URBAN WATER

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Water capture and reuse

Case study

Fitzroy Gardens Stormwater Harvesting System

Fast Facts:

Project description
Stormwater collection and reuse, underground tanks and biofiltration

Purpose
Irrigation volume 69 million litres per year

Catchment
67 hectares, 47% impervious, 200ML runoff per year

Cost
$4.2M

Completion date
December 2013

This new stormwater harvesting system at Fitzroy Gardens is the largest in the City of Melbourne. It provides 70 million litres of water every year, helping us to keep the heritage garden healthy in a changing climate

Fitzroy Gardens is located on the eastern fringe of Melbourne's central city. It covers an area of 26 hectares. It was set aside as a public reserve in 1848 and named Fitzroy Gardens in 1862. Fitzroy Gardens was included on the Victorian Heritage Register in 1998. With its tree lined avenues and broad array of horticultural and built features, it is the park most people readily identify as unique to Melbourne.

At the time of the system design, it was estimated that 117 million litres of water was needed to irrigate Fitzroy Gardens annually. In recent years, our ability to provide this water has been challenged by drought, water restrictions and the impacts of climate change. To combat these challenges, we've built a system to ensure that the garden's trees, plants and turf exist and thrive into the future

The Fitzroy Gardens stormwater harvesting system captures, treats and stores stormwater to be reused for irrigation in the park. It is estimated that system will replace 59 per cent of the drinking water used for irrigating the park. One of the benefits of this visitor centre is that information about the system and other water saving initiatives can be shared with the general community. You can read about the other environmental features of the visitor centre here.

The system was funded as part of the Eastern Melbourne Parks and Gardens Stormwater Harvesting Scheme, which received a total of $4.8 million from the Australian Government's Water for the Future initiative in 2011.

What benefits has the stormwater harvesting system provided?

- Saved approximately 70 million litres of drinking water per year.
- Provided a reliable alternative water source for irrigation of the heritage gardens
- Reduced pollutants such as nitrogen, sediment, phosphorous and heavy metals entering the Yarra River and Port Phillip Bay.
- Improved our ability to manage the impacts of climate change, such as heat waves and drought.
- Helped reach our City of Melbourne target to source 30 per cent of all the water we use from alternative sources.

Project details

How does the system work?

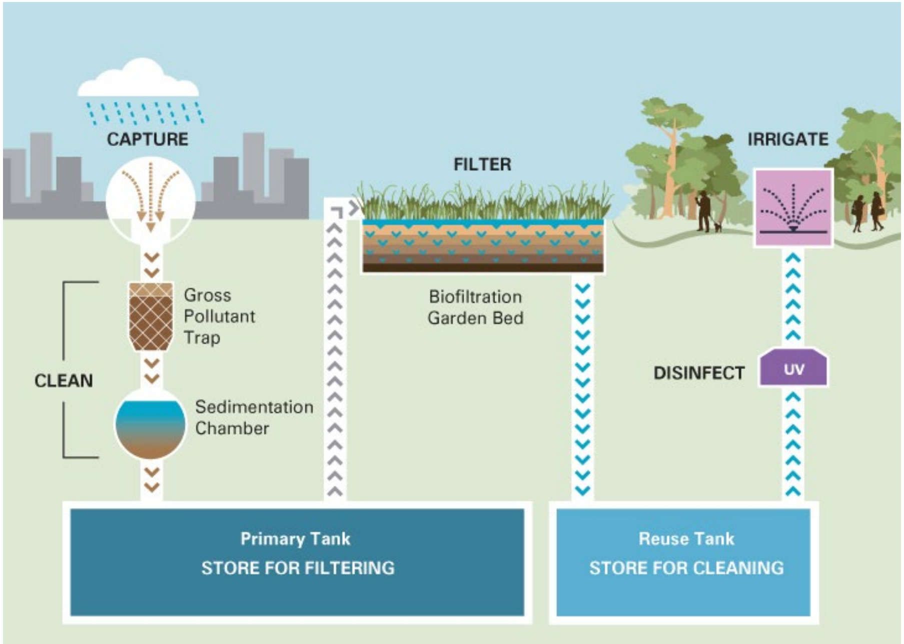
The depot site at Fitzroy Gardens is the natural low point for the surrounding 67-hectare catchment. It is an ideal location to capture and treat stormwater runoff because rainwater naturally flows there. Stormwater is diverted to the system from the underground drainage network beside Wellington Parade.

The treatment process begins with a gross pollutant trap that removes large pollutants, such as litter and leaves. The water then flows to a sedimentation chamber. In this chamber, we remove suspended particles of pollution such as fine sands and oils.

Next to the chamber is the primary storage tank, which can store four million litres of partially treated water. From here, the water is pumped to the surface where a biofiltration bed naturally removes invisible pollutants like nitrogen and phosphorus.

One million litres of treated stormwater is stored in a secondary tank and used for irrigation. Any excess treated water returns to the stormwater drains.

Finally, before the water is pumped to the Fitzroy Gardens irrigation network, it is passed over Ultraviolet (UV) light tubes to kill any remaining bacteria.



The stormwater harvesting system collects water from drains, cleans it using biofiltration and stores it for irrigating the garden.

TECH TIP

Double check the design

An independent assessment of the proposed design is a valuable way to cross check the details and prevent costly mistakes.

Timeline

Research and planning
2009 – 2012

Concept designs
January 2010

Funding application submitted
February 2010

Funding agreement signed
May 2011

Construction
April 2012 – December 2013

Testing and monitoring
December 2013

TECH TIP

Planning and design for this project took longer than usual due to heritage considerations and soil contamination.

Project Team

Due to the size and complexity of the project, we needed a wide range of consultants to undertake:

- geotechnical analysis
- irrigation system design and construction
- soil contamination assessment and management
- contaminated soil repository design and EPA submission
- civil and structural design and documentation
- construction
- tree impact studies
- site feature survey
- site demolition
- heritage advice and submission
- heritage inspection and report
- ongoing maintenance

Having a multi-disciplinary team was valuable. Gathering this team regularly to cover all aspects of the project provided different insights into issues and encouraged innovation.

TECH TIP

Project manager is key to success

Consistent project management helps to ensure delivery of the original objectives.

Be prepared for new opinions

Contractors will put forward alternatives to the tendered design. These may or may not be to the benefit to the project, particularly from a performance and operational perspective. Access to expertise is required to confidently access these alternatives.

Project Cost

Total cost:
$4.2 million

Cost per kilolitre of water, over the lifespan of the system:
$2.49 per kilolitre.

Geotechnical survey:
$10,000

Soil contamination documentation and management:
$251,000

Design and documentation:
$314,000

Diversion:
$284,000

Tanks:
$2,631,000

Treatment:
$100,000

Irrigation connections:
$610,000

The project was over budget by about 20 per cent, largely due to the costs associated with managing soil contamination on the site.

This cost information is just for the basic system infrastructure and does not include additional requirements, such as landscaping and signage.

TECH TIP

External funding can boost internal support

External funding was helpful to fast track the implementation of this project. It, along with the multidisciplinary team required to deliver these projects, has enhanced the knowledge and support for whole of water cycle management within Council.

Bundle your projects

Bundling several water sensitive urban design (WSUD) projects together into one larger project proved more cost efficient than completing them individually because the consultants were contracted to work on all three projects at once. By considering the environmental benefits of the three projects collectively, it also became more attractive to potential funding partners.

Funding takes time

Funding agreements often require regular reporting and evaluation. Time must be set aside as part of the project planning to apply, report and evaluate projects for funding partners.

PLANNING AND DESIGN PHASE

Research and Preparation

Water plan

A water plan for Fitzroy gardens was developed in 2008 to show the exact size and lay out of different vegetated areas and their primary uses. This was completed in-house and used as a base for estimating irrigation requirements and priorities.

Geotechnical survey

A geotechnical survey was commissioned in 2009 as part of the initial investigations of the site. Based on the soil conditions and groundwater levels, the report made recommendations that shaped the ultimate design of the stormwater harvesting system, visitor centre and depot.

Soil contamination assessment

A soil contamination assessment was undertaken in 2010 to determine the extent of the contamination, outline a management approach, and gain approval from the EPA proceed with proposed works.

MUSIC modelling

Rainfall data and stormwater pollution levels were used to calculate the effectiveness of the proposed treatment system and to determine the most appropriate size for the biofiltration bed.

Statement of Heritage Impact

The Statement of Heritage Impact was completed in 2010 by specialist consultants. Heritage Victoria required this report as part of the permit application process.

TECH TIP

Ensure calculations are correct before commencing design

The processing ability of the biofiltration bed was overestimated in the concept design. As a result, the size of the biofiltration bed had to be increased from 120m2 to 240m2 in the final design to accommodate the volume of harvested water, causing project delays and increasing costs.

Understand your soil from day one

Soil conditions and contamination should be investigated early in the design process as it can influence the feasibility and cost of the project. Cost effective management of contaminated soil is possible, but it takes time and persistence to achieve.

Planning approval process

Two main factors involved in gaining planning approval were:

- to uphold the heritage status of Fitzroy Gardens
- to be able to manage contaminated soil on the depot site.

Gaining these planning approvals was an extensive process that took over 18 months and required relevantly qualified consultants. We submitted a Statement of Heritage Impact to gain approval for the entire depot site redevelopment. As expected, there were further discussions Heritage Victoria before finalising the plan.

One of the key considerations from a heritage point of view was the proposal to demolish a building in the depot which had identified heritage qualities to allow the construction of the stormwater harvesting system. This was approved because providing a secure source of water for the gardens was a greater priority than retaining this building.

The visual impact of the completed project also had to respect the surrounding heritage landscape, including existing vegetation.

Heritage requirements during construction phase included:

- Creation of a five-metre buffer from construction applied to all existing heritage listed buildings on site, limiting the size and location of the tank.
- Tree protection measures, including protection of the root systems of the existing elm trees. The extent of root systems was mapped during the design phase to ensure that the excavation would not damage any root systems.

Due to classification level of the contaminated soil on site, a works approval was also needed from the Environment Protection Authority (EPA) for the project. Due to the classification level of the contamination we were not allowed to remove all of it from the site. While the less contaminated soil was allowed to be removed off site, the cost of this was prohibitive.

For other projects, such as the construction of Birrarung Marr parkland, contaminated soil has been incorporated into the design by creating undulating hills in the landscape. This was not possible at Fitzroy Gardens because it wasn't the design intention to create such visible changes to the existing landscape.

Instead, the majority of the contaminated soil was stored on site during construction, and then reburied around the tank. This required careful planning and supervision during construction.

TECH TIP

During excavation, one side of the wall collapsed into the 5 metre protection zone due to water logging. A temporary water diversion pipe was installed to enable the excavation to proceed.

The limited site available to work in compounded some of these issues.

Due to the volume of soil required to be excavated, the EPA had to grant special permission because it was not covered by the standard regulations. As it turned out, the initial calculations of soil volume underestimated the actual amount of contaminated soil, which had to be managed.

Design Challenges and Constraints

Soil management and services

Land throughout the municipality of Melbourne has a long history of urbanisation and as a result soil contamination is often a concern for major projects, particularly where significant excavation will take place. The presence of contaminated soil on the depot site was a challenge during the design and construction phases because regulations required that it could not be removed from the site. Instead, the soil was reburied around the storage tank and contained within a specially designed casing.

Heritage considerations

The heritage status of Fitzroy Gardens was an important consideration during the design phase, influencing the size of the tank, the type of structures that could be built or removed and the type of landscaping that could occur. Gaining approval for the project under heritage controls was a lengthy and considered process.

Working in public open space

Public open space is a valuable asset to any community which has the primary purpose to provide for a range of recreational activities and uses. The proposed system had to be of minimal impact on existing and future uses of the space and be well integrated into the existing landscape. The amount of available space had a big impact on the size and type of system which could be installed.

TECH TIP

Think about access

Safe access for cleaning or inspection of underground structures must be considered as part of the concept design, otherwise it can be a hidden cost until the detailed design phase.

Keep an eye on the pits

Pits frequently multiplied as the project developed, adding to the cost and complexity of the project. A good Landscape Architect can help hide them or question the need for extra pits.

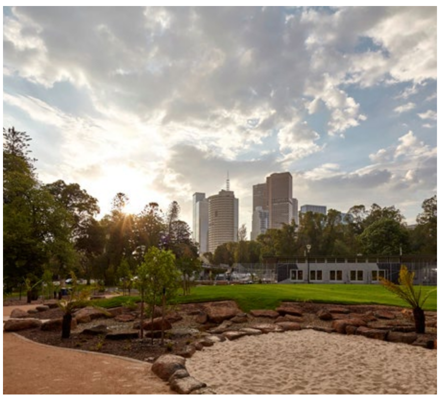
Designing water into the landscape

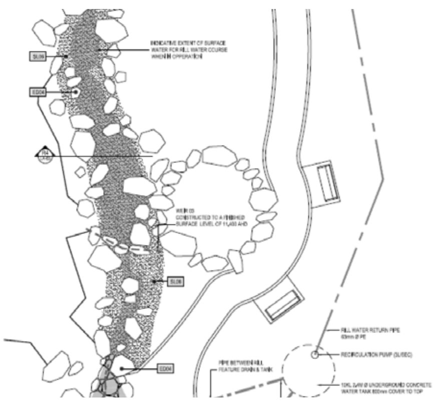
Water is a defining element of the Fitzroy Gardens landscape. The central spine of the gardens features the rill, a stream-like water feature. It follows the natural drainage line from north to south and includes a number of ponds.

Although the rill is an artificial landscape feature, it represents the creek that flowed through the area prior to construction of the stormwater drain beneath the gardens. Due to low rainfall, the rill only flows intermittently.

The new visitor centre and stormwater harvesting system sits at the bottom of the rill, so an extension of the stream was included in the new landscape. The new stream encourages people to connect with water in the gardens and celebrates the history of the landscape.

Recycled water from the stormwater harvesting system flows through the new stream. This water is taken from the reuse tank and diverted into a separate tank that cycles through the water feature.





Community consultation and involvement

We worked closely with the community when designing this project, and people showed strong support for our sustainable water management designs. The consultation was part of the development of the Fitzroy Gardens Master Plan.

We created a communications plan to identify a range of stakeholder and the local community. The plan identified appropriate communication methods and channels for the various audiences.

We shared news about the project in many ways, including:

- Installing three project information signs at the site.
- A media event with the Lord Mayor Robert Doyle and Senator Don Farrell when construction began. We reached a wide audience through evening television news coverage.
- Presentations about the scheme to Australian and international governments, at a range of industry conferences and to university students.
- Site visits/tours with a range of industry figures and groups from local and international organisations.

In addition, we produced a video with the Victorian Government that focussed on our Total Watermark Strategy. It included information on the Fitzroy Gardens system.

PLANNING AND DESIGN PHASE

System components

Gross pollutant trap (GPT)

Type: HumeGard model HG30A-R

Location: stormwater drain diversion point, 3 metres from the sedimentation chamber

Structure: concrete unit, installed separately

Pollutant capacity: 9.7 m3

Purpose: the gross pollutant trap (GPT) is the initial screening device to remove gross pollutants and coarse sediments (greater than 150 microns) from the collected stormwater. The GPT is essential for the operation of the system because it prevents debris from entering the storage tanks.

In this system, the GPT removes approximately:

- 90 per cent of gross pollutants (litter, vegetation)
- 85 to 99 per cent of sediment
- 90 per cent of hydrocarbons
- 20 per cent of nutrients (phosphorus and nitrogen).

Maintenance: The GPT is inspected every three months and cleared of debris and silt/sand/gravel accumulation using a suction hose. A high-pressure jet can be used to clean the GPT, if required. Ideally, inspection and cleaning should take place after a major storm event.

The typical lifespan of a gross pollutant trap is 10 years and the replacement of this part has been factored into the maintenance budget.

Sedimentation chamber

Dimensions: nine metres deep, two metres wide and five metres deep

Structure: concrete, poured on site

Location: immediately next to the primary storage tank.

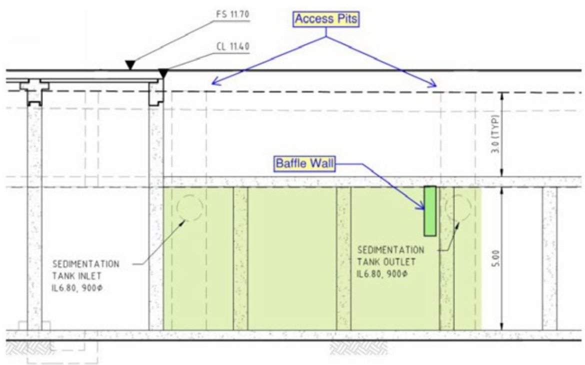
Purpose: The sedimentation tank collects and 'settle out' fine sands, sediments, oils and hydrocarbons that would otherwise accumulate in the primary tank. It is easier to access the sedimentation tank to clean away these pollutants than trying to clean the primary storage tank.

Maintenance: Once the accumulated sediment in the tank reaches a depth of two metres, the chamber is drained and the sediment removed using a suction loading truck.

TECH TIP

Pump monitoring

The pumps are fitted with temperature sensors and linking cables to monitor the pump operating temperatures and prevent motors from overheating.



Section drawing of the sedimentation chamber

Dual tank system

Dimensions: 40.6 metres long, 25.6 metres wide, four metres high (internally)

Volume: Five million litres (four million primary tank, one million reuse tank)

Structure: Concrete tank poured on site.

The dual tank system is a large, oblong, underground tank with an internal dividing wall that creates two separate storage areas.

We used a dual tank system to ensure that flows of stormwater into the primary storage tank are not limited by the rate at which the biofiltration system can clean it. When it rains heavily the primary storage tank can take a large volume of water and gradually treat it through the biofiltration bed.

The design also allows for the secondary tank to be sized according to the irrigation needs of the park, rather than for the peak stormwater flow. This reduced the cost of the tanks.

We could have used modular plastic tanks for this system, but chose the structural stability of reinforced concrete because trucks need to regularly access the site.

The size and location of the underground storage tanks was influenced by the presence of heritage-listed buildings on site, which require buffer zones from construction areas.

Maintenance:

- Annually isolate all inflows and outflows and measure water levels (using dip stick) four times over 48 hour period to confirm no draw down and no leaks (and verify/calibrate level sensors readings).
- Drain tanks every five years to remove sludge and debris from (pump) sump pits using vacuum loading truck.
- Drain tanks after 50 years to access tank and remove sludge and debris and low pressure clean all wall and floor areas.

Plan drawing of the dual tank system

Biofiltration bed

Type: Biofilta system

Size: 241 m2

Maintenance: top layer of substrate replaced annually (using suction hose)

Purpose: To remove nutrients from the water (nitrogen and phosphorus)

The biofiltration bed was constructed the same way as a typical raingarden, with a sand filtration layer, a transition and a drainage layer. Unlike a raingarden however, the biofiltration bed is surrounded by a one-metre retaining wall. It is periodically flooded with water from the underground primary storage tank.

The flooding and resting cycle is based on the detention time of the water, which is determined by the hydraulic conductivity of the filter media. The cycle time is pre-set, but will be monitored and adjusted over time as the filter medium clogs and slows the detention time. Replacing the top of the filter media on an annual basis will renew the conductivity. The clean water drains naturally under gravity to the secondary tank where it is stored until needed for irrigation.

A wetland was considered as a treatment option for the system, but it was decided that bioretention would provide greater treatment capacity within the limited footprint of the site.

Plants

Species: Juncus gregiflorus and Juncus procerus

The top layer of the biofiltration bed was planted with ephemeral wetland plants. These native Australian grasses were pre-grown and installed in large format blocks to ensure fast establishment and high quality water within the first month.

Once per year, when the filter medium is replenished, the grasses are cut back to encourage vigour. Juncus have a clumping growth pattern at the base, which gives easy access to the suction hose that is used to replace the top layer of filter media. It is also a hardy plant that can easily withstand the slight disturbance of this process.

We consulted Heritage Victoria to ensure that the plants used in the biofiltration bed respected the heritage landscape of Fitzroy Gardens, while also enhancing the filtration properties of the sandy medium.

Pumps

Treatment system

Two Grundfos heavy-duty submersible pumps are located in a 580 mm deep sump pit at the base of the primary storage tank. These pumps transfer the untreated stormwater from the primary storage tank up to the biofiltration bed on the surface, via a rising main. Each pump has a duty of 40 litres per second.

Irrigation system

The irrigation pumping system consists of three primary vertical multi-stage submersible bore pumps and a single jockey vertical multi-stage submersible bore pump. The four pumps are located in a sump within the secondary storage tank.

The pumps deliver treated stormwater from the secondary storage tank to the irrigation ring main, via the tank services room for UV treatment. The pumping system is set to maintain a constant pressure of 900 kPa in the ring main.

The jockey pump delivers water to the visitor centre for toilet flushing.

Maintenance

In general, pumps and operation panels should be visibly checked for correct operation every month. Pumps should be raised, removed and delivered to an authorised pump servicing workshop for overhaul every five years or 3000 hours, whichever comes first.

The following tasks are completed on each pump annually:

- check for external corrosion or signs of wear
- check motor insulation resistance
- check motor current draw
- check for excessive bearing noise
- inspect oil seal and replace if necessary
- inspect cables for damage
- inspect pump inlets and clear any accumulated debris/build up or fouling objects.

UV filter

Type: Xylem Wedeco model LBX-200-U on line series UV disinfection unit with automatic wiping system and 3-phase ballast/control panel

The UV disinfection system is used to remove any remaining bacteria from the treated stormwater before it is used for irrigation. Located in the tank services room, the UV filter is controlled remotely by the IRRInet system.

Irrigation system

We operate an automated irrigation system in the Fitzroy Gardens. It distributes treated water from the stormwater harvesting system around the gardens via a large ring main. The ring main also receives drinking water to supplement the treated stormwater supply.

We use sensors in the tanks to record water levels. During times of low rainfall – when there is less stormwater being treated by the system – watering schedules are reduced to prolong the availability of alternative water.

Construction gallery





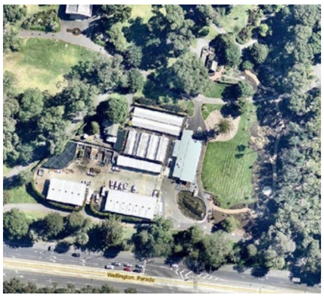









Aerial image sequence









ONGOING MANAGEMENT

Testing and commissioning

After it was complete, we tested the stormwater harvesting system for six months. This included testing for possible problem scenarios and refining level and pump control system settings.

A detailed water quality monitoring strategy was developed and integrated into the operations and maintenance manual. As a baseline, water quality samples were taken immediately upstream of the diversion point.

We monitored the quality of the water in the reuse tank during and after construction. This was to ensure that it complied with the Australian Guidelines for Water Recycling – Stormwater Harvesting and Reuse (July 2009), as well as Victorian plumbing standards.

The stormwater harvesting system is monitored and controlled remotely by the IRRInet irrigation control system. The IRRInet system receives live data from water level sensors, flow meters and water quality detection devices and provides detailed information to the management team.

The water quality is monitored for turbidity, pH and salinity to ensure that the water is fit for irrigation. Monitoring of other water quality indicators will also be conducted, with expected pollutant reductions detailed in the table below.

Stormwater pollutant load reduction

	Total suspended solids	Total phosphorus	Total nitrogen	Gross Pollutant
Pollutant load reduction	12100 kg	18 kg	155 kg	4960 kg
Contribution to pollution reduction targets (Targets outlined in our Total Watermark Strategy)	6.8%	9.2%	18.5%	2.8%

Issues and solutions during testing

Algae crust

An algae crust formed on top of the filter medium in the biofiltration bed as a result of the regular flooding. Although algae contribute to the biological processes that naturally clean the stormwater, in this case it was preventing the water from filtering through the substrate and blocking the system.

The top layer of the filter media, a fine sandy soil, was removed and mixed with large pea gravel and replaced. The larger size gravel pieces allow the water to move through the filter medium more easily. Although the algae still forms around the gravel granules, it no longer forms a crust that prevents filtration.

High salinity levels

When water was first diverted into the system, high levels of salinity were measured, making it unsuitable for irrigation. We flushed the system by emptying both tanks and allowing them to refill naturally. In addition, gypsum was added to the biofilter to offset the effect of any remaining sodium.

These measures have been effective, suggesting that the saline water was a one-off event, likely caused by something in the stormwater drains.

Maintenance

We undertake regular maintenance of the Fitzroy Gardens Stormwater Harvesting Scheme equipment, including:

- inspecting and cleaning out gross pollutant trap
- inspecting and clean out sedimentation chamber
- monitoring operation of pumps, EC meters and pH meters (daily)
- inspecting tanks using camera
- removing weeds from the biofiltration bed and replacing plants as required
- monitoring detention time for filter media and replacing as required (using suction hose).

Note that specific maintenance activities for each system component are included in the construction phase section of this page.

Maintenance cost

Initial calculations by the design consultants suggest that ongoing maintenance will cost around $28,000 per year (in 2012 dollars). This includes removing litter from the gross pollutant trap, replacing plants and filter media, and replacement of the pump and GPT every 10 years.

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State Government Victoria

CITY OF MELBOURNE

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