BEDP ENVIRONMENT DESIGN GUIDE

WATER SENSITIVE URBAN DESIGN IN THE MELBOURNE DOCKLANDS – RAINGARDENS AND BIORETENTION TREE PITS

Kerrie Burge, Robin Allison, Tony Wong, Peter Breen

This paper describes Water Sensitive Urban Design (WSUD) initiatives in Melbourne Docklands and outlines experiences from design, construction and operational phases. Additionally, it captures learnings that have occurred as a result of these experiences. It is hoped these experiences can be used to further inform design, construction and operation of WSUD in either subsequent stages of Melbourne Docklands as well as more broadly.

This paper is one of a series of papers that explain the case study. Refer also to the companion papers: CAS 46: Water Sensitive Urban Design in the Melbourne Docklands – An Overview *and* CAS 48: Water Sensitive Urban Design in the Melbourne Docklands – Wetlands, Storage and Reuse System.

Keywords
bioretention swales, raingardens, bioretention tree pits, Water Sensitive Urban Design, water storage, water reuse, wetlands, WSUD

1.0 INTRODUCTION

Melbourne Docklands is a 200 hectare urban renewal project of premium mixed use development in the heart of Melbourne. The redevelopment of the site provided opportunities to incorporate WSUD into a large scale urban development at a variety of scales including regional, local precinct and individual site. The variety of WSUD elements that have been incorporated into the design include passive tree watering, bioretention systems (raingardens and tree pits as described in section 2.0 and 3.0 of this paper), wetlands and stormwater storage and reuse systems (as described in CAS 48).

The Melbourne Docklands currently boasts a wide range of different WSUD elements. The WSUD measures were, in many cases, the first of their kind to be integrated into such an urban setting. Due to the fact that these were often new designs, and had not been implemented in such a setting previously in Australia, there were lessons learned during the design, construction and operation of these systems that these papers aim to outline. The intent is that documenting the design evolution and the lessons learned relating to the implementation of these devices can provide useful information for future developments.

In part due to the extended time frame of WSUD implementation across the site (over many years), as well as VicUrban's support of innovation, many of the lessons learned (as described in this paper) have influenced the design, construction and operation of other WSUD elements on the site. In this way, the Melbourne Docklands site has greatly supported the evolution in the design, construction and operation of WSUD elements in a highly urban setting. The implementation of the lessons learned that are described in this paper, during future works, have resulted in a much more streamlined delivery of WSUD elements.

As a result of the successful implementation of WSUD across the Melbourne Docklands site, all stormwater captured on site is treated to best practice objectives for pollutant removal. Additionally, millions of litres of water will be captured, treated and reused to enhance the landscaped areas of Docklands Park. Passive watering of many of the WSUD elements, as stormwater infiltrates through the systems, (e.g. tree pits and raingardens) also provide green streetscapes and landscapes with a much reduced need for irrigation.

2.0 RAINGARDENS IN WSUD

Raingardens are also called bioretention systems, bioretention cells, biofilters or biofiltration pods. Often long linear forms of raingardens are known as bioretention swales, especially where surface conveyance during high flow form part of the raingarden design. When high flows exceed the infiltration capacity of the filter media, they are directed along the surface of a linear raingarden, often before being discharged to the conventional drainage system at a downstream location. The principles behind raingarden design are the same as those for bioretention tree pits, however there is often no groundcover vegetation on the surface of the bioretention tree pits to manage surface porosity and therefore increased maintenance of the surface is required. Typically, the design of bioretention tree pits without groundcover vegetation is a response to the landscape and aesthetic requirements of the site.

In raingardens a vegetated soil media layer is used to filter stormwater run off to remove or reduce pollutants. Stormwater is then collected in perforated pipes at the base of the soil media. Treated stormwater then flows to downstream waterways or storage facilities for reuse (see Figure 1). Vegetation that grows in the filter media enhances its treatment function by preventing erosion of the filter medium and continuously breaking up the soil through plant growth. This prevents clogging of the system while the biofilms found on plant roots are important sites for pollutant removal processes. These biofilms are films made up of bacteria, fungus and other micro-organisms that surround the plant root.

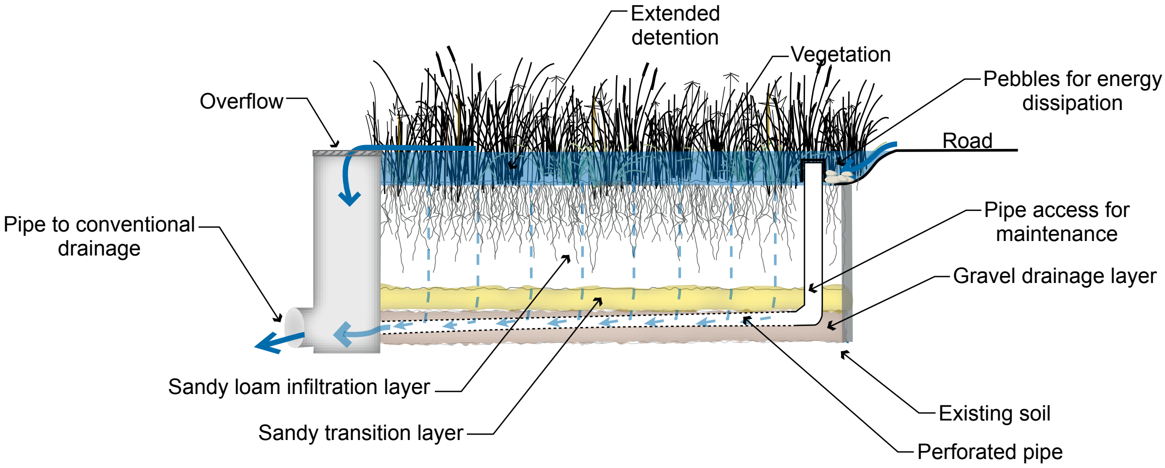


Figure 1. Concept illustration of raingarden
(Source: EDAW)

Selection of an appropriate filter media is a key issue that involves a trade-off between providing sufficient hydraulic conductivity (i.e. passing water through the media as quickly as possible), and providing sufficient water retention to support vegetation growth (i.e. retaining sufficient moisture by having high field capacity). These devices can be installed at various scales, for example in planter boxes, in retarding basins or in streetscapes integrated with traffic calming measures. A key feature of raingardens is that they are free draining and do not have areas of permanent water. They also have a bypass for flood flows that ensure the standard levels of service for drainage and flood management are preserved.

Raingardens can form attractive landscape elements and are essentially self-irrigated by having relatively large impervious areas draining to them. Figures 2 and 3 below are examples of raingardens in Melbourne, Victoria.

Figure 2. Raingarden in Mernda, Melbourne, Victoria
Note the absent length of kerb which allows stormwater to flow into the raingarden.
(Source: EDAW)

Cremorne St, Richmond

Baltusrol Estate, Heatherton

Figure 3. Raingardens in Melbourne
The raingarden is set down from the surrounding surface area to allow for extended detention (ponding) on the surface, thereby increasing the volume of stormwater treated with each rainfall event.
(Source: EDAW)

3.0 BIORETENTION SWALES IN WSUD

Bioretention swales are essentially a linear form of raingarden as seen in Figure 4. They contain an underlying filter media through which water percolates down to where it is collected in pipes at the base of the system. The primary difference between bioretention swales and raingardens is that the bioretention swales can also have a flood conveyance function which allows water to flow across the surface of the media during higher flows, and therefore need to be designed to withstand high flow velocities during floods.

Figure 4. Bioretention swale in Lynbrook Estate, Melbourne
This is a linear raingarden, also known as a bioretention swale, which provides a conveyance function during high flows to manage flooding.
(Source: EDAW)

4.0 NAB PROMENADE RAINGARDEN

4.1 Overview

The NAB promenade bioretention system is located on the lower deck of the Victoria Harbour wharf promenade as seen in Figure 5. The bioretention area collects run off from the western side of the north-south link between the promenade planter trees and the edge of the stairs. In addition, the pedestrian area at the western end of NAB Building 2, which is approximately 15 metres wide, also drains into the bioretention system.

To meet best practice objectives for pollutant load reductions, the bioretention system has an extended detention depth of 250mm and a filter media depth of 450mm. The sandy loam filter media is specified with a hydraulic conductivity of 80 mm/hr. Stormwater that percolates down through the filter media is collected in perforated pipes at the base of the system and is discharged directly to Victoria Harbour. A concept illustration showing flow pathways through the system is shown in Figure 6.

Victoria Harbour is stratified with a saline bottom layer, a freshwater surface layer and a mixed (brackish) layer in between. Early work looking at flow and detention time within Victoria Harbour showed that the freshwater surface layer is poorly flushed and has a long residence time in the harbour. This makes it particularly susceptible to poor water quality outcomes as a result of stormwater pollutants being introduced into this layer. To alleviate this, the raingarden discharges into the harbour via a discharge pipe carefully located at the specific depth of the mixed layer, to minimise the impacts of fresh stormwater discharges. This mixed layer is more regularly flushed out of the harbour. In this way, there is less risk of a build up of nutrients in the harbour such as algal blooms, that could lead to water quality deterioration.

Figure 5. NAB promenade raingarden, Melbourne Docklands
Note the raingarden is incorporated into public seating and is densely vegetated with a range of species.
(Source: EDAW)

Project Objectives

The primary objective for the development of this system was water quality treatment, to protect the downstream receiving waters and to allow discharge into Victoria Harbour. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, developed by the CRC for Catchment Hydrology) was used to demonstrate that the NAB promenade raingarden meets best practice water quality objectives.

Catchment and site characteristics

The catchment area for the NAB promenade raingarden is the paved surface between the NAB buildings and the harbour side timber deck. This area is around 1030m^2 and the bioretention system surface area is approximately 15m^2.

4.2 Design and Construction Challenges

The main challenge with this site was to deliver stormwater from the pavement of the relatively flat, existing concrete podium area into the bioretention system. This problem was solved by cutting slots in the concrete which then directed runoff into a grated trench. The trench then discharges onto the surface of the bioretention system that is located at a level change in the podium space and is incorporated with pedestrian seating.

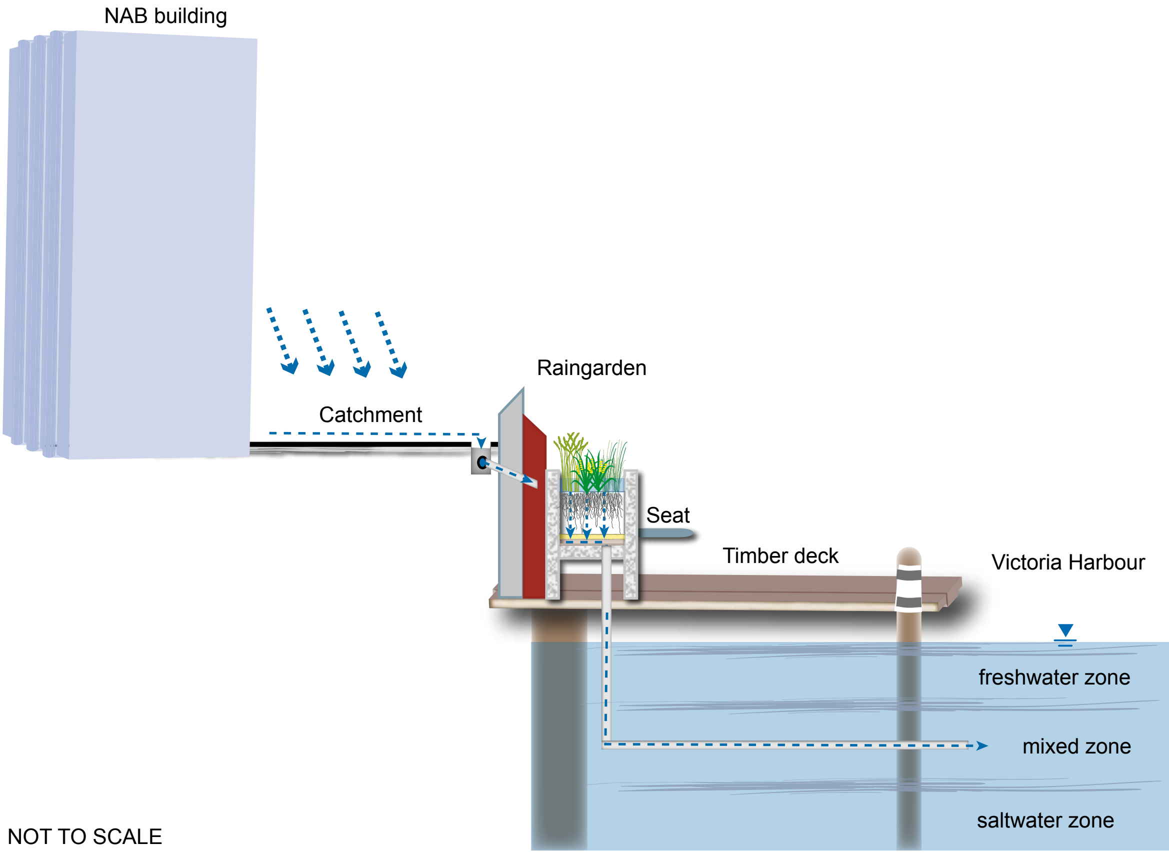


Figure 6. NAB Promenade raingarden – concept illustration of long section
Water flows from surrounding impervious areas, onto the surface on the filter media where it infiltrates through to the drainage layer, and the treated stormwater is then discharged below the freshwater layer within Victoria Harbour. (Source: EDAW)

4.3 Maintenance and Operation Experiences

Construction of the system was carried out as designed. After installation it was noted that the filter media within the raingarden had a higher hydraulic conductivity than originally intended, which led to a loss of vegetation. To rectify this some additional organic matter was added to the filter media and more drought tolerant plant species were selected.

4.4 Summary of Lessons Learned

Specific tests of bioretention filter media are critical to ensure that the soils will be freely draining yet retain sufficient moisture to support vegetation. A hold point on any construction program is recommended to test soil media before placement.

5.0 TREE PITS IN WSUD

Bioretention tree pits, or raingarden tree pits, are raingardens where a street tree is planted into bioretention filter media located at the kerbside. Stormwater runoff enters the tree pit through a modified road kerb and is filtered through the soil media within the cell. Treated stormwater is then collected via perforated pipes located within a drainage layer at the base of the cell before being discharged into conventional stormwater pipes that also act as an overflow (see Figure 7). As the inclusion of tree pits into the drainage system does not affect other conventional drainage elements, stormwater discharge exceeding the capacity of the tree pit may continue along the kerb, and is collected in a conventional side entry pit.

Tree pits designed in this way not only provide the dual function of streetscape amenity and stormwater treatment, but the passive irrigation from stormwater reduces the demand for irrigation from other sources such as potable water. Figures 8 and 9 show some examples of bioretention tree pits in Melbourne Docklands.

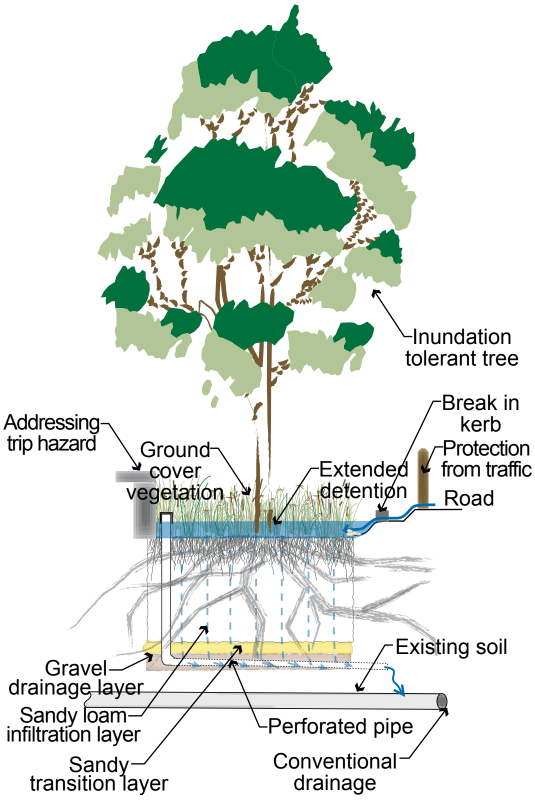


Figure 7. Concept illustration of bioretention tree pit
This shows the typical flow pathways through a bioretention tree pit including the provision of an extended detention volume, or ponding, on the surface of the filter media to increase the overall stormwater treatment efficiency of the system.
(Source: EDAW)

6.0 BOURKE STREET TREE PITS

Figure 9. Bourke Street bioretention tree pits
(Source: EDAW)

Melbourne Docklands

Little Bourke Street

Figure 8. Bioretention tree pits in Bourke Street extension
Note the two different options for addressing the trip hazard, both use a ‘pit lid’ that allows for future growth of the tree, however one is designed to integrate into the surrounding pavement while the other is similar to a conventional tree surround.
(Source: EDAW)

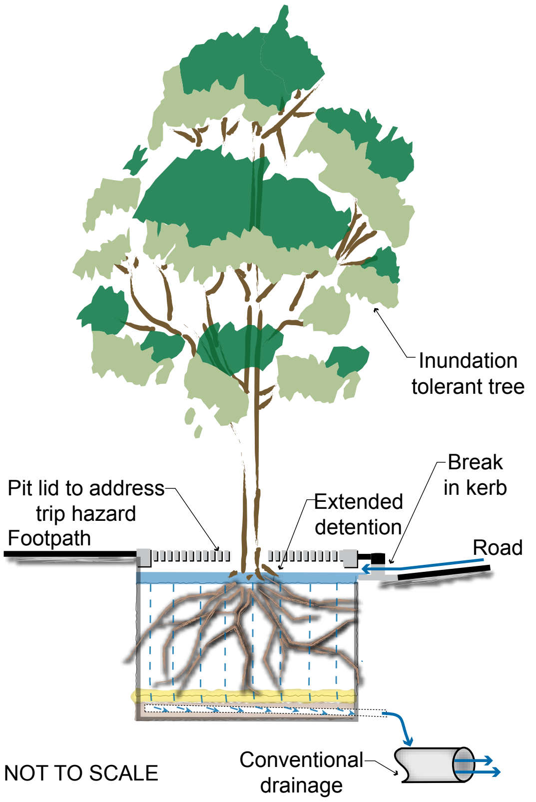


Figure 10. Concept illustration of Bourke Street tree pit function
Note the design of these bioretention tree pits does not incorporate groundcover vegetation because the street trees at this site were designed to provide a classic boulevard effect.
(Source: EDAW)

6.1 Overview

Bourke Street is currently the main transport entry into the Victoria Harbour precinct. The streetscape design for Bourke Street creates a boulevard effect with tree planting at regular spacing along the footpath on both sides of the road (Figure 9). The typically 8 metre regular spacing of the trees created an opportunity to incorporate bioretention tree pits as part of the stormwater treatment system for stormwater generated from the road and footpaths. Incorporating stormwater treatment into street tree pits in Melbourne Docklands was the first application of this kind in Australia and was a creative response to the high density redevelopment and limited space for landscaping.

The Bourke Street tree pits line both sides of the Bourke Street extension. Stormwater runs along a standard road kerb and channel and is directed onto the filter media surface of tree pits through a standard stormwater side entry opening in the kerb. Stormwater then percolates down through the filter media in which the tree grows. Treated stormwater is collected in a drainage layer at the base of the tree pit (Figure 10 and Figure 11).

Treated stormwater is then discharged to the Bourke Street culvert and then to the Yarra River. When the rate of stormwater discharge to each street tree exceeds the capacity of the extended detention volume (ponding above the filter media), the run off continues down the kerb and channel as in a conventional road drainage system, and is collected by a standard drainage side entry pit acting as an overflow. These pits are located so as to provide trafficability to the road pavement during the peak 10 year ARI (Average Recurrence Interval) storm flow which is Melbourne City Council's minor storm standard. The frequency of

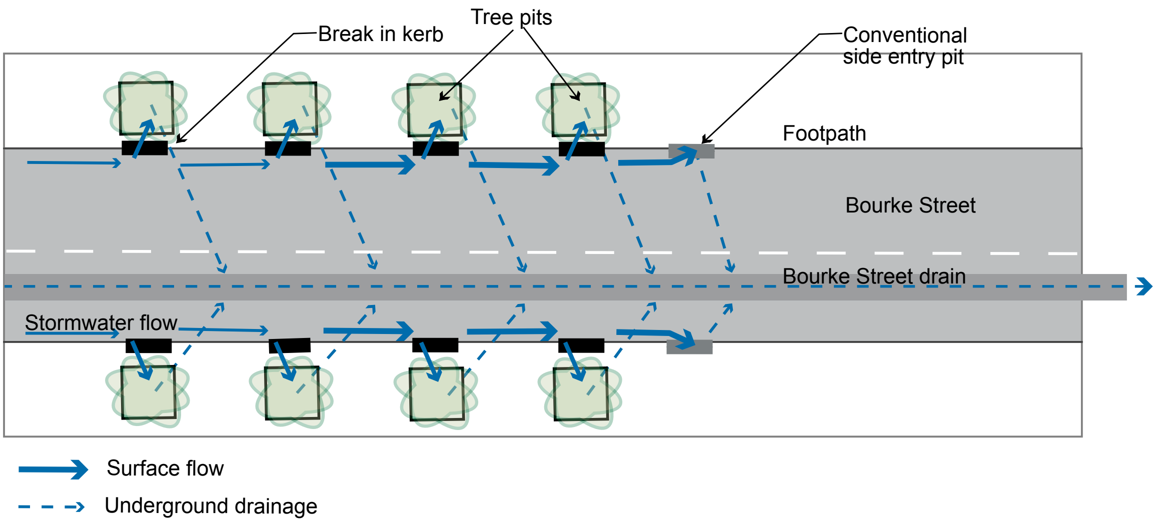


Figure 11. Bourke Street tree pits – concept illustration in plan view
Note the flow pathways where initially stormwater travels down the kerb and is directed onto the surface of the tree pit. In larger storm events, when the rate of stormwater discharge to each street tree exceeds the capacity of the extended detention volume (ponding above the filter media), the run off continues down the kerb and channel as in a conventional road drainage system, and is collected by a standard side entry pit.
(Source: EDAW)

bypass, that is, when flows discharge to the Yarra River via a conventional pipe system or directly to Victoria Harbour for major event flows, is generally less frequently than 1 in 3 months ARI.

The Bourke Street tree pits are designed to allow extended detention, or ponding, on the soil surface to maximise the volume of stormwater that passes through the soil media and is treated. The provision of this extended detention volume requires that the soil surface and base of the trees are set some depth below the road surface and footpath. A grated cover is placed across each tree pit, around the base of the tree trunk to minimise the tripping hazard for pedestrians.

6.2 Project Objectives

The primary objective of the Bourke Street tree pits is water quality treatment for protection of the downstream receiving water, the Yarra River. As water infiltrates through the soil, pollutants are removed as a result of various physical and biological processes. The MUSIC tool was used to demonstrate that the Bourke Street tree pits met best practice water quality objectives.

The system has additional benefits including:

- passive irrigation of the trees within the pits, reducing potable water demand for irrigation
- stormwater retention and reduction as the water is collected from the catchment, ponds on the surface of the soil and slowly infiltrates through the soil (retention) with some of the water lost through evapotranspiration (reduction)

Catchment and Site Characteristics

The stormwater catchment for the Bourke Street tree pits is the road surface and adjacent footpaths. The road surface drains to both sides of the road and run-off is directed into slots in the kerb. These slots drain directly onto the surface of the tree pit. Each pit has approximately 56m^2 of road and footpath draining to it.

Site Constraints

The main site constraint is that the existing major outfall drains in the area are all relatively shallow and therefore the design and installation of the tree pits is constrained vertically to ensure flows collected in the perforated pipes at the base of the tree pit could discharge to the existing Bourke Street drain.

6.3 Design and Construction Challenges

6.3.1 Soil Levels

During construction of the Bourke Street tree pits, the soil media around the trees was filled to the surrounding pavement level, like a conventional street tree, rather than being set down to allow street runoff to enter and the extended detention volume to fill. This prevented runoff from flowing onto the soil surface around the trees, instead bypassing it into the conventional drainage system and providing no stormwater treatment. This was remedied by removing the entire tree and setting it lower.

Clear communication with construction contractors is important to ensure the design intent of WSUD systems is captured in the built form.

6.3.2 Tree Pit Covers

By setting the tree pit surface below the surrounding footpath to allow stormwater to flow in from the street gutter, the tree pit surface was 300-500mm below the surrounding footpath. This created a potential trip hazard that needed to be addressed. Initially it was proposed to fill the gap between the tree pit surface and the footpath with gravel, which would still allow water to percolate through to the filter media. However, the risk of sediment accumulation within the pores between the gravel, and resultant blockage, was deemed too high.

Due to the lack of groundcover vegetation to manage surface porosity it is important to have the surface of the media exposed so that any fine sediment accumulation can be easily removed during regular maintenance. The reduction in extended detention volume, due to the presence of the gravel, was also deemed unacceptable. An alternative was proposed that involved the use of a plastic drainage cell laid horizontally on top of the tree media, allowing for efficient drainage into the tree media from the kerb slot. This also provided the load bearing capacity to support pavement above. This solution was proposed but was not incorporated in the final design. Steel framed lids with hinges for opening and solid concrete inserts were proposed but then rejected on the basis of their cost and time to develop. These have since been used in street tree treatment systems in Little Bourke Street, Melbourne by Melbourne City Council.

The final design for the pit 'lids' involved conventional steel grated tree surrounds as shown in Figure 12. These are not typically designed to free span the width of pits, and so began to sag without sufficient support. Additionally, these grates were bolted together which made maintenance of the soil media surface, such as litter removal, difficult.

Figure 12. Original tree pit covers
These began to sag due to their lack of support. (Source: EDAW)

A further design was later constructed to avoid any sag in the grates by having stronger supports. These also improved maintenance access of the tree pit surface. The new, customised tree pit covers are shown in Figure 13.

Figure 13. Customised free-spanning tree pit covers
(Source: EDAW)

6.4 Maintenance and Operation Experiences

6.4.1 Jurisdiction of Maintenance Responsibilities

Maintenance responsibilities for the Bourke Street tree pits lies with a variety of departments, and thus the exact jurisdiction of a particular maintenance task is not always clear. Pit lids are the responsibility of the maintenance contractor's engineering unit, as they possess the equipment to lift the lids when required. The tree is the responsibility of the horticulture unit, while the gutters and roads come under a separate contract. As a result, the jurisdiction for maintenance of elements such as the soil media can be unclear thus risking that the routine maintenance is overlooked.

6.4.2 Provision of a Maintenance Plan

Some of the current maintenance tasks applied to the Bourke Street tree pits are the same as those specified for conventional streets, street trees and parklands such as litter removal, weeding, inspection of pits and pumps and street sweeping. Other tasks such as the application of fertiliser and filling in of soil around street trees to reduce trip hazards are in direct conflict with the functional requirements of the design or require additional works to ensure the function of WSUD elements is not compromised. Specific maintenance plans are required to clearly identify where maintenance of WSUD elements differs from that of conventional horticultural and drainage maintenance.

6.5 Summary of Lessons Learned

Strong communication between constructors and designers is important to ensure the functional intent of a WSUD system is transferred from design to the built form. For example, ensure that trees and surrounding soil media are installed at correct levels. Contractors, particularly those with limited experience in building WSUD systems, require clear communication from designers on how the systems operate, to ensure the transfer of the functional intent into built form.

Where tree pit covers are required to be flush with the footpath level, conventional tree pit lids are generally not appropriate. More robust versions that are customised for the clear spans of the pits are required, as discussed above.

On large sites, where a number of maintenance departments/companies operate, it is important that specific maintenance responsibilities, such as the maintenance of filter media within raingardens, are clearly allocated.

The insertion of hold points in the construction program allows for early detection of problems. If detected early enough in the construction program, many issues can avoid costly reworking, as noted with the replanted trees mentioned above.

Maintenance plans provide critical information to maintenance personnel, and should be developed for all WSUD systems. These should clearly outline issues required for the successful operation of each system, such as removal of sediment build up on the surface of bioretention systems, and inspection for evidence of filter media clogging.

Provisions for carrying out of irregular tasks such as, back-flushing of the underlying perforated pipe drainage system to remove any blockages should also be included in the maintenance plan. Maintenance plans should be based on design reports and used to disseminate information on the system's design intent to long-term maintenance personnel.

7.0 BATMANS HILL DRIVE TREE PITS AND BIORETENTION SWALE

Figure 14. The southern end of Batmans Hill Drive
Showing bioretention tree pits in the background and bioretention swale in the foreground.
(Source: EDAW)

7.1 Overview

South of Collins Street, Batmans Hill Drive incorporates WSUD elements along both edges of the road pavement (Figure 14). Footpaths, bike paths and road surfaces are graded so that stormwater is directed into bioretention systems. Along the eastern side of

Batmans Hill Drive the road surface and footpaths drain to bioretention tree pits. Along the western side, the road surface, footpath and bike path drain to a series of bioretention swales (linear raingardens) that are located between the road and the shared footpath.

Run-off from the road, footpaths and bike path is conveyed via conventional kerbs to tree pits or is discharged directly into landscaped, planted areas located between the footpath and the road pavement. Flows percolate through the filter medium and pollutants are retained, while treated water is recovered in slotted pipes beneath the soil media and discharged to the main Batmans Hill Drive drainage system (see Figure 15).

The bioretention tree pits along the eastern side of Batmans Hill Drive are constructed using 3.6 metre diameter concrete pipes that have been cut lengthwise and placed vertically. This design was a more cost-effective method to provide vertical walls for the tree pit, maximising the area available for water quality treatment by reducing the need for batters. The concrete pipes also provide high enough walls around each tree pit to address any tripping hazards and provide pedestrian seating. Both forms of bioretention system along Batmans Hill Drive are large in comparison to their catchment area and therefore only require shallow extended detention depths in the order of 50mm.

Flow from the Batmans Hill Drive system discharges into a trunk drainage pipe. A proposal currently exists to install a weir and pump system. This would allow for more water to be pumped to Docklands Park Wetlands for reuse until the whole of the catchment for the Docklands Park wetlands is developed.

Project Objectives

The primary objective of the Batmans Hill Drive bioretention systems is water quality treatment for protection of the downstream receiving waters, the Yarra River. The water quality treatment efficiency of the Batmans Hill Drive bioretention systems has been estimated using MUSIC and meets best practice water quality objectives.

The system has additional benefits, including passive irrigation of the vegetation within the system, which reduces potable water demand for irrigation.

Catchment and Site Characteristics

The catchment for the Batmans Hill bioretention systems is the Batmans Hill road pavement, footpaths and bike paths on both sides of the road, south of Collins Street.

Site Constraints

Major services, particularly gas, run under the western side of this section of the road, and this was a major consideration when locating bioretention swales and street trees. Existing surface levels and road profiles needed to be retained due to prohibitive costs. This led to a road alignment with three quarters of the road surface draining to the east and one quarter to the west, which includes the shared bike path.

With flush kerbs along the western side of the street, traffic controls were required to protect the filter media and vegetation from large traffic volumes, especially during events at the stadium. To manage this risk, specially designed traffic bollards were used, as shown in Figure 16.

Figure 16. Batmans Hill Drive bioretention swale with traffic bollards
Showing bollards required to protect the filter media and vegetation in the absence of kerbs.
(Source: EDAW)

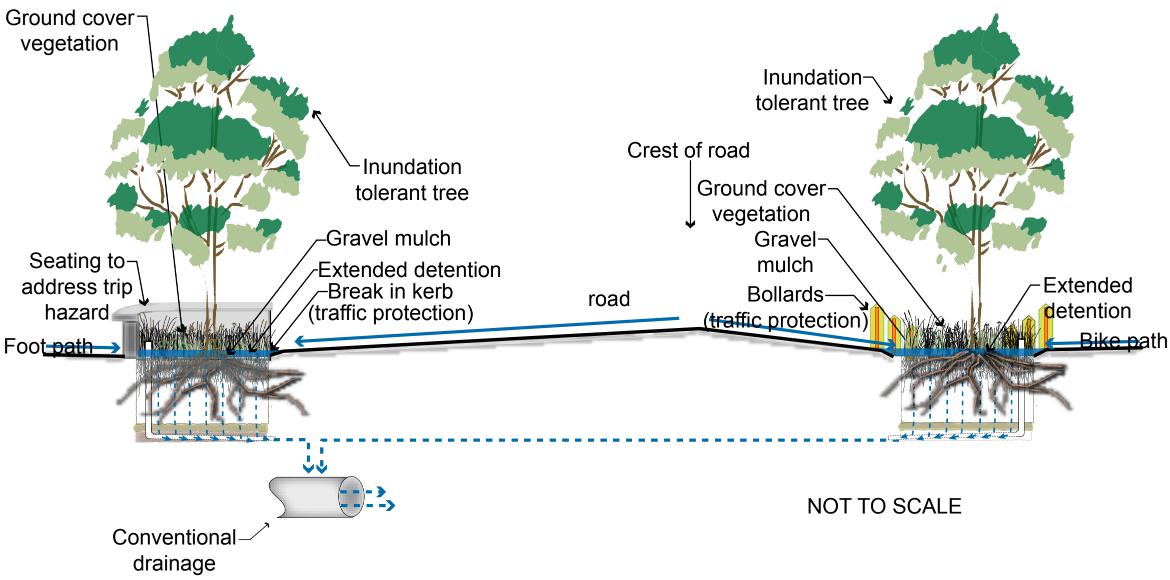


Figure 15. Batmans Hill Drive long section
Showing the path of stormwater through the tree pits and bioretention swale. (Source: EDAW)

An additional constraint was surface levels on the western boundary where the bike path/landscape was required to match with existing surfaces at the road reserve boundary adjacent to the Kangan Batman TAFE, Fox Car Museum.

7.2 Design and Construction Challenges

7.2.1 Protection During Construction

There was some delay during construction, between civil works and planting, when the filter media was left exposed to construction run-off. Better protection of the soil media with geofabric or turf, would maintain the integrity of the filter media until planting occurs.

7.2.2 Gravel Mulch

The street tree pits and the bioswale have been constructed with a layer of gravel mulch to control weeds and retain moisture. A large amount of sediment has built up on the surface of the gravel from the large amount of local construction traffic occurring in the area. Sediment build up is more difficult to remove when gravel mulch is used, as the sediment settles within the pore spaces between the gravel mulch, and requires removal and washing of the gravel to remedy.

The use of a sacrificial geotextile on the surface of the gardens during construction phases would result in less damage to bioretention filter media and easier maintenance.

7.2.3 Irrigation of Trees

Agricultural (Ag) pipe was installed during construction to allow irrigation closer to tree roots, as occurs with many conventional street trees. However, the placement of this Ag pipe meant that short circuiting of flows occurred and therefore the volume of water that is treated is substantially reduced.

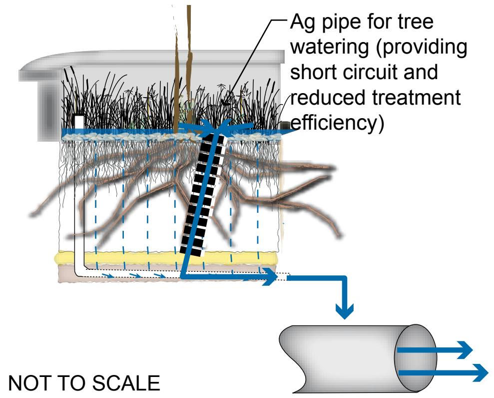
7.3 Maintenance and Operation Experiences

7.3.1 Deciduous Leaf Litter

The Batmans Hill Drive tree pits can be subject to high organic matter loads of deciduous tree leaf litter that has the potential to limit the growth of groundcover plants in the tree pits and reduce the hydraulic conductivity of the filter media. This issue appears to be exacerbated by the fact that street sweeping pushes leaf litter from the road surface onto the surface of the tree pits.

Figure 17. Sediment build-up on top of and within gravel mulch
(Source: EDAW)

Ag pipes visible at garden surface



Section showing short-circuit

Figure 18. Short-circuit from tree watering pipe
An illustration of short circuiting within tree pit as a result of Ag pipe installation
(Source: EDAW)

Figure 19. Deciduous leaf litter build up
(Source: EDAW)

On an individual site basis, impacts from leaf litter can vary. High loads of organic matter need to be assessed to ensure the loading is not having a significant impact on hydraulic conductivity across the surface of the filter media, or plant growth within the filter media. Methods of remediation in the form of manual removal of the leaf litter should be outlined in a maintenance plan.

Tree Stakes

Tree stakes were used to support immature trees until they established. Removal of tree stakes led to holes through the filter media that created a short circuit pathway to the underlying pipes. Flows therefore did not percolate through the soil media/plant roots and therefore were not treated. These holes, shown in Figure 20, were large enough to provide a substantial reduction in treatment performance because of short circuiting.

Figure 20. Short-circuit from tree stake
Hole in filter media after tree stake removed visible in centre of photograph
(Source: EDAW)

Maintenance during the establishment phase should include a requirement for filling in any substantial holes in the media to ensure long term treatment efficiency is maintained.

7.4 Summary of Lessons Learned

Filter media should be protected during civil works to maintain the integrity of the filter media until planting occurs. The use of a sacrificial geotextile on the surface of raingardens during construction phases would result in less damage to bioretention filter media and easier maintenance. Once construction is substantially complete, the geotextile and collected sediments can be removed and replaced with gravel mulch if desired.

Specific maintenance plans that outline issues such as removal of sediment build up on the soil surface, including how to address sediment collecting within gravel mulch, should be supplied to contractors. Maintenance plans should also require inspections for signs of clogging of the filter media.

Short-circuiting of the filter media by irrigation pipes, removed tree stakes etc, should be avoided. Any voids in the media should be filled to retain filter function of garden.

Maintenance during the establishment phase should include a requirement for backfilling any substantial holes in the media (e.g. from tree stakes) to ensure long term treatment efficiency is maintained.

Deciduous trees should be avoided where leaf litter build up will degrade aesthetics. Additionally, for low maintenance sites, the use of deciduous trees should be carefully considered, as high leaf litter loading can result in a reduction in the hydraulic conductivity of the filter media.

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BIOGRAPHY

Kerrie Burge is an ecologist with EDAW with skills in water chemistry, aquatic ecology and environmental impact assessment. Kerrie graduated from Monash University with first class honours, and has experience in the field of urban stormwater management, with a particular focus on vegetation specification for WSUD elements such as bioretention systems and wetlands. She has skills in hydrologic modelling including the use of the MUSIC tool, and has worked with the Facility for Advancing Water Bio-filtration at Monash University on a number of projects including filter media specification for bioretention systems.

Robin Allison is an environmental engineer with specialist skills in urban stormwater management, particularly delivering WSUD. His experience includes urban development, water policy development, research on stormwater treatment devices, and redevelopment projects at many scales. He has given many industry seminars and training courses. His expertise covers the investigation, planning, design, construction supervision and project management of water infrastructure.

Dr Tony Wong is formerly a founding partner of the consulting firm Ecological Engineering which is now EDAW. He is also CEO of the Facility for Advancing Water Bio-filtration at Monash University. Tony has over 25 years of experience in the fields of water resources engineering and management, advancing ESD, particularly in integrated urban water cycle management and WSUD. His expertise has been gained through consulting, research, and academia. Tony provides strategic advice to governments, and the land development industry, on sustainable urban water management and has led the development of many state and corporate policies on WSUD.

Dr Peter Breen is a Principal of EDAW's Ecological Engineering practice area in Melbourne and has published on aquatic botany, wetland, stream and lake ecology, stormwater and wastewater treatment, water quality management and restoration ecology and has authored or co-authored over 100 papers and delivered numerous presentations. His research and design expertise has contributed to urban stream ecology in Australia, where Peter established and led the urban ecology group in the Cooperative Research Centre for Freshwater Ecology at Monash University from 1992 to 2001, as well as best practice stormwater management objectives and guidelines on the design of constructed wetlands, waterways, bioretention systems and lakes. Peter remains a director of The Facility for Advancing Water Biofiltration, a joint venture between EDAW and Monash University.