Advancing Raingarden Design
June 2008
# Agenda

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

► Design process
► Sizing and design attributes
► Construction
Design Process

Opportunities & constraints

Conceptual design

Functional design

Detailed design

Construction
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

<table>
<thead>
<tr>
<th>Raingarden</th>
<th>Swale</th>
<th>Wetland</th>
<th>Anaerobic raingarden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
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<tr>
<td>Filter media</td>
<td></td>
<td></td>
<td>Filter media</td>
</tr>
<tr>
<td>Drainage layer</td>
<td></td>
<td></td>
<td>Drainage layer</td>
</tr>
<tr>
<td>Geofabric liner</td>
<td></td>
<td></td>
<td>Geofabric liner</td>
</tr>
<tr>
<td>(optional)</td>
<td></td>
<td></td>
<td>(optional)</td>
</tr>
<tr>
<td>Collection pipes</td>
<td></td>
<td></td>
<td>Collection pipes</td>
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</tbody>
</table>

**Raingarden**
- Vegetation
- Filter media
- Drainage layer
- Geofabric liner (optional)
- Collection pipes

**Swale**
- Vegetation
- Geofabric liner (optional)
- Collection pipes

**Wetland**
- Vegetation

**Anaerobic raingarden**
- Vegetation
- Geofabric liner (optional)
- Collection pipes
- Drains to anaerobic zone

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*MONASH University*

*Institute for Sustainable Water Resources*

*FAWB*

*Facility for Advancing Water Biofiltration*
Similarities to other treatment elements

Sand Filter

- geofabric liner (optional)
- collection pipes
- filter media
- drainage layer

Infiltration

- vegetation
- filter media
- ext. det.
- collection pipes
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

Cremorne St, Richmond, Melbourne
CONCEPT DESIGN

- STEP THREE: Size treatment measures
  - Treatment Curves

![Treatment Performance Curves Diagram](image-url)
MUSIC

- Stormwater quality model
  - Rainfall runoff
  - Pollutant concentrations
  - Storage and treatment
Sizing using MUSIC

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

Landscaped area = 200 m²

Paved areas 400 m²
Roof 700 m²
Garden & Lawn 400 m²
Bioretention
Road and footpath area = 500 m²

Stawell St, Melbourne, Browne 2005

MONASH University
Engineering
Institute for Sustainable Water Resources

FAWB
Facility for Advancing Water Biofiltration

EDAW | AECOM
Sizing using MUSIC

• Treatment system dimensions and characteristics
## Sizing using MUSIC

### Properties of Bio-Retention

<table>
<thead>
<tr>
<th>Location</th>
<th>Bio-Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inlet Properties</strong></td>
<td></td>
</tr>
<tr>
<td>Low Flow By-Pass (cubic metres per sec)</td>
<td>0.000</td>
</tr>
<tr>
<td>High Flow By-pass (cubic metres per sec)</td>
<td>100.000</td>
</tr>
<tr>
<td><strong>Storage Properties</strong></td>
<td></td>
</tr>
<tr>
<td>Extended Detention Depth (metres)</td>
<td>0.30</td>
</tr>
<tr>
<td>Surface Area (square metres)</td>
<td>24.0</td>
</tr>
<tr>
<td>Seepage Loss (mm/hr)</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Infiltration Properties</strong></td>
<td></td>
</tr>
<tr>
<td>Filter Area [square metres]</td>
<td>11.0</td>
</tr>
<tr>
<td>Filter Depth (metres)</td>
<td>0.4</td>
</tr>
<tr>
<td>Filter Median Particle Diameter (mm)</td>
<td>0.45</td>
</tr>
<tr>
<td>Saturated Hydraulic Conductivity (mm/hr)</td>
<td>180.00</td>
</tr>
<tr>
<td>Depth below underdrain pipe (% of Filter Depth)</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Outlet Properties</strong></td>
<td></td>
</tr>
<tr>
<td>Overflow Weir Width (metres)</td>
<td>21.0</td>
</tr>
</tbody>
</table>
MUSIC - Outputs

- Predicts treatment performance for reducing pollutant concentrations and loads

![Graph showing concentration reduction in streetscape bioretention systems]
FUNCTIONAL DESIGN

► Entry provision
► Overflow provision
► Edge treatments
► Drainage pipes
Entry provision

- Freely Draining

- Surcharge
Entry provision

- Set down (sediment accumulation)

Road surface

Road edge

Buffer strip

Sediment accumulation area

40-50 mm set down
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
### Bioretention Basin Design Assessment Checklist

<table>
<thead>
<tr>
<th>Bioretention Location:</th>
<th>Hydraulics</th>
<th>Major Flood: (m³/s)</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catchment Area (ha):</td>
<td>Bioretention Area (ha)</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Y N</td>
<td>Treatment performance verified from curves?</td>
<td></td>
</tr>
<tr>
<td>Inlet zone/ hydraulics</td>
<td>Y N</td>
<td>Station selected for IFD appropriate for location?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall flow conveyance system sufficient for design flood event?</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Maximum upstream flood conveyance width does not impact on traffic amenity?</td>
<td></td>
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<tr>
<td></td>
<td>Velocities at inlet and within bioretention system will not cause scour?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bypass sufficient for conveyance of design flood event?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bypass has set down of at least 100mm below kerb invert?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection System</td>
<td>Y N</td>
<td>Slotted pipe capacity &gt; infiltration capacity of filter media?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum spacing of collection pipes &lt;1.5m?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transition layer/ geofabric barrier provided to prevent clogging of drainage layer?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basin</td>
<td>Y N</td>
<td>Maximum ponding depth will not impact on public safety?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selected filter media hydraulic conductivity &gt; 10x hydraulic conductivity of surrounding soil?</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Maintenance access provided to base of bioretention (where reach to any part of a basin &gt;6m)?</td>
<td></td>
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<tr>
<td></td>
<td>Protection from gross pollutants provided (for larger systems)?</td>
<td></td>
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<tr>
<td>Vegetation</td>
<td>Y N</td>
<td>Plant species selected can tolerate periodic inundation?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plant species selected integrate with surrounding landscape design?</td>
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<td></td>
<td>Detailed soil specification included in design?</td>
<td></td>
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</tbody>
</table>
4 Slotted collection pipe capacity

- pipe diameter: 100 mm
- number of pipes: 1
- pipe capacity: 0.004 m³/s
- capacity of perforations: 0.015 m³/s
- soil media infiltration capacity: 0.004 m³/s

CHECK PIPE CAPACITY > SOIL CAPACITY: YES

5 Check flow widths in upstream gutter

- Q₅ 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 (<0.5 m/s): 0.03 m/s
- Velocity for 100 year flow (<1.0 m/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
WSUD Technical Manual
Case Study 3
Off-Line Bioretention System

Figure 3.1

Institute for Sustainable Water Resources
Water Desalination
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