EDAW | AECOM

MONASH University Engineering
Institute for Sustainable Water Resources

FAWB
Facility for Advancing Water Biofiltration

# Advancing Raingarden Design

June 2008

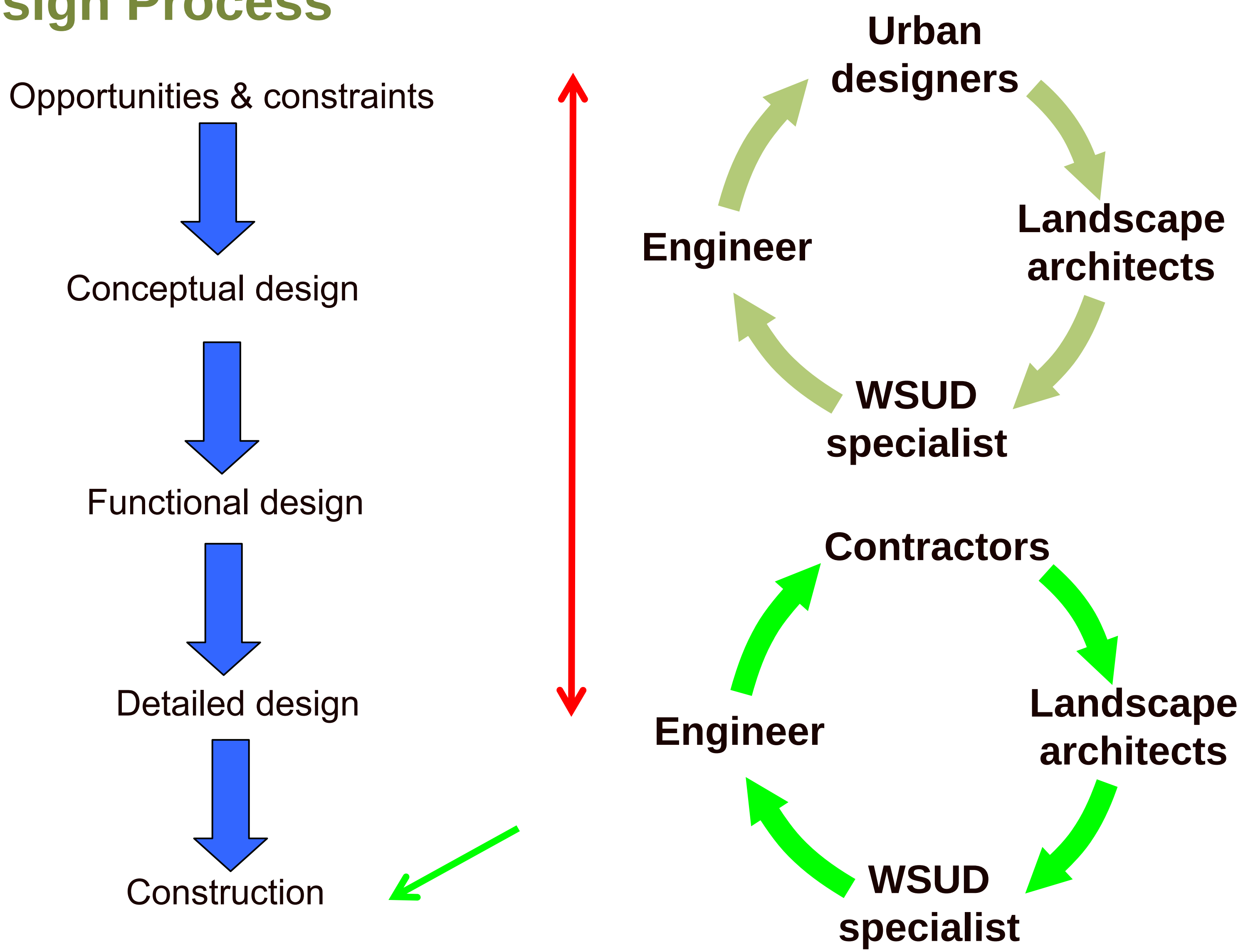
# Agenda

| Session | Time |
|---|---|
| Introduction and overview | 9:00-9:15 |
| Designing rain gardens<br>• Design process<br>• Sizing and design attributes<br>• Construction<br>• Soil media and drainage layer<br>• Vegetation selection<br>• Maintenance and management | 9:15-10:45 |
| Morning tea | 10:45-11:15 |
| Overcoming your challenges - Q&A's #1 (breakout into 4 groups)<br>Opportunity for attendees to discuss and work on their own projects | 11:15-12:45 |
| Lunch | 12:45-1:30 |
| Overcoming your challenges - Q&A's #2 (break out into 6 smaller groups)<br>Opportunity for attendees to discuss and work on their own projects with peers | 1:30-3:00 |
| Afternoon tea | 3:00-3:30 |
| Reporting back case studies for all participants | 3:30-4:45 |
| Close | 4:45-5:00 |

# Presentation outline

- Design process
- Sizing and design attributes
- Construction

# Design Process



# Opportunities and Constraints

- Landscape/urban design theme
- Treatment targets
- Water demands
- Catchment properties (size, flow rates, landuse)
- Site levels
- Existing drainage
- Space
- Soil properties (salinity, acidity)
- Urban design (e.g. solar orientation)

# Opportunities and Constraints

# Concept Design

- STEP ONE: Select stormwater treatment measure(s)
  - Rain gardens
  - Wetlands
  - Swales
  - Ponds




# Why might we choose a rain garden?

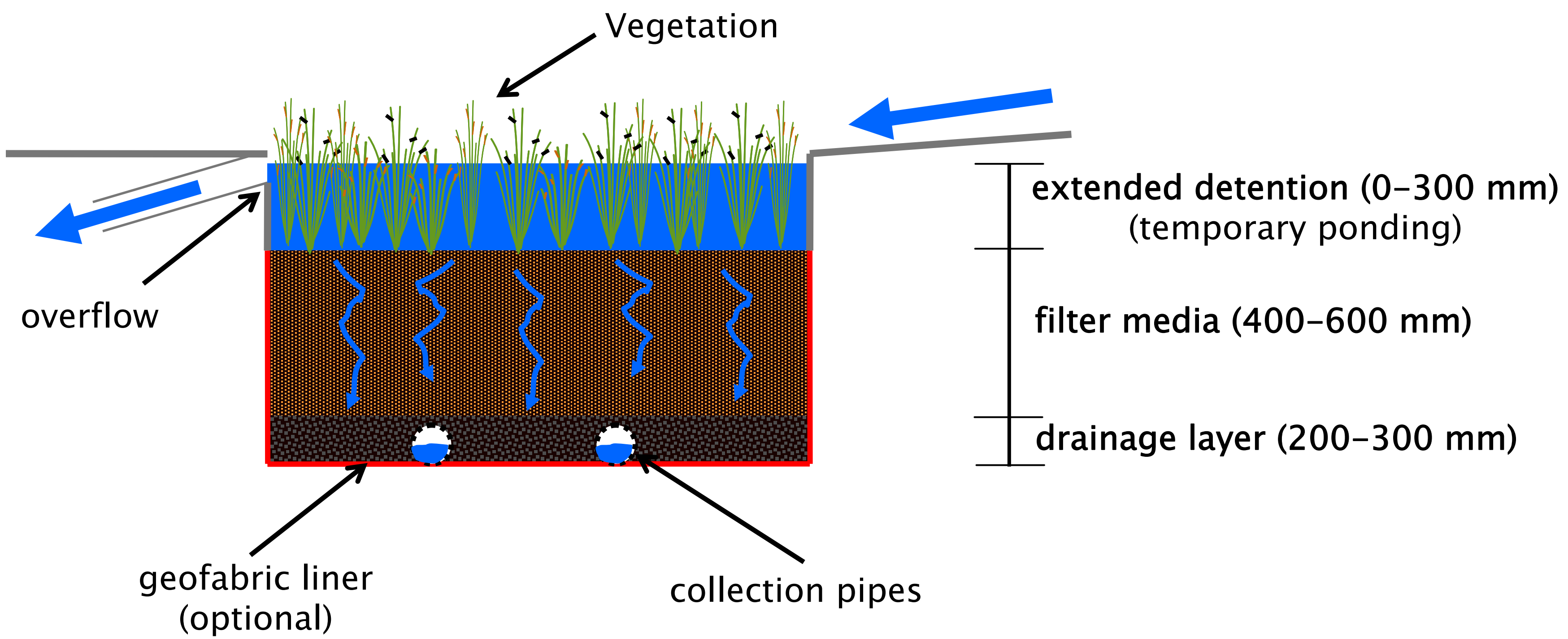
- Attractive landscape features
- Self irrigating (and fertilising) gardens
- Habitat creation
- Potential source of water for reuse
- Not restricted by scale
- Integration with urban design (streetscape)
- Reduce impacts of urbanisation on hydrology
- Remove stormwater pollutants (protect receiving waters)



# Rain gardens

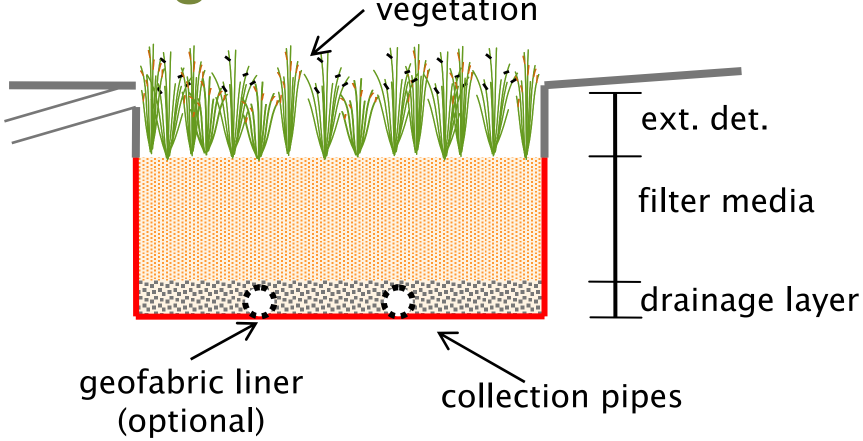
Also referred to as:

- Bioretention systems
- Biofiltration systems
- Biofilters

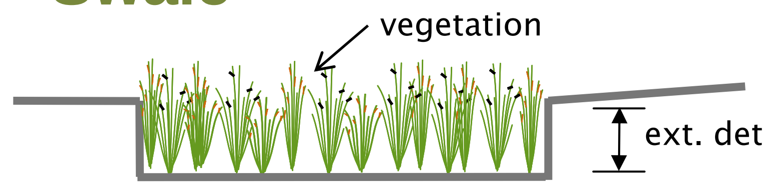


# Similarities to other treatment elements

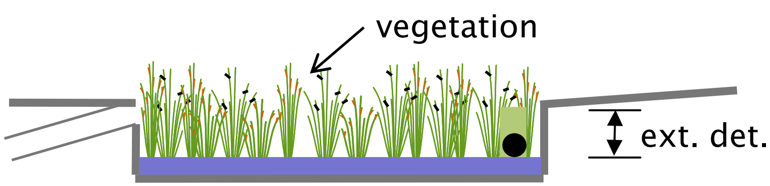
## Raingarden



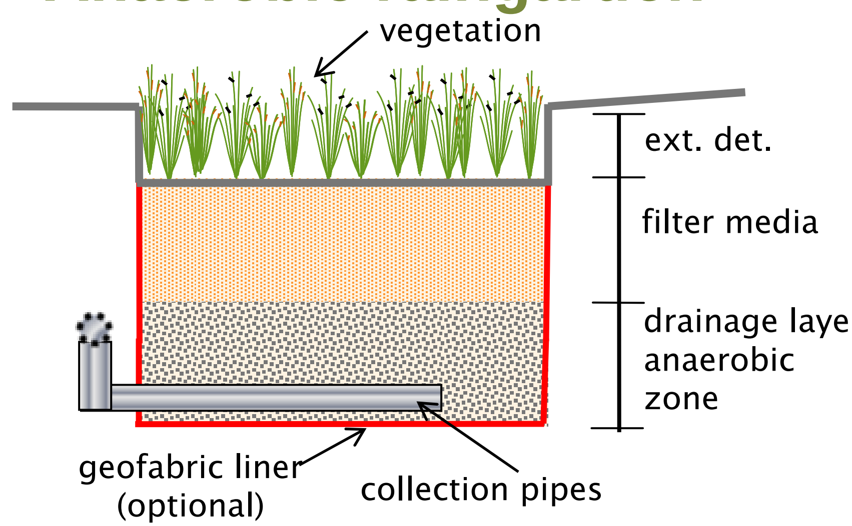

## Swale



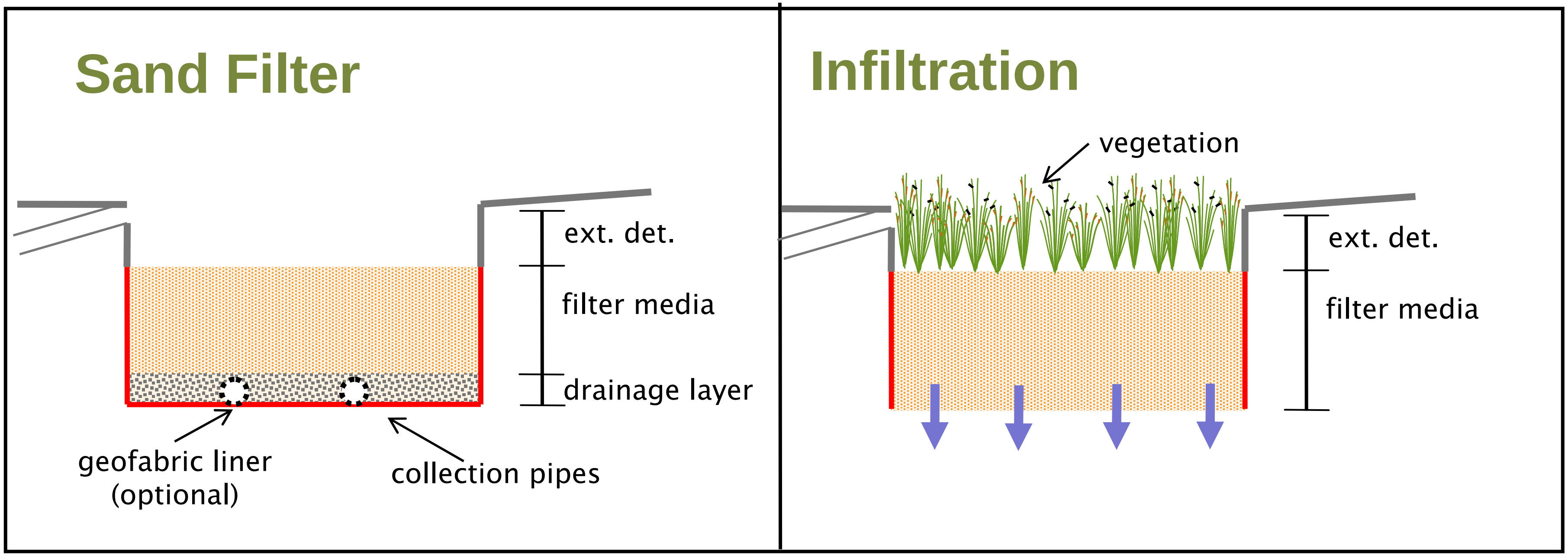

## Wetland




## Anaerobic raingarden



# Similarities to other treatment elements



# Integration of scale for rain gardens

Regional Scale

Hoyland St
(Brisbane)

Ascot Waters
(WA)

Lynbrook Blvd
(Lynbrook)

Batman Drv
(Melbourne Docklands)

Allotment Scale

Adelaide Museum
(SA)

Lt Bourke St
(Melbourne CBD)

Mernda Villages
(Mernda)

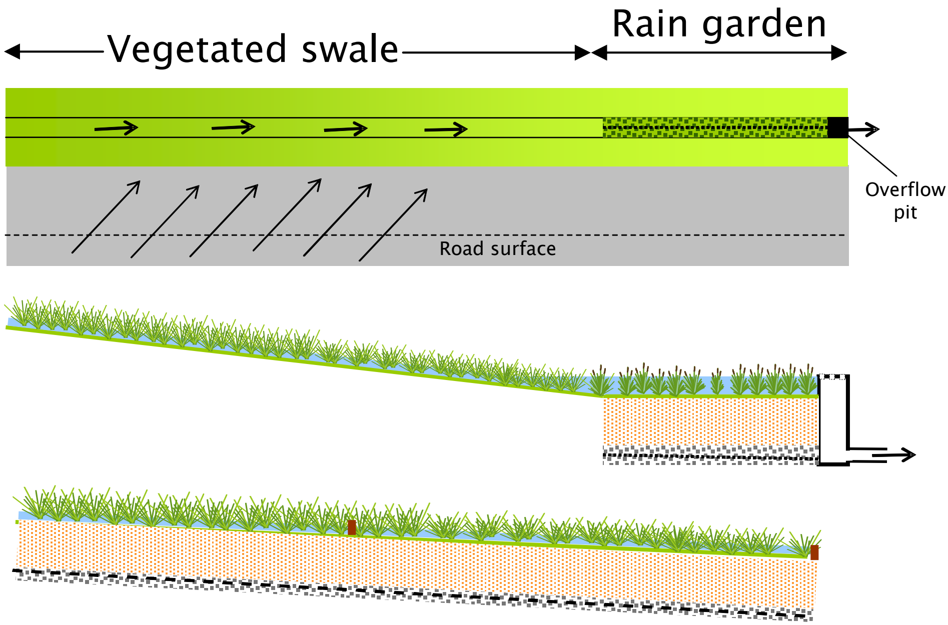
Baltusrol Estate
(Melbourne)

# CONCEPT DESIGN

- STEP TWO: Determine how treatment elements will be integrated with urban design
  - Streetscape vs end of pipe
  - Basins vs swales

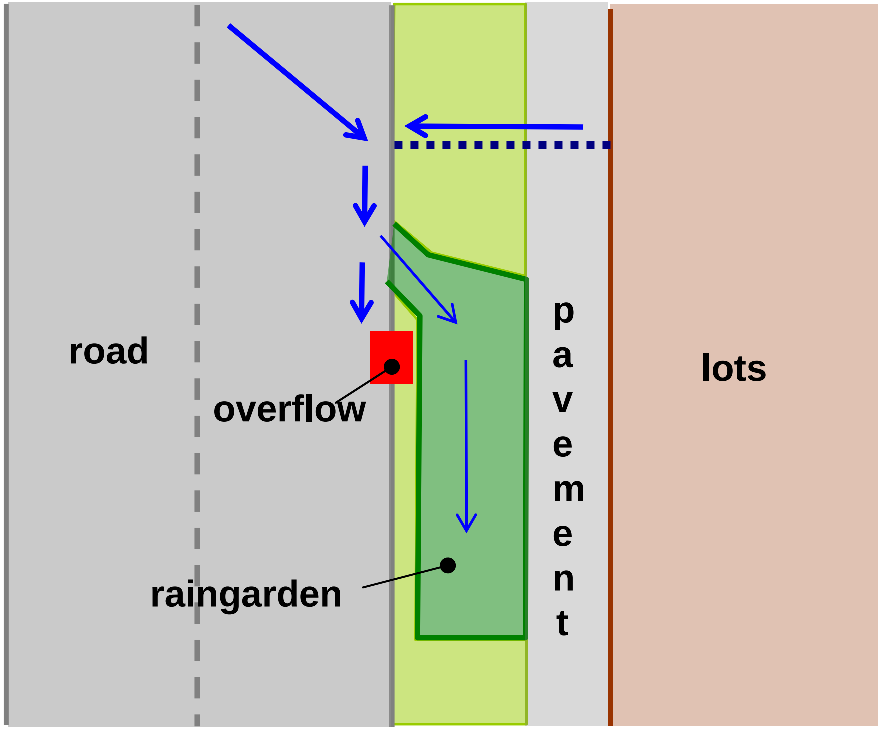
# Raingarden Swales

- Online (treatment and conveyance)
- Part or full length of swale
- Slope 1-4% (or check dams)



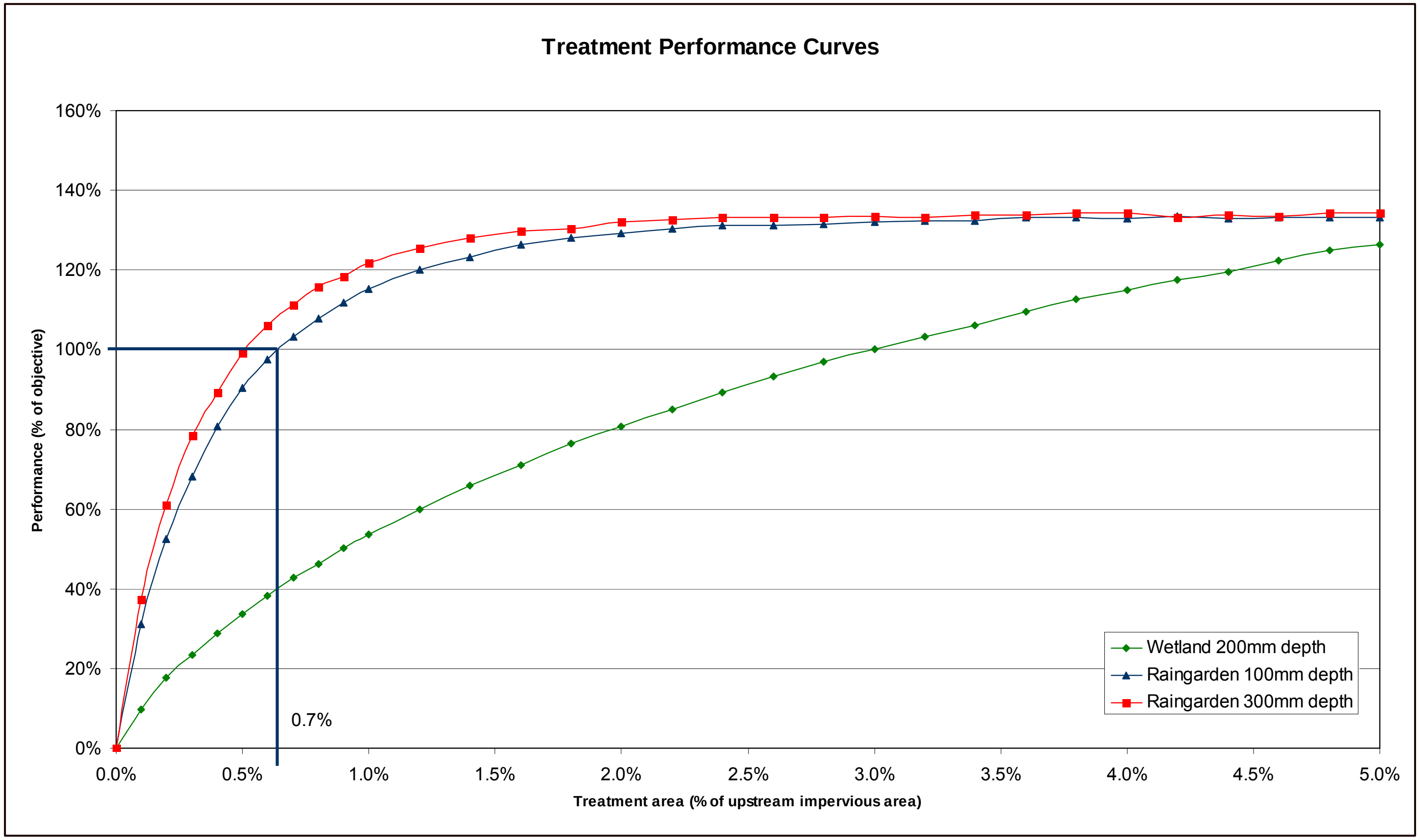

# Raingarden Basins

- Offline
- Less likely to scour
- Various scales



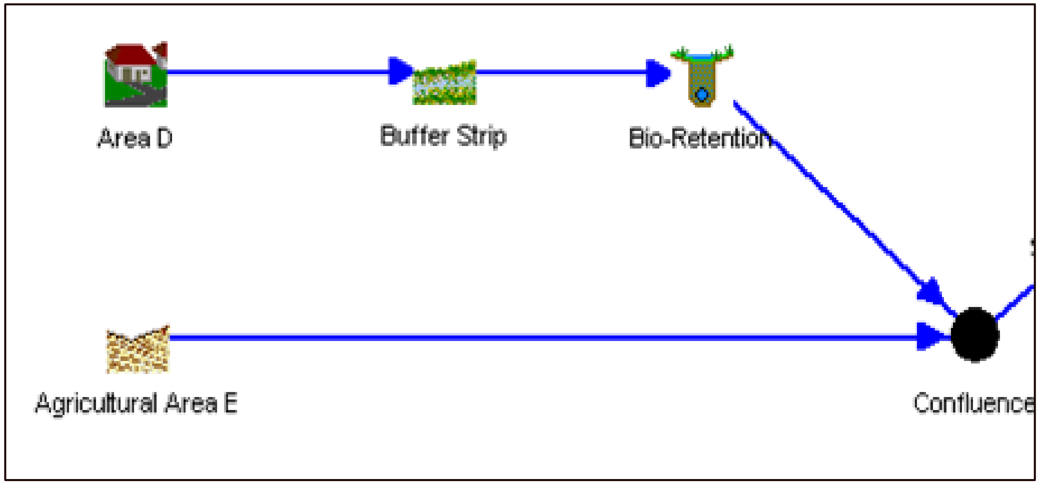

# CONCEPT DESIGN

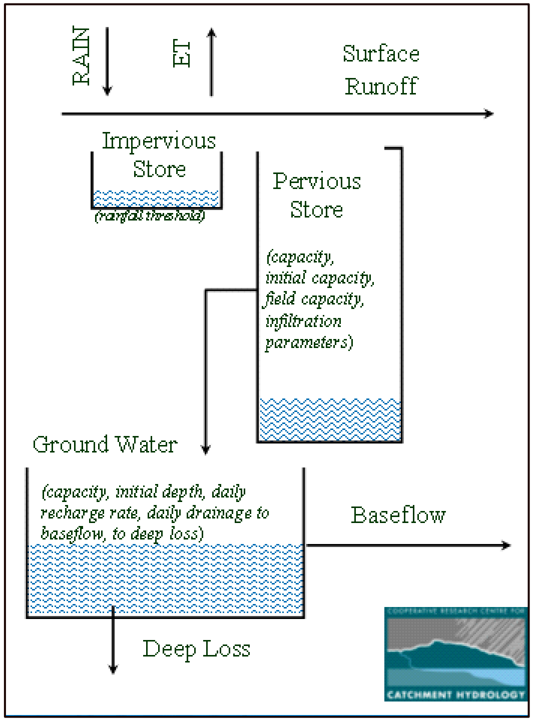
- STEP THREE: Size treatment measures
  - » Treatment Curves



# MUSIC

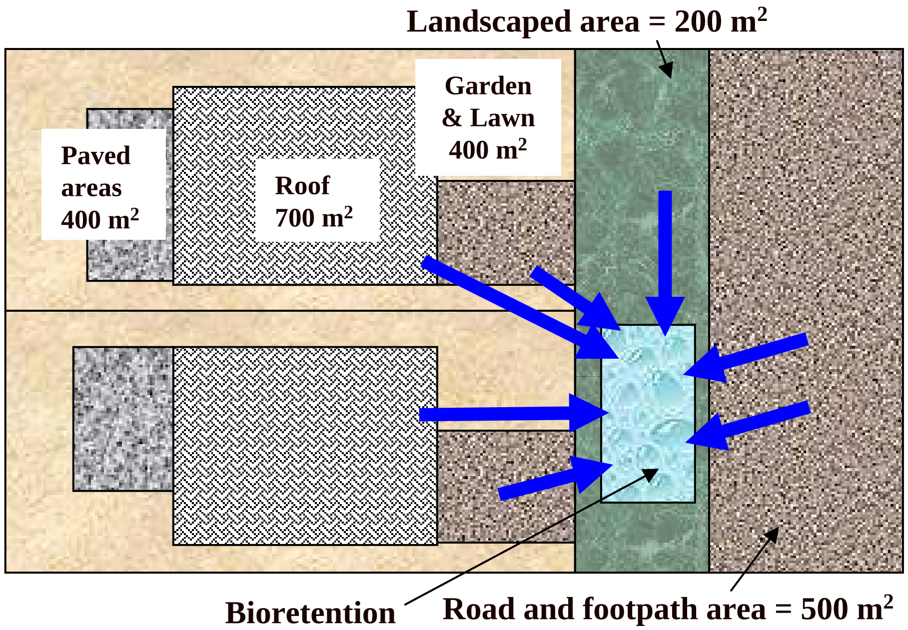
- Stormwater quality model
  - Rainfall runoff
  - Pollutant concentrations
  - Storage and treatment



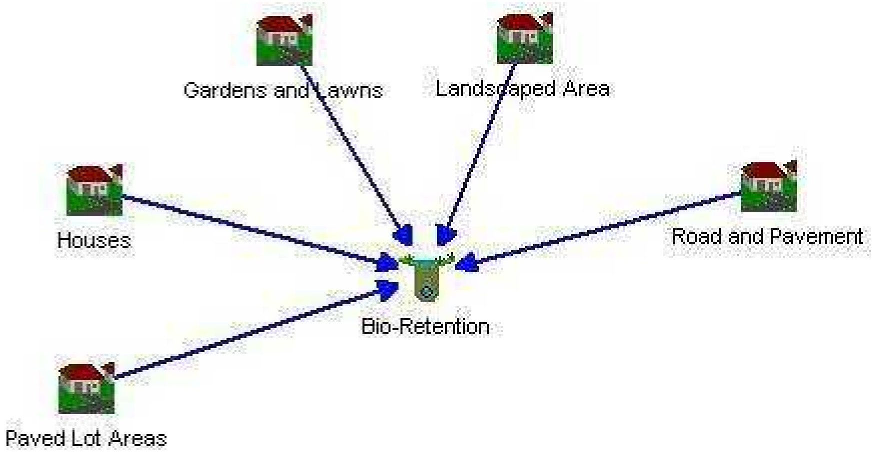



# Sizing using MUSIC

- Continuous Rainfall Data
- Catchment details
(area, impervious fraction, soils)



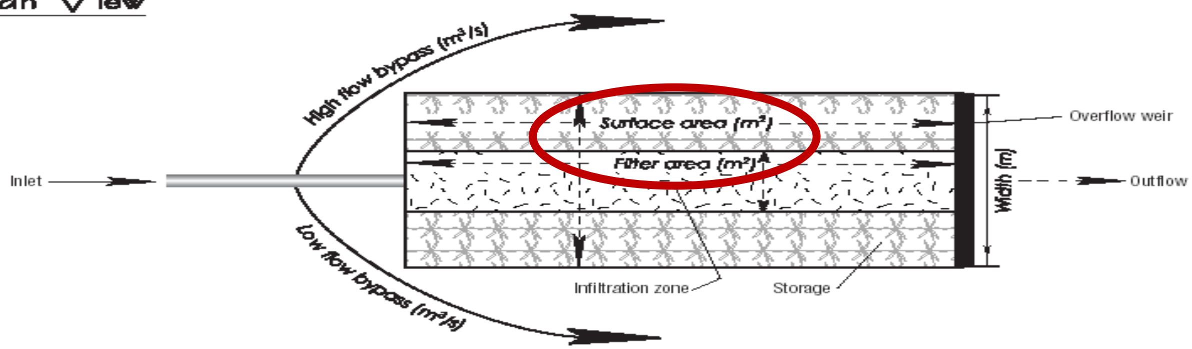

Stawell St, Melbourne, Browne 2005



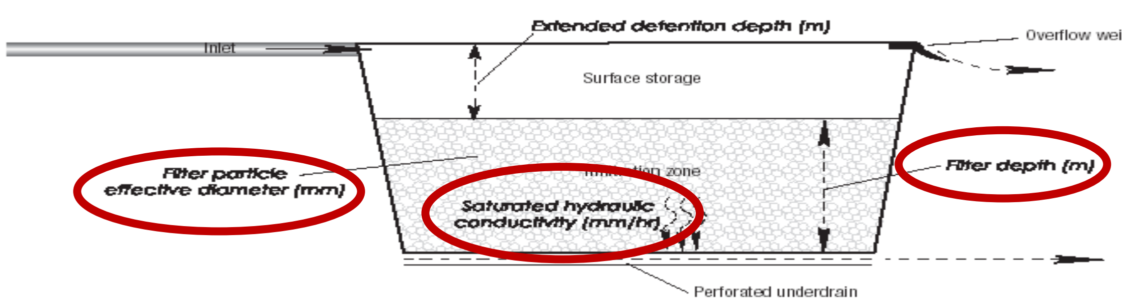
# Sizing using MUSIC

- Treatment system dimensions and characteristics

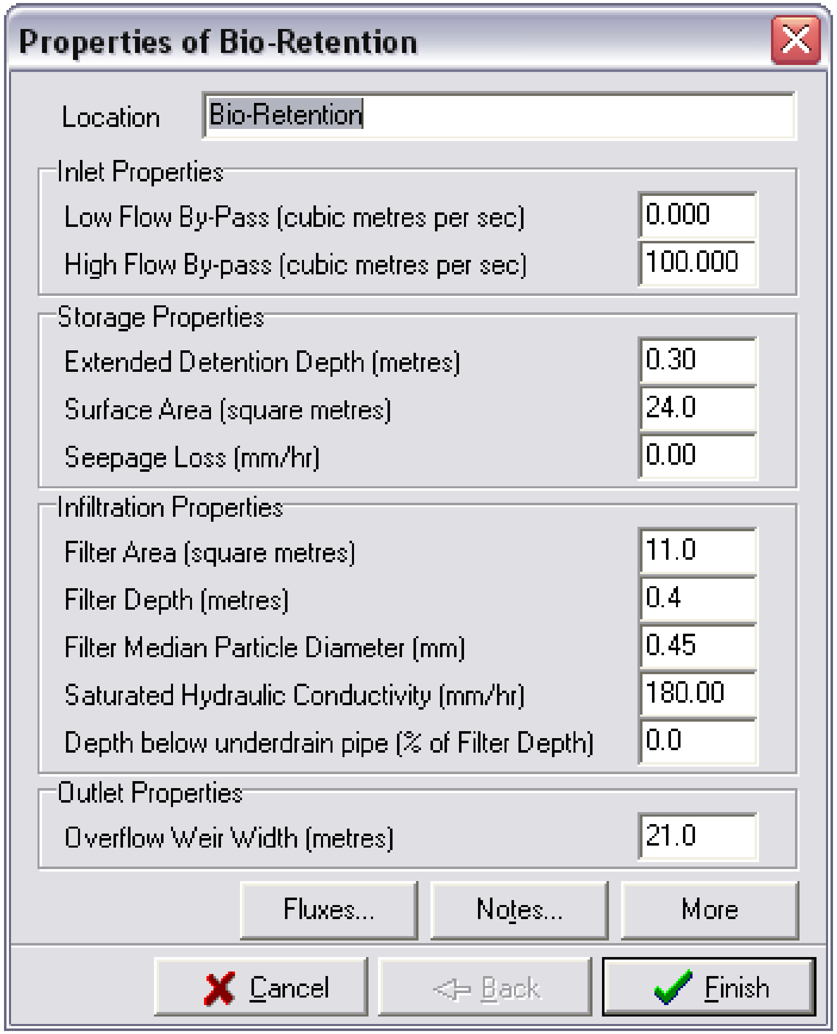
Plan View




Longitudinal Section

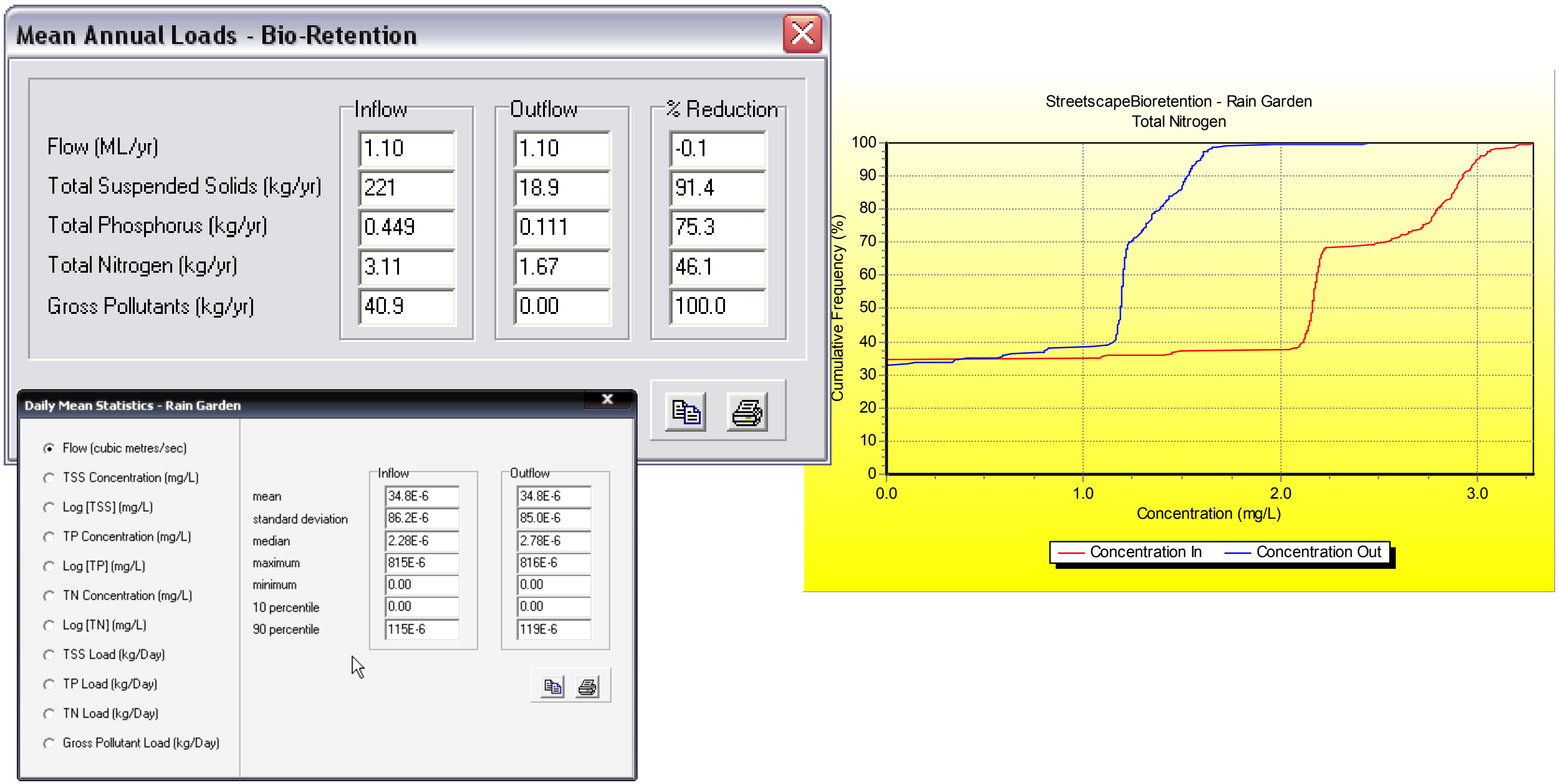


# Sizing using MUSIC



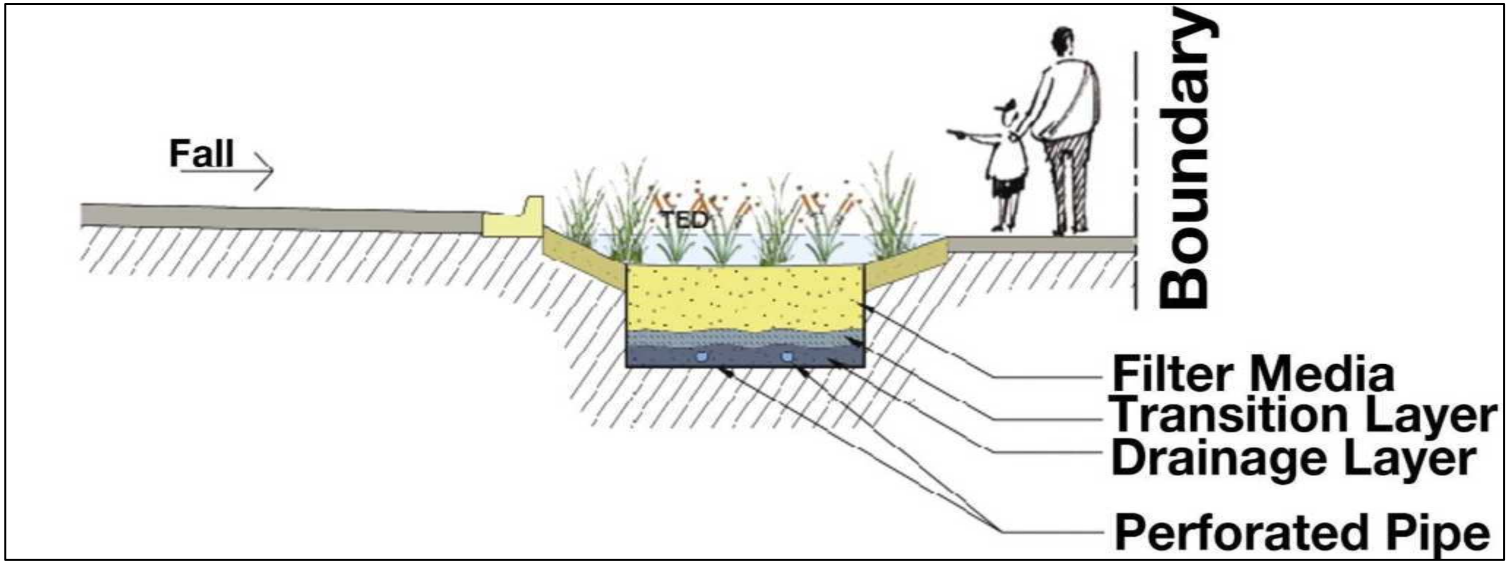
# MUSIC - Outputs

- Predicts treatment performance for reducing pollutant concentrations and loads



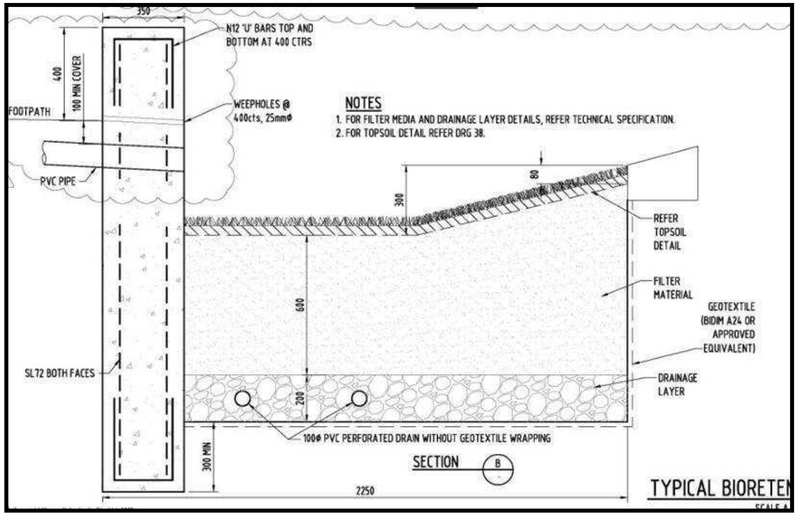
# FUNCTIONAL DESIGN

- Entry provision
- Overflow provision
- Edge treatments
- Drainage pipes

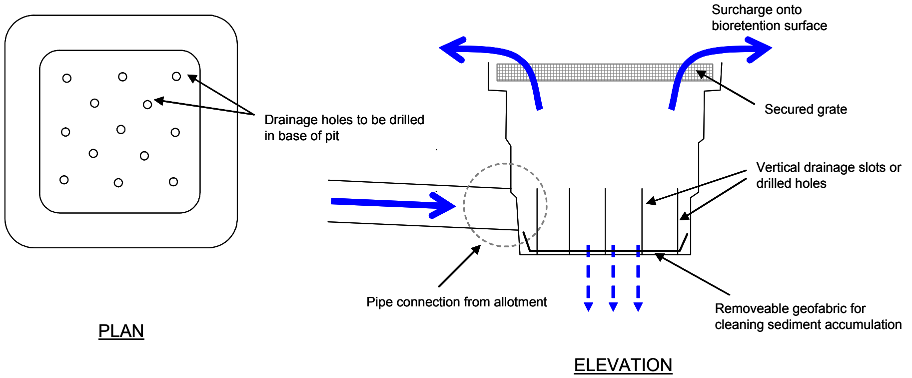


# Entry provision

- ## Freely Draining

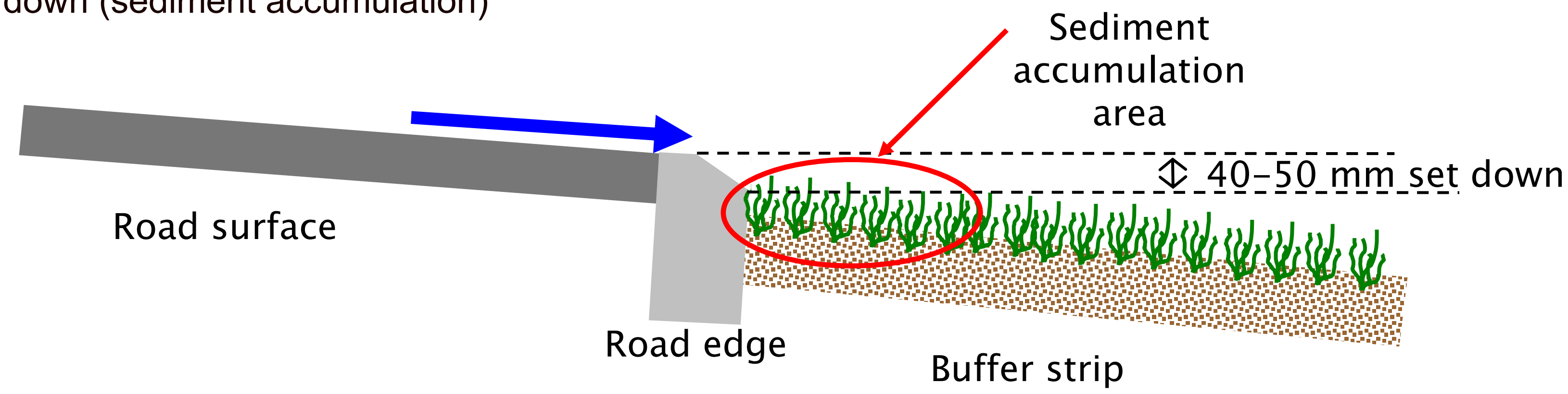



- ## Surcharge



# Entry provision

- Set down (sediment accumulation)




# Entry provision

- Manage scouring

Technical manual suggests planting can cope with

- Velocity < 0.5 m/s for minor flows
- Velocity < 1.0 m/s for 100 year ARI flow

High velocities at entrance can be managed with

- Rock/concrete apron

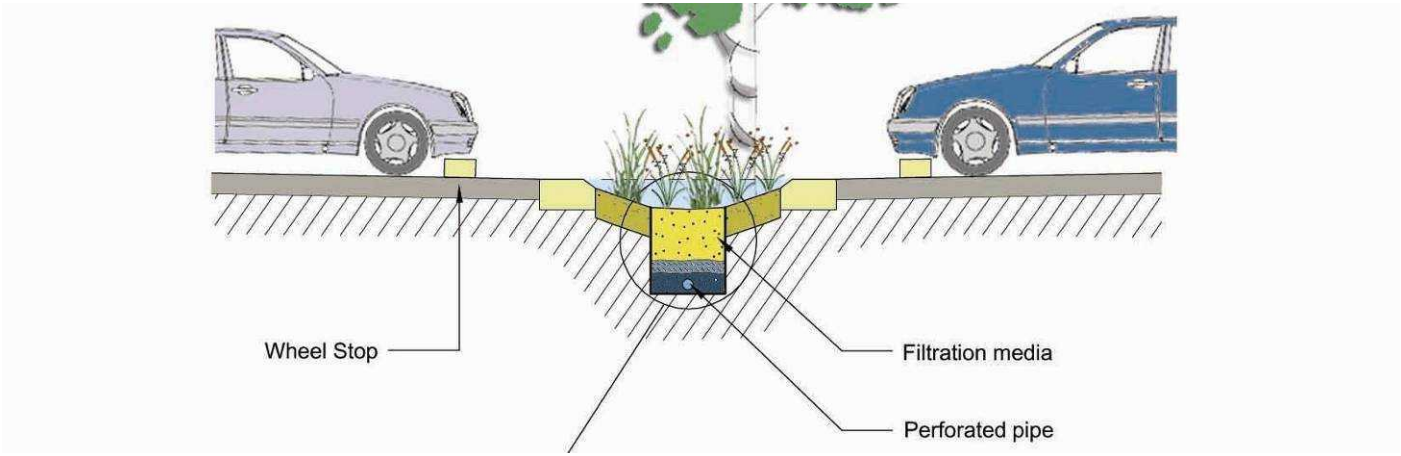
- Geo textiles

# Overflow provision

- Make sure full extended detention provided!!
  - Feedback to side entry pits
  - Grated pits
  - Weirs

# Edge treatments

- Barrier to cars



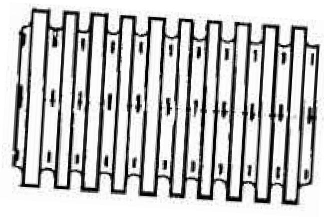

# Edge treatments

- Pedestrian safety (dense planting, fencing)

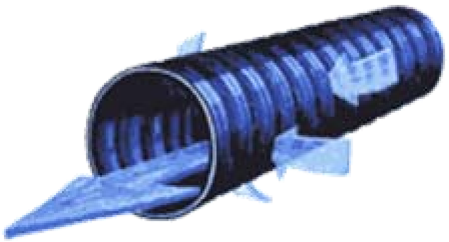
Cremorne St, Melbourne

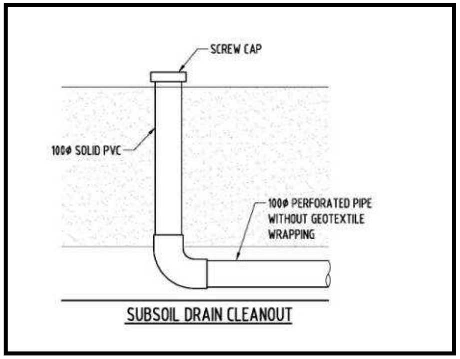
Docklands, Melbourne

# Drainage Layer



- Pipes
  - Capacity of perforations AND pipe must be higher than maximum infiltration rate through filter media (freely draining)
  - Slotted pipes must have transition layer (slots bigger than perforations)
  - Geofabric sock not recommended (clogging risk)
  - Each pipe should extend to surface with inspection opening
  - Maximum 1.5 m spacing





# Tools in WSUD Engineering Procedures: Stormwater

- Design assessment checklist

| Bioretention Basin Design Assessment Checklist | | | | | |
|---|---|---|---|---|---|
| *Bioretention location:* | | | | | |
| *Hydraulics* | Minor Flood: ($m^3/s$) | | Major Flood: ($m^3/s$) | | |
| *Area* | Catchment Area (ha): | | Bioretention Area (ha) | | |
| Treatment | | | | Y | N |
| Treatment performance verified from curves? | | | | | |
| | | | | | |
| Inlet zone/hydraulics | | | | Y | N |
| Station selected for IFD appropriate for location? | | | | | |
| Overall flow conveyance system sufficient for design flood event? | | | | | |
| Maximum upstream flood conveyance width does not impact on traffic amenity? | | | | | |
| Velocities at inlet and within bioretention system will not cause scour? | | | | | |
| Bypass sufficient for conveyance of design flood event? | | | | | |
| Bypass has set down of at least 100mm below kerb invert? | | | | | |
| | | | | | |
| Collection System | | | | Y | N |
| Slotted pipe capacity > infiltration capacity of filter media? | | | | | |
| Maximum spacing of collection pipes <1.5m? | | | | | |
| Transition layer/geofabric barrier provided to prevent clogging of drainage layer? | | | | | |
| | | | | | |
| Basin | | | | Y | N |
| Maximum ponding depth will not impact on public safety? | | | | | |
| Selected filter media hydraulic conductivity > 10x hydraulic conductivity of surrounding soil? | | | | | |
| Maintenance access provided to base of bioretention (where reach to any part of a basin >6m)? | | | | | |
| Protection from gross pollutants provided (for larger systems)? | | | | | |
| | | | | | |
| Vegetation | | | | Y | N |
| Plant species selected can tolerate periodic inundation? | | | | | |
| Plant species selected integrate with surrounding landscape design? | | | | | |
| Detailed soil specification included in design? | | | | | |

## 4 Slotted collection pipe capacity

| | | | |
|---|---|---|---|
| pipe diameter | 100 | mm | |
| number of pipes | 1 | | |
| pipe capacity | 0.004 | $m^3/s$ | |
| capacity of perforations | 0.015 | $m^3/s$ | |
| soil media infiltration capacity | 0.004 | $m^3/s$ | |
| CHECK PIPE CAPACITY > SOIL CAPACITY | YES | | ✓ |

## 5 Check flow widths in upstream gutter

| | | | |
|---|---|---|---|
| $Q_5$ flow width | 0.9 | m | |
| CHECK ADEQUATE LANES TRAFFICABLE | YES | | ✓ |

## 6 Kerb opening width

| | | | |
|---|---|---|---|
| width of brak in kerb for inflows | 0.6 | m | ✓ |

## 7 Velocities over vegetation

| | | | |
|---|---|---|---|
| Velocity for 5 year flow (<0.5m/s) | 0.03 | m/s | |
| Velocity for 100 year flow (<1.0m/s) | 0.08 | m/s | ✓ |

## 8 Overflow system

| | | | |
|---|---|---|---|
| system to convey minor floods | grated pit | | ✓ |

## 9 Surrounding soil check

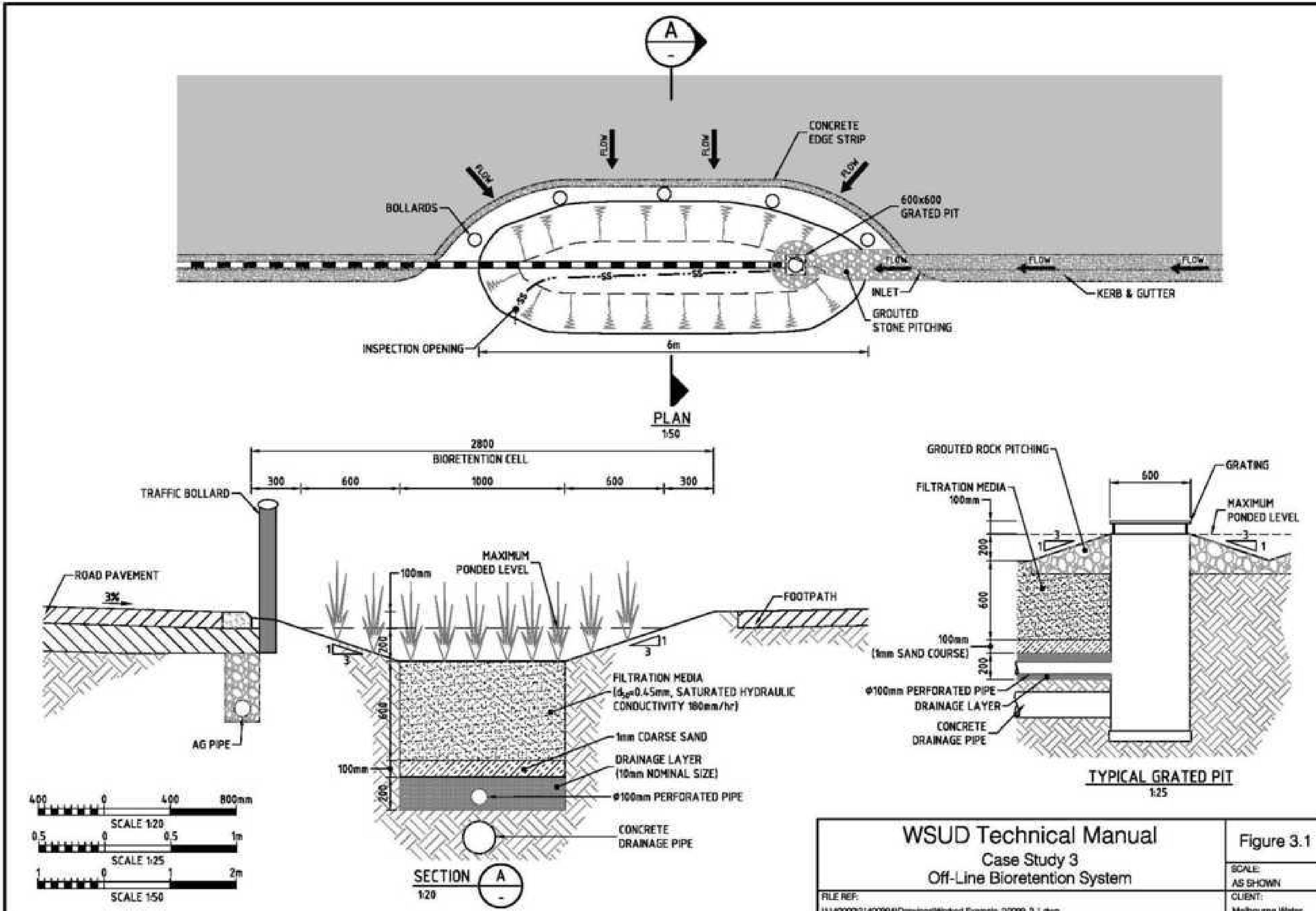
| | | | |
|---|---|---|---|
| Soil hydraulic conductivity | 0.36 | mm/hr | |
| Filter media | 180 | mm/hr | |
| MORE THAN 10 TIMES HIGHER THAN SOILS? | YES (no liner) | | ✓ |

## 10 Filter media specification

| | | | |
|---|---|---|---|
| filtration media | sandy loam | | |
| transition layer | coarse sand | | |
| drainage layer | fine gravel | | ✓ |

## 11 Plant selection

| | | | |
|---|---|---|---|
| | *Carex appressa* | | ✓ |



A
CONCRETE EDGE STRIP
FLOW
BOLLARDS
600x600 GRATED PIT
INLET
KERB & GUTTER
GROUTED STONE PITCHING
INSPECTION OPENING
6m
PLAN
1:50
2800
BIORETENTION CELL
300
600
1000
600
300
TRAFFIC BOLLARD
MAXIMUM PONDED LEVEL
100mm
ROAD PAVEMENT
3%
FOOTPATH
AG PIPE
FILTRATION MEDIA
(d50=0.45mm, SATURATED HYDRAULIC CONDUCTIVITY 180mm/hr)
1mm COARSE SAND
DRAINAGE LAYER
(10mm NOMINAL SIZE)
ø100mm PERFORATED PIPE
CONCRETE DRAINAGE PIPE
SECTION A
1:20
SCALE 1:20
SCALE 1:25
SCALE 1:50
GROUTED ROCK PITCHING
GRATING
FILTRATION MEDIA
100mm (1mm SAND COURSE)
ø100mm PERFORATED PIPE
DRAINAGE LAYER
CONCRETE DRAINAGE PIPE
TYPICAL GRATED PIT
1:25
WSUD Technical Manual
Case Study 3
Off-Line Bioretention System
Figure 3.1
SCALE: AS SHOWN
CLIENT: Melbourne Water
FILE REF:

# Detailed Design

- Recommend that someone who understands functional intent of treatment system supports detailed designers and reviews plans

# Design Process

- Concept Design
  - Opportunities and constraints
  - Choose a system
  - Integration with urban design
  - Sizing

- Functional Design
  - Entry
  - Overflow
  - Edges
  - Drainage pipes
  - Checklists

- Detailed Design
  - Plans
  - Follow through from functional design