapse of the media. This leads to a substantial reduction in the treatment capacity of the system because water will not filter through the media but will pond on the surface instead and spill out through the overflow. A symptom of this compaction is often the loss of vegetation within the raingarden or tree pit.

Similarly, the filter media must be correctly installed with an appropriate level of compaction during installation. Guidelines currently recommend that filter media be lightly compacted during installation to prevent migration of fine particles. In small systems, a single pass with a vibrating plate should be used to compact the filter media, while in large systems, a single pass with roller machinery (e.g. a drum lawn roller) should be performed (FAWB 2008).

2.2 Vegetation cover

Nutrients have been identified as a key pollutant in stormwater, particularly nitrogen and phosphorus. The nutrient removal efficiency of raingardens and bioretention tree pits is related to the root structure and density of the plants within the system. Early analysis carried out by FAWB suggests that dense fibrous roots provide the most efficient pollutant removal. Further, as plants mature and their roots penetrate the filter media they play a role in maintaining the hydraulic conductivity of the media. Root growth helps to maintain the surface porosity and the infiltration capacity of the filter media. As a result, it is important that dense vegetation cover is established at an early stage to prevent compaction or surface sealing by promoting extensive root penetration. Some bioretention tree pits are designed without understorey vegetation. In these instances, it is likely that additional maintenance will be required to maintain the porosity of the surface of the filter media (e.g. physical removal of any fine sediments accumulating on the surface).

2.3 Protection during construction phases

Protection of raingardens and bioretention tree pits during construction allows for good plant establishment and prevents disturbance or scour of the filter media surface. It is also important to protect the raingarden and bioretention tree pits from heavy sediment loads, or other wash off (e.g. cement washings), during any construction in the catchment to prevent clogging of the surface of the filter media. See Section 3 for more detail.

3 ESTABLISHMENT PHASE MAINTENANCE

A number of maintenance activities have been identified that are, in most cases, only required during the establishment phase of a raingarden or tree pit. The end of the establishment phase can be defined by the completion of both of the following:

(i) The plant establishment – where plants are suitably established to no longer require irrigation and are close to their mature height and/or when larger trees no longer require tree stakes for support. This period is typically 18 to 24 months.

(ii) The raingarden or tree pit is completely connected to its intended catchment and the catchment is no longer under construction (therefore there is less risk of high sediment loads or other contaminants, such as cement washings or fine clay sediments, being washed onto the surface of the filter media and causing clogging). It is also important that the entire catchment is connected to ensure adequate water availability for plants under normal climatic conditions.

3.1 Protection of filter media during construction

Construction sites usually generate very high loads of sediment in stormwater runoff. These exceptionally high loads can cause the filter media within a raingarden or tree pit to become clogged or blocked. Blockage may occur as a result of the accumulation of fine sediment on the surface; this can sometimes be manually removed. Accumulation of fine sediment may also occur in a layer deeper within the filter media, usually resulting in the need to remove and replace the filter media.

To protect the filter media while construction activities are occurring in the catchment, at least one of the following precautions should be taken:

1. Keep the raingarden or tree pit off-line during this period to prevent any stormwater entering- Note: adequate alternative sediment control measures must also be installed during construction to prevent heavy sediment loads being discharged directly to the stormwater system while the raingarden or tree pit is off-line.

2. Delay final landscaping and protect system by covering the entire bioretention surface with geofabric (and turf or gravel if desired for aesthetic purposes) as shown in Figure 2 (left).

3. Temporarily partition the bioretention system, creating a sacrificial sediment forebay. This allows the vegetation to establish in the rest of the system while the sacrificial sediment forebay at the inlet is protected using geofabric and turf as described above and shown in Figure 2 (right). This approach is best suited when the over flow pit is located close to the inlet zone.

Figure 2. Protection of filter media with a geofabric and turf cover (left) and use of a sacrificial sediment forebay during construction and plant establishment (right).

3.2 Irrigation

Plants and trees in raingardens and tree pits will probably require irrigation during the establishment phase. Irrigation should be applied directly to the surface of the filter media. The use of Ag pipes for irrigating young trees is not recommended as it creates a short circuit pathway, or preferential flow path, for stormwater. As illustrated in Figure 3, the stormwater flows straight down the Ag pipes and into the drainage layer at the base where it is conveyed downstream to the conventional stormwater system, effectively bypassing any pollutant removal processes that occur as the stormwater filters through the soil media.

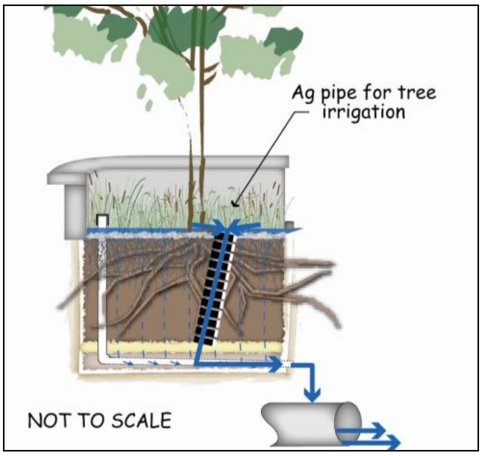

Figure 3. Concept illustration showing how Ag pipes installed for tree watering can result in short circuiting and reduced stormwater treatment.

3.3 Tree stake removal

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 should be removed and the holes filled in with filter media. Failure to fill in the holes will result in the creation of a short circuit pathway, or preferential flow path, for stormwater. Instead of ponding on the surface of the raingarden, the holes left behind after the stakes are removed allow water to bypass the filter media and drain directly into the drainage layer at the base of the cell, effectively bypassing any pollutant removal processes.

4 LONG TERM MAINTENANCE TASKS

4.1 Schedule of visits

4.1.1 Schedule of Site Visits (Regular Inspec & Maint)	
Purpose of visit	Frequency
Inspection	Regular inspection and maintenance should be carried out to ensure the system functions as designed. It is recommended that these checks be undertaken on a three monthly basis during the initial period of operating the system. A less frequent schedule might be determined after the system has established.
Maintenance	

4.2 Tasks

The scope of maintenance tasks should include verifying the function and condition of the following elements:

- Filter media
- Horticultural
- Drainage infrastructure
- Other routine tasks

4.2.1 FILTER MEDIA TASKS	
Sediment deposition	Remove sediment build up from forebays in raingardens and from the surface of bioretention street trees. **Frequency – 3 MONTHLY AFTER RAIN**
Holes or scour	Infill any holes in the filter media. Check for erosion or scour and repair, provide energy dissipation (e.g. rocks and pebbles at inlet) if necessary. **Frequency – 3 MONTHLY AFTER RAIN**
Filter media surface porosity	Inspect for the accumulation of an impermeable layer (such as oily or clayey sediment) that may have formed on the surface of the filter media. A symptom may be that water remains ponded in the raingarden or tree pit for more than a few hours after a rain event. Repair minor accumulations by raking away any mulch on the surface and scarifying the surface of the filter media between plants. For bioretention tree pits without understorey vegetation, any accumulation of leaf litter should be removed to help maintain the surface porosity of the filter media. **Frequency – 3 MONTHLY AFTER RAIN**
Litter Control	Check for litter (including organic litter) in and around treatment areas. Remove both organic and anthropogenic litter to ensure flow paths and infiltration through the filter media are not hindered. **Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**

4.2.2 HORTICULTURAL TASKS	
Pests and Diseases	Assess plants for disease, pest infection, stunted growth or senescent plants. Treat or replace as necessary. Reduced plant density reduces pollutant removal and infiltration performance. **Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
Maintain original plant densities	Infill planting: Between 6 and 10 plants per square metre should (depending on species) be adequate to maintain a density where the plant's roots touch each other. Planting should be evenly spaced to help prevent scouring due to a concentration of flow. **Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
Weeds	It is important to identify the presence of any rapidly spreading weeds as they occur. The presence of such weeds can reduce dominant species distributions and diminish aesthetics. Weed species can also compromise the systems long term performance. Inspect for and manually remove weed species. Application of herbicide should be limited to a wand or restrictive spot spraying due to the fact that raingardens and bioretention tree pits are directly connected to the stormwater system. **Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
4.2.3 DRAINAGE TASKS	
Perforated pipe	Ensure that perforated pipes are not blocked to prevent filter media and plants from becoming waterlogged. A small steady clear flow of water may be observed discharging from the perforated pipe at its connection into the downstream pit some hours after rainfall. Note that smaller rainfall events after dry weather may be completely absorbed by the filter media and not result in flow. Remote camera (e.g. CCTV) inspection of pipelines for blockage and structural integrity could be useful. **Frequency – 6 MONTHLY AFTER RAIN**
High flow inlet pits, overflow pits and other stormwater junction pits	Ensure inflow areas and grates over pits are clear of litter and debris and in good and safe condition. A blocked grate would cause nuisance flooding of streets. Inspect for dislodged or damaged pit covers and ensure general structural integrity. Remove sediment from pits and entry sites etc. (likely to be an irregular occurrence in mature catchment). **Frequency – MONTHLY AND OCCASIONALLY AFTER RAIN**
4.2.4 OTHER ROUTINE TASKS	
Inspection after rainfall	Occasionally observe raingarden or bioretention tree pit after a rainfall event to check infiltration. Identify signs of poor drainage (extended ponding on the filter media surface). If poor drainage is identified, check landuse and assess whether is has altered from design capacity (e.g. unusually high sediment loads may require installation of a sediment forebay). **Frequency – TWICE A YEAR AFTER RAIN**

4.2.5 FORM (REGULAR INSPECTION & MAINTENANCE)			
Location	**Raingarden/Tree Pit**		
Site Visit Date:		Site Visit By:	
Weather:			
Purpose of the Site Visit	Routine Inspection	☐	Complete section 1 (below)
	Routine Maintenance	☐	Complete sections 1 and 2 (below)

NOTE: Where maintenance is required ('yes' in Section 2), details should be recorded in the 'Additional Comments' section at the end of this document.

1. Filter media				
***In addition to regular inspections, it is recommended that inspection for damage and blockage is made after significant rainfall events that might occur once or twice a year.**	Section 1		Section 2	
	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Filter media (*CIRCLE* – pooling water/accumulation of silt & clay layer/scour/holes/sediment build up)	☐	☐	☐	☐
Litter (*CIRCLE* – large debris/accumulated vegetation/anthropogenic)	☐	☐	☐	☐
2. Vegetation				
Vegetation health (*CIRCLE* – signs of disease/pests/poor growth)	☐	☐	☐	☐
Vegetation densities (*CIRCLE* – low densities– infill planting required)	☐	☐	☐	☐
Build up of organic matter, leaf litter (*CIRCLE* – requires removal) **BIORETENTION TREE PITS ONLY**	☐	☐	☐	☐
Weeds (*CIRCLE* – isolated plants/infestation) (*SPECIES* – ....)	☐	☐	☐	☐

3. Pits, pipes and inflow areas				
	Section 2		**Section 3**	
	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Perforated pipes (*CIRCLE* – full blockage/partial blockade/damage)	☐	☐	☐	☐
Inflow areas (*CIRCLE* – scour/excessive sediment deposition/litter blockage)	☐	☐	☐	☐
Over flow grates (*CIRCLE* – damage/scour/blockage)	☐	☐	☐	☐
Pits (*CIRCLE* – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐
Other stormwater pipes and junction pits (*CIRCLE* – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐

4. Additional Comments

5 REFERENCES

FAWB (2008) *Guidelines for Soil Filter Media in Bioretention Systems* (Version 2.01), published by the Facility of Advancing Water Biofiltration, March 2008, Available: http://www.monash.edu.au/fawb/publications/index.html