Water Sensitive Urban Design Strategy

Case Studies

Book Three

January 2004

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Contents

Introduction

Hypothetical case studies are presented to show the types of Water Sensitive Urban Design (WSUD) elements that could be employed in Landcom projects. Projects were selected to represent a range of conditions that are typical of the variety of developments that Landcom is involved with. These include greenfield and urban renewal developments, inner city and fringe areas and developments at different stages of planning (ie. some have street layouts and house types determined while others are at preliminary concept stage).

While these are hypothetical case studies, only realistic opportunities that could be implemented are presented. Depending on the stage of progress of the projects, the suite of WSUD opportunities varies. For example, where street layouts have been determined, the extent to which Best Planning Practices (BPPs) can influence the development is limited. In these cases, a range of potable water demand, stormwater management and wastewater management measures are considered with regard to the planned layout. In examples where the layout of the development is yet to be determined, a range of BPPs are also presented.

For each case study, a range of WSUD elements are presented as opportunities. Impacts of the measures on potable water demand and stormwater pollutant export from the development site are estimated. These results can then be compared against targets set for each development. The case studies provide examples of WSUD elements with preliminary sizing of elements presented. They represent a conceptual design of opportunities and do not represent detailed designs.

Table 3.1 shows the range of WSUD elements that have been included in the four case studies presented. Each case study describes the nature of the development and site constraints, shows WSUD opportunities and estimates the likely treatment performance should the measures be employed.

WSUD elements	Warnervale Town Centre	Willoughby Market Gardens	Rosebery Site	Second Ponds Creek
Best Planning Practices				
Public open space		✓	✓	✓
Road layouts		✓		
Lot layouts		✓		
Potable water demand				
Water conservation	✓	✓	✓	
Water reuse	✓	✓	✓	
Stormwater management				
Gross pollutant traps	✓	✓		
Rainwater tanks	✓		✓	
Vegetated swales*	✓			
Buffer strips	✓		✓	
Bioretention systems	✓	✓	✓	✓
Wetlands			✓	✓
Retarding basins		✓	✓	✓
Waterway rehabilitation	✓	✓		✓

* For the purpose of this table vegetated swales are assumed to have no bioretention trench

Table 3.1

Case Study One – Warnervale

1.1 Nature of the Development

Warnervale Town Centre is a new retail development in Warnervale, located just north of Gosford in New South Wales.

The Warnervale Town Centre will provide retail shops, entertainment facilities, offices and community facilities to the future surrounding greenfields development and the existing Warnervale township. A major carpark will also form part of the development. The site will also contain a watercourse which currently runs across the south eastern corner of the site. The site will be entirely covered with the retail centre and its corresponding carpark.

A refined masterplan for the development is presented as an example of how Best Planning Practices (BPPs) can be incorporated. Opportunities for WSUD are presented given the suggested layout of the development.

1.2 WSUD Objectives

The performance targets for stormwater management this site are the best practice targets of 80% Total Suspended Solid (TSS), 45% Total Phosphorous (TP) and 45% Total Nitrogen (TN) reductions from typical urban runoff. Water conservation measures are also encouraged as well as retaining natural landscape features to improve aesthetics of the development.

1.3 Site Constraints

The site has close proximity to the existing township of Warnervale. Major open space areas are proposed south of the site.

There are steep areas in the north eastern portion of the town centre site (between 1:5 and 1:30). A terraced carpark is proposed for this area. Areas in the south western portion of the site have relatively mild slopes.

Upstream catchment runoff is conveyed through the site, via an existing ephemeral watercourse located in the south western portion of the site. This discharges to the open space areas to the south. All surface flows from the development drain to this watercourse.

1.4 Opportunities for WSUD

Opportunities for BPPs were investigated as part of this case study. In summary these are:

- Using steep upper areas of the site for terraced carpark areas. The terracing reduces surface slopes and provides opportunities for WSUD elements to be incorporated into the design.
- Construct "water art" features within retail areas to provide landscaped focal areas, treat stormwater and highlight WSUD.
- Align the main street along the site contours to reduce street slopes and facilitate the use of WSUD systems within the road reserve.
- Locate retail areas separately from the entertainment areas. Large retail centres are located at the periphery with more boutique shops in the centre of the development.
- Retain and rehabilitate natural ephemeral waterways by locating retail areas around them. These areas will provide a focus corridor for community amenities.

Potable water demand initiatives identified for this site include the use of AAA rated appliances and rainwater tanks to collect roof runoff from all centre roof areas and plumb for toilet flushing. Preliminary sizing of the tanks would suggest the total tank volume of 1.2 ML is required (made up of several large tanks within the site). This would supply 90% of the demand for toilet use in the commercial area. Tanks that collect roof water and allow its reuse will also perform a stormwater treatment function, by reducing the runoff from the site and by allowing suspended solid settlement within the tank.

The dominant stormwater treatment measures are bioretention systems within swales to collect and treat car park and road surface runoff. These systems collect, treat and convey runoff for up to the five-year ARI[1] storm flows and replace a conventional drainage system. Water is collected and passed through fine organic media layer that is heavily vegetated. The treated runoff is then passed into a conventional pipe systems for conveyance to water art features within the retail area.

1.5 WSUD Performance

By installing all of the identified WSUD opportunities in the Warnervale Town Centre, the stormwater treatment objectives can be met. In addition, by collecting and using roof runoff for flushing toilets, 90% of toilet flushing demand can be reduced for all the retail areas.

1 ARI – Average Recurrence Interval. An indication of how frequently a flood of a particular size is likely to occur on average.
For example a 100 year ARI flood is likely to occur once in 100 years.

Warnervale Town Centre

BPP Opportunities

This diagram presents opportunities for best planning practices in the Warnervale Town Centre development.

Re-establish the Natural Waterway through the Site
Align the retail development to allow for the natural ephemeral waterway to be rehabilitated as part of the development and provide a focus corridor for community amenities. This feature will become a community focus with the surrounding development incorporating aspects towards this landscape feature.

Shopping Centre Design
As in current best practice urban design the retail areas are located separately from the entertainment areas. Large retail centres are located at theperiphery with boutique shops in the centre of the development.

Overall development area layout plan

Sensitive Carpark Layout
The steep upper areas of the site to be terraced to accommodate carpark areas and reduce surface slopes. Vegetated carpark dividers can then be used for WSUD systems.

Sensitive Street Layout and Design
The main street thoughthe development is aligned to run along the site contours.The street is to have a centre median which will facilitate the use of WSUD systems within the road reserve.

Focal Points
Treated stormwater can be used in urban art features in highly prominent locations in retail areas. This helps to highlight the WSUD applications within the development to users of the retail facility. These features will become a community focus with the surrounding development incorporating aspects towards the landscape features.

Warnervale Town Centre

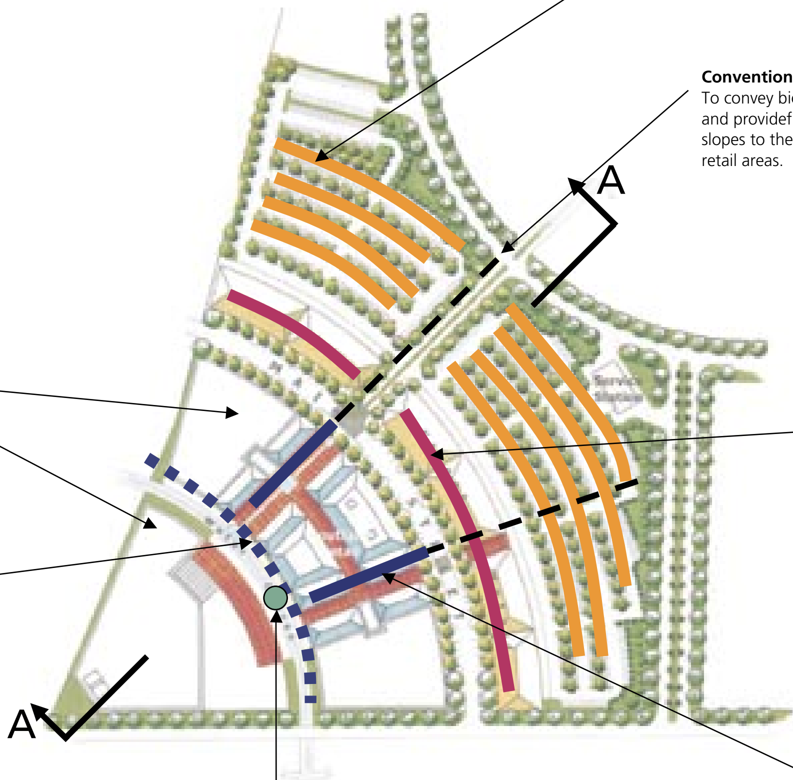
WSUD Concept Plan

- Recycled Water Art Feature
- Bioretention System (Carpark)
- Bioretention system (Roadside)
- Constructed Vegetated Waterway
- Conversional Drainage System
- Gross Pollutant Trap

Rainwater Tanks
Rainwater tanks will be used to collect rainfall from the Cinema, food court and retail areas. Stored water can then be pumped and used for toilet flushing within the shopping centre and cinema. To achieve a 90% reliability a total tank volume of about 500 m³ is required for the cinema and food court and 700m³ for the large retail and boutique areas area.

Constructed Vegetated Waterway
The waterway though the retail area will provide improved amenity and be a recreation link to surrounding areas. Treated water from the retail development and carpark areas will be conveyed within this ephemeral system to a regional wetland located downstream. Design issues include litter control, design capacity, integration of the landscape design and waterway stabilisation.

Gross Pollutant Traps
Required to treat stormwater from all paved areas not receiving any other treatment. Litter, course sediment and some fine sediments will be removed before discharge to the constructed vegetated waterway.



Car Park Bioretention System
To be located in all carpark dividers. The carpark will be required to be terraced to provide a suitable slope for the systems. Design issues include the provision of adequate discharge capacity, the provision of stormwater treatment for flows up to the 3-month ARI peak discharge and incorporation into the carpark landscape design.

Conventional Drainage System
To convey bioretention system outflows and provideflood capacity down steep slopes to the water art features in the retail areas.

Main Street Bioretention System
To be incorporated on the high side of the street and be within a vegetated swale. Road and footpath stormwater be treated via infiltration though soil media in the base of the swale and conveyed, via perforated pipes to the water art feature. High flows will be accommodated within the swale. Design issues include the provision of adequate discharge capacity, provision of adequate stormwater treatment, incorporation into the street landscape design and the provision of main drainage connections.

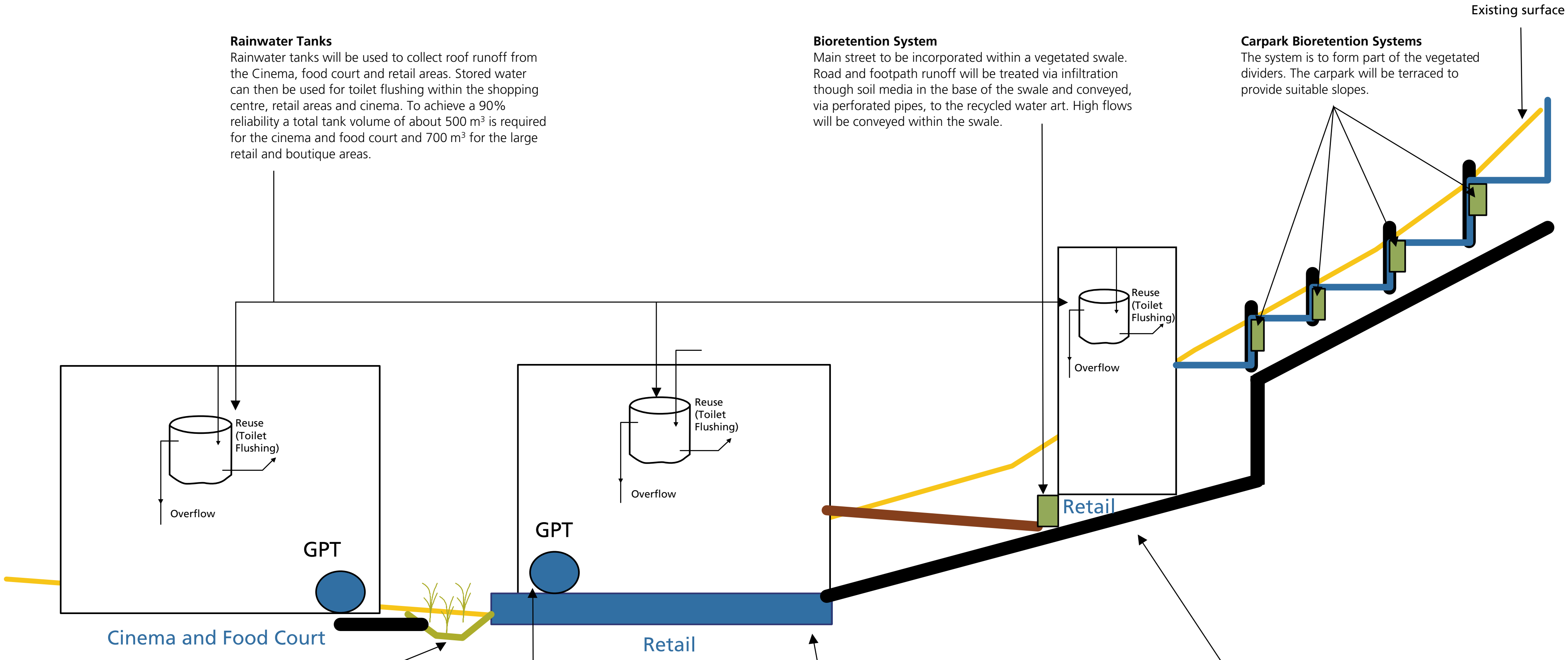
Water Art Features
Treated stormwater from upstream bioretention systems will discharge into the water art features. These features highlight the water treatment within the precinct and provide a significant landscape feature within the retail areas.

Warnervale Town Centre
WSUD Concept Plan

Rainwater Tanks
Rainwater tanks will be used to collect roof runoff from the Cinema, food court and retail areas. Stored water can then be used for toilet flushing within the shopping centre, retail areas and cinema. To achieve a 90% reliability a total tank volume of about 500 m^3 is required for the cinema and food court and 700 m^3 for the large retail and boutique areas.

Bioretention System
Main street to be incorporated within a vegetated swale. Road and footpath runoff will be treated via infiltration though soil media in the base of the swale and conveyed, via perforated pipes, to the recycled water art. High flows will be conveyed within the swale.

Carpark Bioretention Systems
The system is to form part of the vegetated dividers. The carpark will be terraced to provide suitable slopes.



Constructed Vegetated Waterway
Treated water from the retail development and carpark areas will be conveyed within this ephemeral system.

Gross Pollutant Traps
To remove litter from all paved area runoff not receiving any other treatment. Litter and course sediment will be removed from the water column before discharge to the ephemeral swale system.

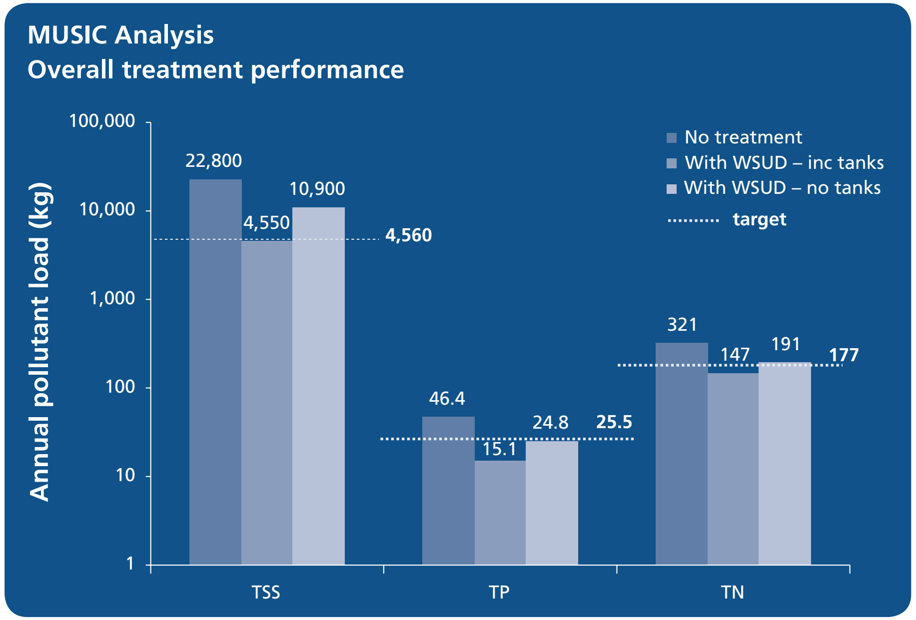
Recycled Water Art Features
Treated stormwater from the upstream bioretention systems will discharge into the water art features. These features will highlight the water treatment within the precinct and provide a significant landscape feature within the retail areas.

Conventional Drainage System
To convey bioretention system outflows and provide flood capacity for steep slopes. This system will discharge into the water art features in retail areas.

Warnervale Town Centre

Performance Assessment

MUSIC Model Structure to Assess Treatment Performance



MUSIC was used to assess the performance of the identified WSUD opportunities for Warnervale Town Centre. The plot presents the results with the load of pollutants generated with no treatments installed, the loads generated with all identified WSUD elements installed, loads generated with WSUD elements installed excluding rainwater tanks and the target pollutant loads for the development.

The plots shows that the development can meet the stormwater quality targets with all identified WSUD elements installed. In addition, rainwater tanks, installed to collect roof runoff and be reused for toilet flushing in the retail areas, will reduce potable water demand for toilet flushing by 90%.

Case Study Two – Willoughby Market Gardens

2.1 Nature of the Development

Willoughby Market Gardens is an urban renewal development in Willoughby, in the inner north of Sydney. It is bounded by well established residential areas, a creek and a school. 80 residential lots are proposed on the elongated 4.8 hectare site that is adjacent to Sailors Bay Creek. The site will also contain substantial parkland areas (approximately 25% of the area) and pedestrian corridors. Housing densities are planned to be between 20 and 25 lots per hectare in the housing area.

Development plans for the area are well established with street and housing layouts complete as well as preliminary house plans developed. The refined masterplan has been presented to community groups and council. Opportunities for WSUD are presented given the proposed layout of the development.

2.2 WSUD Objectives

Natural areas in the development area are to be retained as much as possible and where practical, become landscape features. Water conservation is also important to the development. Reducing potable water demand by 65% through reuse measures is the ultimate objective.

Stormwater treatment objectives are to meet State guidelines of best practice, which include 80% TSS, 45% TP and 45% TN reduction from typical urban loads.

2.3 Site Constraints

The area is in the inner north of Sydney and has close proximity to existing urban areas. All surface flows drain to Sailors Bay Creek on the southern boundary. The site has typically shallow erodable soils with shallow bedrock. In addition, areas of the development contain up to two metres of fill that will require removal prior to construction.

There are steep areas (between 1:5 and 1:10) in the east end of the development with streets that run directly down the slope. Other areas have relatively mild slopes.

Upstream catchment runoff is conveyed through the site, via an informal drainage path after being discharged from existing pipes from a conventional drainage system. Only limited details of the upstream drainage system have been identified.

2.4 Opportunities for WSUD

With the layout of the site determined, opportunities for BPPs were not investigated as part of this case study.

Potable water demand initiatives identified for this site include the use of AAA rated appliances, education of the residents on water conservation matters and the use of rainwater tanks to collect roof water and plumb the collected water for toilet flushing and hot water demands. Preliminary sizing of the tanks would suggest a 1.1 kL tank for each dwelling would supply 85% of the demand for hot water and toilets use. This would reduce internal potable water use by approximately 47%.

The dominant stormwater treatment opportunities are the use of bioretention trenches with swales to collect and treat surface runoff. The bioretention systems collect, treat and convey runoff for up to the five-year ARI storm flows and replace a conventional drainage system. Water is collected and passed through a fine organic media layer that is heavily vegetated.

In steeper areas, conventional pipe systems are used to convey flows and reduce flooding risks as the steep grades could lead to erosion of bioretention systems and swales. Bioretention planter boxes along the streets are used in these areas to provide some stormwater quality treatment before flows enter a conventional drainage system.

At the southern end of the park, a bioretention rain garden could be installed as a water quality improvement facility as well as becoming a local amenity focus for the park area. Collected water from this area could also be reused as irrigation water for the parkland or the community gardens.

Tanks that collect roof water and allow its reuse will also perform a stormwater treatment function, by reducing the runoff from the site and by allowing suspended solid settlement within the tank.

Household backyards could also be fitted with small bioretention rain gardens. These areas would collect runoff for backyards and filter the water before it drains into a pipe to convey it off the property.

Runoff from upstream catchments enters the site at the end of Mowbray Road and currently finds its way to the creek through an informal drainage path. This runoff could be treated to remove gross pollutants (litter and debris) and then discharged via a rehabilitated waterway.

Opportunities for local treatment and reuse of wastewater were not considered viable for this development because of its small scale and the presence of existing infrastructure.

2.5 WSUD Performance

By implementing all the WSUD elements identified here for Willoughby Market Gardens stormwater treatment objectives can be met. The installation of rainwater tanks, with reuse to hot water and toilets, will not only help to satisfy the stormwater treatment objectives, but will also meet 85% of toilet and hot water demand. This will reduce household potable water demand by approximately 35%.

Willoughby Market Gardens

WSUD Opportunities

This diagram presents opportunities for stormwater collection, treatment and reuse within the Willoughby Market Gardens development.

- Bioretention System
- Bioretention Planter Boxes
- Rain Garden
- Gross Pollutant Trap
- Constructed Vegetated Waterway
- Conversional Drainage System

Rainwater Tanks
Used to collect rainfall from all household roof areas. Stored water can then be used for toilet flushing and hot water services. Design issues include sizing tanks for reliable supply and incorporating tanks into urban design.

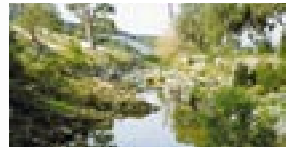
Gross Pollutant Trap
Installed to remove litter and debris from a conventional drainage system (from an upstream catchment) prior to entering a rehabilitated waterway. Design issues include the siting of the trap, determining treatment flows and maintenance practices.

Bioretention Systems
For mild sloped streets. The system is to form part of the “nature strip” of residential allotments with the adjoining street having a single crossfall towards the bioretention system. Provision of footpath and location of services to be on the opposite of the street. Design issues include provision of adequate discharge capacity to contain the 5-year ARI peak discharge, incorporation into streetscape design and provision of house connections.

Riparian Zone Rehabilitation
Areas along Sailors Bay Creek are to be stabilised and rehabilitated in accordance with best practice. Design issues include selection of vegetation to provide habitat for local fauna and aquatic species and integrate into the parkland as well as stablisation of the creek banks and bed.

Conventional Drainage System
To provide flood capacity in steep areas and to direct water into Sailors Bay Creek. Creek entries will be required to compliment rehabilitated area and provide stabilisation.

Bioretention Planter Boxes
For steep streets.The system will be installed in the footpath reserve on both sides of the streets. Planted with native vegetation, water is filtered through a chamber filled with a medium capable of growing dense vegetation as well as passing stormwater. Filtered water drains from the planter boxes into a conventional drainage system. Design issues include provision of stormwater treatment and incorporation into the street design.



Constructed Vegetated Wateryway
To convey upstream catchment runoff to the creek and provide park amenity. Design issues include litter and debris control of upstream flows, integration of waterway through parklands and stablisation of the entry into Sailors Bay Creek.

Rain Garden
Designed for stormwater quality treatment, floodwater detention and as an ornamental feature. This system is to serve as a discharge point for the bioretention/ swale system. Stormwater in the rain garden will be filtered through sand/organic mulch media before entering a more conventional pipe system that flows to the creek. Design issues include the appropriate selection of stormwater detention time, vegetation, storage volume and design of connections to creek.

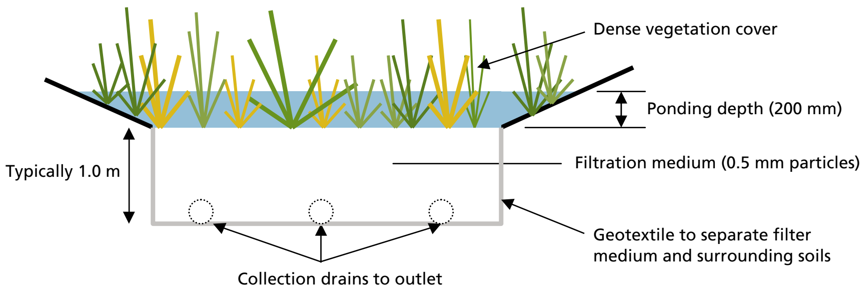
Willoughby Market Gardens

Treatment Details

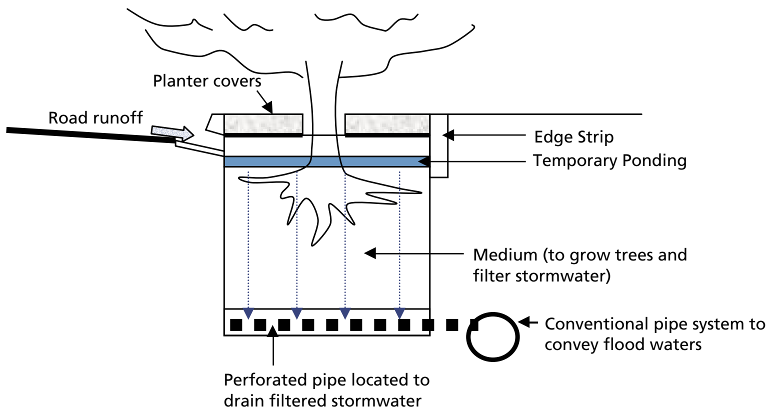
This presents some details and dimensions of possible treatment measures for the Willoughby Market Gardens development. The diagrams here represent how the systems were modelled in the MUSIC package to estimate their treatment performance.

Bioretention Rain Gardens

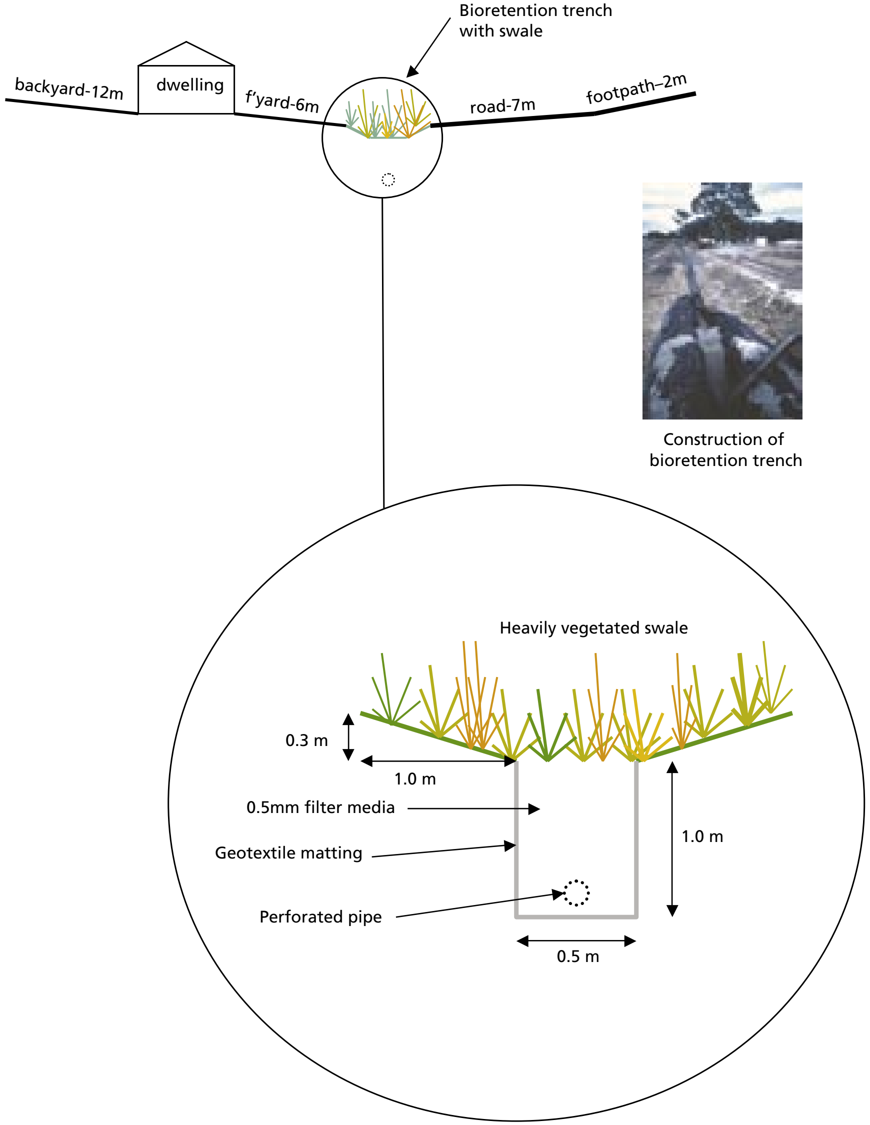
Rain gardens are possible in the backyards of houses as well as a larger rain garden to collect and treat street runoff from the western end of the development. Both systems operate on similar principles that include infiltrating stormwater through a prescribed medium with dense vegetation. Both also include temporary ponding of water to maximise the volume of water treated.



Bioretention Planter Boxes



Bioretention Drainage System



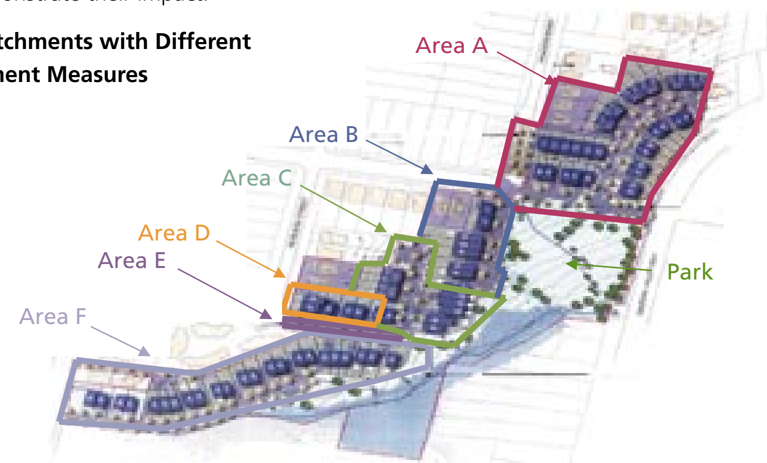
Construction of bioretention trench

Willoughby Market Gardens

WSUD Stormwater Treatment Performance

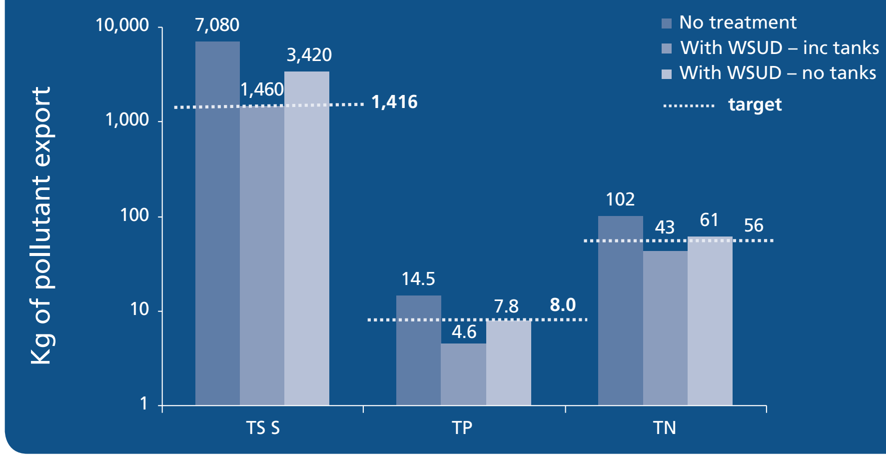
This sheet shows how the development proposal was modelled using the MUSIC package to assess stormwater treatment performance against best practice targets. The system was modeled with and without household rainwater tanks plumbed to hot water and toilets to demonstrate their impact.

Subcatchments with Different Treatment Measures

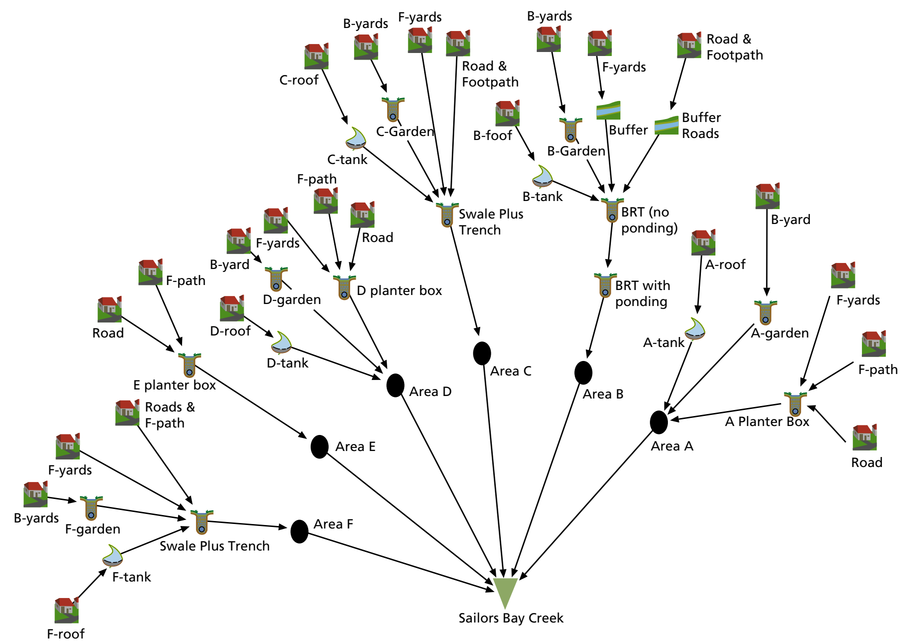


Treatment performance with MUSIC analysis

Overall treatment performance



MUSIC Model Structure to Assess Treatment Performance



MUSIC was used to assess the performance of the WSUD opportunities for Willoughby Market Gardens. The plot presents the results with the load of pollutants generated with no treatments installed, the loads generated with all identified WSUD elements installed, loads generated with WSUD elements installed excluding rainwater tanks as well as the target pollutant loads for the development. The plot shows that the development can meet stormwater quality targets using all of the identified WSUD elements within the accuracy of the modelling. The rainwater tanks (and reuse to toilets and hot water) will also provide the benefit of reducing potable water demand.

Case Study Three – Rosebery Site

3.1 Nature of the Development

The development site is a rectangular 1.8 hectare urban renewal development in Rosebery, in the inner south of Sydney. The site was owned by the Roads and Traffic Authority (RTA) and includes ex-testing laboratories and a nine-storey office building as well as car parks and other ancillary sheds.

Planning for the development is at a concept plan stage, with preliminary designs indicating buildings with approximately between 250 and 275 residential units, underground car parks and areas of open space intended for residential use. The plans show redevelopment of the existing office building and construction of new buildings for the remainder of the proposed housing. These preliminary plans are used as a base for the WSUD opportunities in this report.

3.2 WSUD Objectives

Objectives for this site include reduction of potable water demand by 65% of typical household consumption, the use of WSUD to treat stormwater to meet State quality guidelines (80% TSS, 45% TP and 45% TN reduction from typical loads) and the use of water in the urban landform to enhance wildlife habitat and provide recreation and aesthetic features for residents.

3.3 Site Constraints

The site is completely surrounded by existing development and is bounded by four streets. Flood retention standards of the area have been set at retaining a twenty year ARI storm flow to pre development levels.

The area has approximately three metres of fall across the 80m wide site, with little longitudinal slope. With such high density residential living planned, open space areas are required to suit the development and provide for as many residents as possible.

3.4 Opportunities for WSUD

The ultra urban nature of the development leads to opportunities to incorporate water into the design of the building form and function as well as in landscaped areas.

Opportunities within the buildings include the use of rooftop rain gardens to provide recreation areas for residents, improve aesthetics of overlooking buildings, provide treatment to stormwater and improve insulation of the building. The mass of the soil and vegetation on the rooftop garden provides an excellent insulation layer to regulate the internal building temperature, thus reducing energy requirements.

Collected water could be stored in internal tanks within the building. These would be incorporated into the floor design of the residences and provide an enhanced thermal mass. This would reduce heating and cooling requirements and also provide a source of water for hot water systems (thus reducing potable water demand).

Potable water demand can be further reduced through the use of light greywater for toilet flushing, and surplus amounts treated and used for garden irrigation. Light greywater (collected from bathrooms only) could be stored for up to 24 hours and used for toilet flushing. After this period the surplus water could discharge into a wetland treatment system located in the landscaped areas. Water from the wetland treatment system could then be further used to irrigate surrounding gardens.

The open space areas allow water features to be incorporated into the design that will enhance the aesthetics of the area. A wetland system will treat light-grey water surplus while rain gardens with bioretention systems could treat surface runoff and be installed in other landscaped areas of the development. Hard landscaped areas of the development could drain to the proposed rain gardens, while street stormwater (from New Street) could be treated with bioretention planter boxes. The planter boxes would be integrated into the street design and provide a streetscape feature as well as providing treatment for street runoff.

Open areas in the development also provide opportunities for residents to enjoy aspect over them as well as interacting in the spaces. The rooftop gardens, rain gardens, wetland system and indigenous gardens all improve the aesthetics of the development and provide private spaces for people to use.

3.5 WSUD performance

There are many options for reducing potable water demand in the Rosebery Site. These include using collected rainwater in hot water systems, collecting and reusing light greywater for toilet flushing and using treated light greywater for garden irrigation. The proportion of potable water reduced will depend on the number of opportunities adopted and the extent over the site (i.e. the number of buildings with WSUD elements installed). Potentially 65% of potable water demand could be reduced.

Stormwater treatment objectives could be met with a range of elements selected from the opportunities outlined. An analysis of the treatment performance of these opportunities would require more certainty about the likely configuration and feasibility of the proposed systems in the development plans. In fact, potentially only several of the WSUD elements may be required to meet the stormwater quality objectives. However, it may be opportunistic to maximise the reduction in potable water demand by implementing the light greywater and stormwater treatment systems together.

Rosebery Site

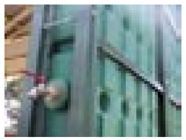
WSUD Opportunities

This diagram presents opportunities to implement WSUD elements into the proposed development in Rosebery.

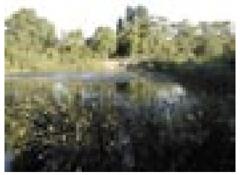
Details of greywater and roof water harvesting.

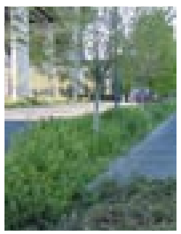
Plan view of WSUD opportunities

Roof Water
To be collected and used for hot water supply. Storage of water to be inside dwellings to improve thermal mass inside buildings and hot water to use solar systems.



Greywater Reuse and Treatment
Collected light greywater to be used for toilet flushing and excess water to be treated in a wetland that also provides a landscape feature and irrigation supply for surrounding areas.

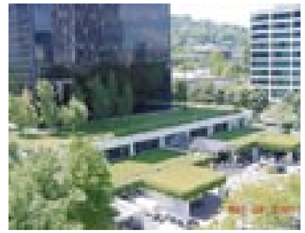




Bioretention Systems
To form part of the garden landscape. Surface runoff will be collected and filtered through a vegetated fine media layer and excess will discharge to the local stormwater system.

Street Planter Boxes
To be installed into footpaths and incorporated into the street design. Planted with native vegetation, water will be filtered through a filter medium and discharge to the local stormwater system.

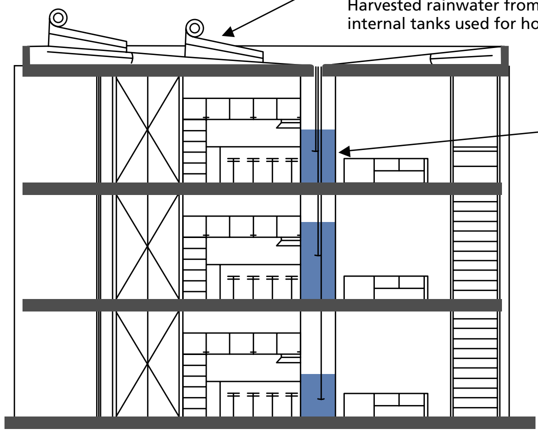
Rooftop Gardens
To improve building insulation and the outlook over them. They will collect rainwater and filter it through a soil medium, collected water will then drain to internal tanks for reuse in hot water services. Stored water will also increase the thermal inertia of the building interior and the garden will insulate the rooftop.



Rain Garden
To treat surface runoff, provide detention and become a landscape feature for recreation.

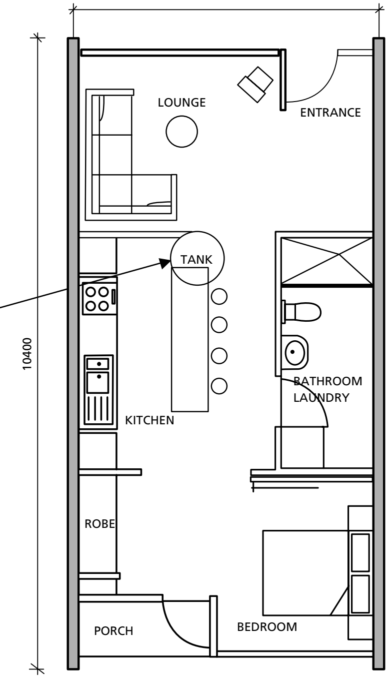
Rosebery Site
WSUD Details

Rooftop Rain Water
It is efficiently collected and transferred to storage tanks. Collection systems and solar hot water services to be designed into roof space.



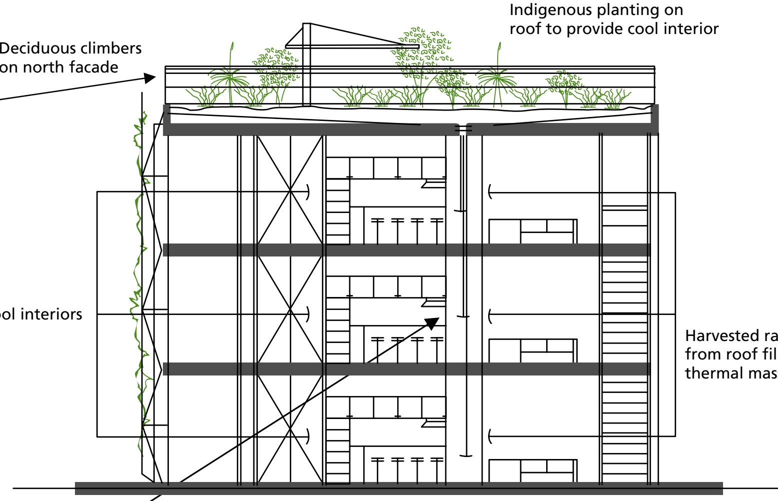
Section of building with roof water collection, storage and solar hot water systems

Storage Tanks
To be incorporated into the building design and increase thermal inertia of building as well as supplying hot water services.



Potential floorplan incorporating storage tank

Rooftop Garden
To provide recreation area, increase building insulation and to collect and treat rainwater.



Section of building with rooftop garden and internal storage tanks

Case Study Four – Second Ponds Creek

4.1 Nature of the Development

Second Ponds Creek is a large scale urban development planned within an environment of high salinity hazard. The site is to be developed in a number of stages and will be staged over a significant period of time. Stage 1 will be subject to a joint venture arrangement while Stage 2 will be developed by Landcom separately. Second Ponds Creek forms the main watercourse through the development site. A landscape strategy for the main watercourse is to be developed independent of the development stages and will be amongst the first series of works to be undertaken on the site.

4.2 WSUD Objectives

Stormwater management on the Landcom's Seconds Ponds Creek development is directed at two principal management objectives aimed at (i) protecting the ecosystem health and channel form stability of Second Ponds Creek, and (ii) the treatment of stormwater runoff to ensure the loads of stormwater pollutants discharged to Second Ponds Creek and downstream receiving waters do not adversely impact on the ecological health of these waterways. A combination of near source control, through the use of streetscape treatment measures, and "end-of-pipe" measures associated with riparian zone rehabilitation and trunk drainage flood management measures will be implemented.

4.3 Site Constraints

The overall site comprises approximately 390 ha of land which slopes from its east and west edges down towards Second Ponds Creek that runs north south through the centre of the site. There are a number of areas of significant vegetation both on the site and within the main watercourse. The site has a shallow A-horizon soil overlying the sodic B-horizon.

Second Ponds Creek is severely degraded with significant exposure of the sodic B-horizon soils.

4.4 Opportunities for WSUD

There are a number of stormwater management measures that can function within an overall network of stormwater elements to achieve the management objectives. Stormwater treatment measures that are capable of achieving best practice stormwater management objectives within an environment of high salinity hazard are fundamentally those that do not rely on infiltrating stormwater into the ground. From consideration of the proposed layout of the development, it is recommended that a combination of vegetated swales, bioretention and constructed wetlands systems be utilised for stormwater management of the proposed development.

There is a requirement to incorporate a number of flood retarding basins for the attenuation of large floods (up to the 100 year ARI event) to acceptable levels. Bioretention systems have been incorporated into the floor of these basins to provide stormwater quality treatment and to attenuate frequent flood events to pre-development levels. These management measures have been designed to meet current best practice objectives in pollutant load reduction and flow targets set by the NSW Environment Protection Authority (EPA) and Blacktown City Council in their respective stormwater management guidelines.

The form of bioretention system adopted is a combined stormwater detention basin with a stormwater filtration system. Stormwater is discharge onto the surface of the bioretention system and filtered through a prescribed media (eg. sandy loam) as it percolates downwards before being collected by an underlying perforated pipe for subsequent discharge to a stormwater system. The hydraulic conductivity of the sandy loam filter media has is significantly higher than the surrounding soils such that the flowpath of infiltrated stormwater is well defined and exfiltration from the trench to the surrounding soils minimised. For the site conditions at Second Ponds Creek, the base of the bioretention system will be lined to eliminate any likelihood of groundwater recharge by stormwater.

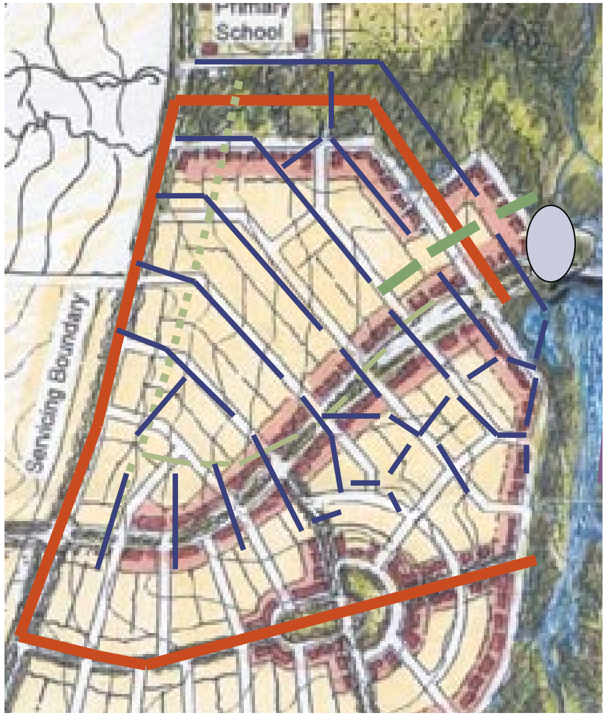
The waterway rehabilitation works are directed at elimination of exposure of the B-horizon soil layer by erosion prevention measures including flow management (ie. attenuation of frequent flood events) and rehabilitation of the geomorphic form of the existing watercourse. There are existing templates of how vegetation is able to stabilise and mitigate bank erosion and the landscape strategy for the rehabilitation of Second Ponds Creek will be guided by these features.

Key features of the proposed waterway rehabilitation works include:

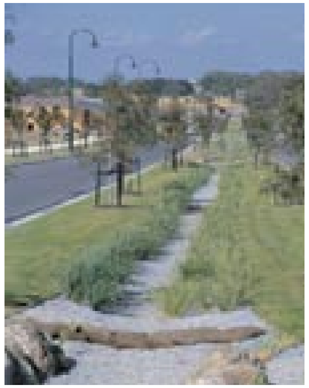
- The construction of regular rock bars to stabilise the bed profile of the creek.
- The provision of a low flow channel with sufficient capacity to convey flows up to the 3-month ARI event.
- The provision of a vegetated watercourse (mid-flow channel) with sufficient capacity to convey flows up to the 2 year ARI event.
- The formation of flatter bank slopes with adequate coverage of A-Horizon soil layer.
- The planting of the mid-flow channel with appropriate vegetation with sufficient density to enable adequate bank erosion protection in addition to its habitat and other riparian zone function attributes.

4.5 WSUD Performance

WSUD elements identified for Second Ponds Creek are sized to satisfy stormwater treatment requirements.

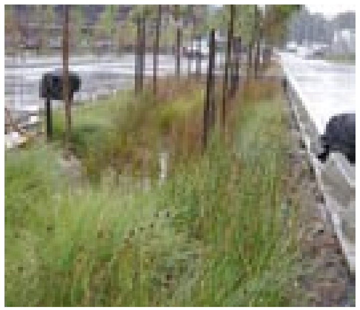


Valley Connector Bioretention type 2



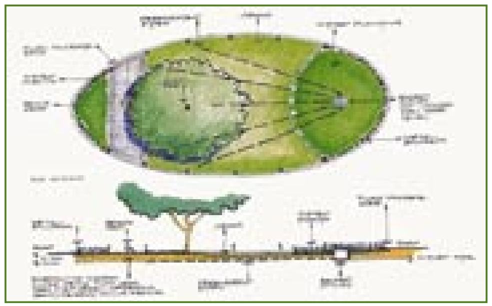
Bioretention System for Valley Connector. Typical width of 3 to 4 m with roads on either side having a single crossfall towards the bioretention system. The example pictured incorporates use of a gravel filter medium. A fully vegetated surface with filtration through sandy loam is recommended unless pre-treatment for course and medium sediments can be ensured through the use of grass buffers.

Valley Connector Bioretention type 1



Similar to Valley Connector bioretention type 2, but used where grades are flat and catchment areas are smaller (where flow capacity and conveyance are less of a design issue). Runoff is detained in a manner approaching treatment within a 'raingarden'; with dense vegetation and a disconnected flow path.

Boulevarde Raingarden



"Rain Garden" designed for stormwater quality treatment, stormwater detention and as an ornamental feature. Stormwater at the rain garden will be directed into a more conventional pipe system following filtration through the sand/organic mulch medium. Design issues include the appropriate selection of stormwater detention time, storage volume and design of hydraulic structure connections to stormwater pipes.

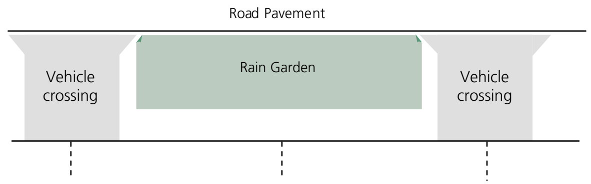
Second Ponds Creek - Subcatchment C

Wetland or Bioretention basin. See Riparian Buffer Strategy.

Subcatchment boundary

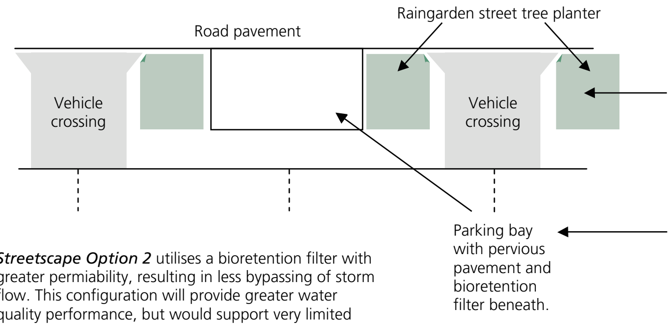
Local streetscape bioretention

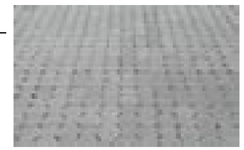
Local Street and Neighbourhood Connector streetscape treatment option 1



"Rain Garden" designed for stormwater quality treatment, stormwater detention and as an ornamental feature. Stormwater at the rain garden will be directed into a more conventional pipe system following filtration through the sand/organic mulch medium. Design issues include the appropriate selection of stormwater detention time, storage volume and design of hydraulic structure connections to stormwater pipes.

Local Street and Neighbourhood Connector streetscape treatment option 2



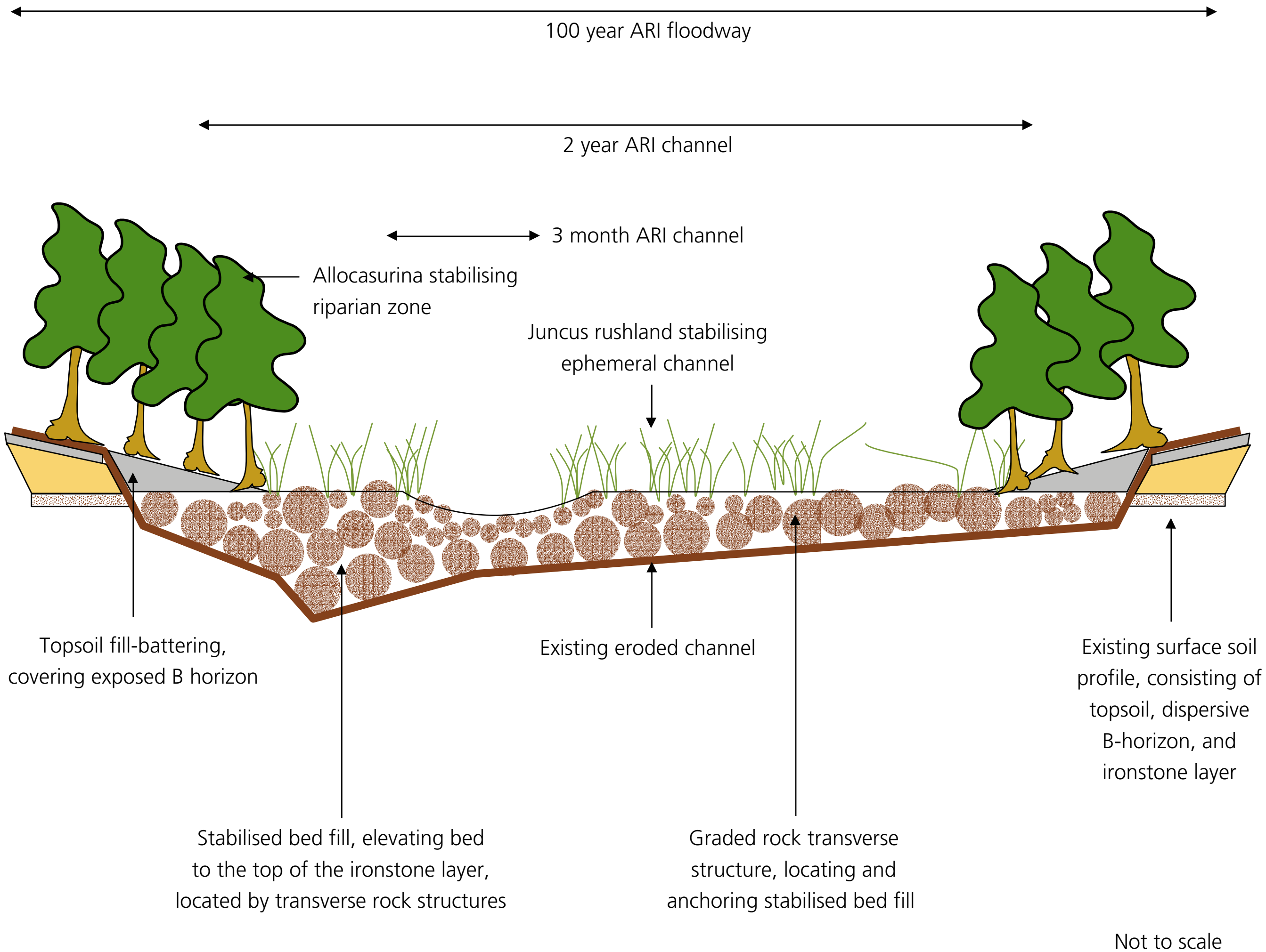


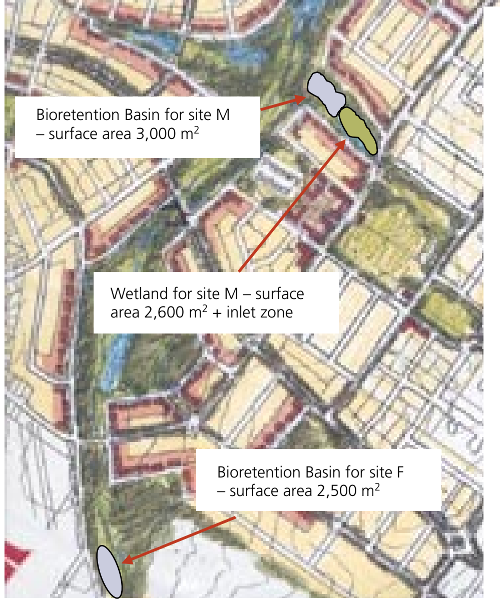
Streetscape Option 2 utilises a bioretention filter with greater permiability, resulting in less bypassing of storm flow. This configuration will provide greater water quality performance, but would support very limited vegetation and is better suited to use beneath a pervious pavement.

Local Street and Neighbourhood Connector streetscape treatment option 3

Bioretention System. The system is to form part of the "nature strip" (~ 2 to 3 m wide) of residential allotments with the adjoining road having a single crossfall towards the bioretention system. Provision of footpath and location of services may need to be on the opposite of the street. Design issues include (i) the provision of adequate discharge capacity to contain the 5-year ARI peak discharge; (ii) incorporation into streetscape design; (iv) provision of house connections etc.

Second Ponds Creek
Strategy for Restoration of Main Watercourse



Second Ponds Creek

Strategy for Stormwater Quality Treatment Measures within Riparian Buffer Combination of Wetlands and Bioretention 'Basins.'

- Areas of Landcom development are assumed to have met NSW EPA Stormwater Quality objectives through adopting initiatives within the development. The treatment measures within the riparian buffer, presented here as Option 2 are required for treatment of runoff from development areas other than Landcom.
- The configuration illustrated here attains BPEM objectives for stormwater quality.
- The intent of the strategy presented as Option 2, is to facilitate the inclusion of wetlands as treatment measures in place of Bioretention Basins wherever possible; given the space available as suitable sites within the riparian buffer.
- Viewed solely from the perspective of stormwater quality treatment, Option 2 is a less efficient use of space, but responds to an anticipated need to develop scope for landscaping and passive recreation alternatives.

Bioretention Basin
Designed for stormwater quality treatment, stormwater detention and as a ephemeral landscape feature with no permanent pools. Flows entering the Bioretention Basin during a storm event will initially pond at a shallow depth in the densely vegetated detention storage, whilst infiltration through a sandy loam medium takes place. The treated flows are then collected by a network of slotted PVC pipes located beneath the filtration medium before being discharged to Second Ponds Creek. Design issues include the appropriate selection of stormwater detention time, storage volume and design of hydraulic structure connections.

Wetland within Riparian buffer

Constructed wetlands
Are shallow ponded systems, which regularly fill and drain. Wetlands are typically extensively vegetated with emergent aquatic macrophytes. Many definitions of wetland exist in the scientific literature. Some parts of the stormwater management industry refer to the whole system of marshland, pond and urban forest as a constructed wetland. A constructed wetland system can be constructed onto the floor of a flood retarding basin and would generally comprise of:

- a sedimentation pond: a relatively deep open water body with vegetated edge and possibly submergent macrophytes (aquatic plants); and
- a wetland: a macrophyte zone, or a permanent or ephemeral shallow water body with extensive emergent vegetation.

Notes

Environmental System

Certified
Environmental
Management

ISO 14001
Lic C10166
Standards Australia

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