WSUD asset audit guidelines

Dale Browne
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Why do we audit WSUD assets?

- Understand condition and functional performance
- Inform works and budgets
- Learning
WSUD assets covered

- Raingarden
- Bioretention basin
- Tree pit
- Wetland
- Swales
- Gross pollutant trap*
- Porous pavement
- Infiltration trench / basin
WSUD Audit Guidelines

Introduction

WSUD asset management

WSUD asset audits

Identification and prioritisation of maintenance and rectification actions

Maintenance and rectification works

Glossary

Resources

Attachments
A consistent and systematic approach to audits to understand condition against performance targets and corresponding works.
Elements

Filter media – permeable vegetated base
*Note: no baffles*

- Inlet
- Surrounds
- Outlet and underdrainage
Audit items

- Sediment accumulation
- Erosion
- Blockage
- Permeability and clogging
- Damage or removal of structures
- Vehicle or pedestrian damage
- Surface levels
- Water levels
- Rubbish
- Plant cover
- ....

Sediment accumulation

Sediment accumulation in WSUD assets can change the profile of the asset, cause bypass, redirection and short-circuiting of flows, smother vegetation and clog filter media.

Audit Criteria

<table>
<thead>
<tr>
<th>Condition rating</th>
<th>Criteria</th>
<th>Maintenance requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance target</td>
<td>No accumulated sediment impeding flows or vegetation growth</td>
<td>None</td>
</tr>
<tr>
<td>Good condition</td>
<td>No accumulated sediment</td>
<td>None</td>
</tr>
<tr>
<td>Moderate condition</td>
<td>Some accumulated sediment (covering less than 50% of surface)</td>
<td>Maintenance</td>
</tr>
<tr>
<td></td>
<td>Causing some redirection of flows through the system</td>
<td></td>
</tr>
<tr>
<td>Poor condition</td>
<td>Accumulated sediment covering more than 50% of the surface</td>
<td>Rectification</td>
</tr>
<tr>
<td></td>
<td>Impeding or significantly redirecting flows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smothering vegetation</td>
<td></td>
</tr>
</tbody>
</table>

Example Images

<table>
<thead>
<tr>
<th>Condition rating</th>
<th>Example images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate condition</td>
<td>![Example images]</td>
</tr>
<tr>
<td>Poor condition</td>
<td>![Example images]</td>
</tr>
</tbody>
</table>
# Audit templates

## Raingarden audit checklist

<table>
<thead>
<tr>
<th>Task Item</th>
<th>Performance target</th>
<th>Good condition</th>
<th>Moderate condition</th>
<th>Poor condition</th>
<th>Condition summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surrounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damage or removal of structures</td>
<td>No damage, erosion or issues / removal of structures</td>
<td>Stable structures</td>
<td>Minor damage</td>
<td>Major damage</td>
<td>Repair two damaged bluestone kerb stones</td>
</tr>
<tr>
<td>Rubbish</td>
<td>No litter present</td>
<td>No litter present</td>
<td>Some litter present</td>
<td>Large amount of litter present</td>
<td></td>
</tr>
<tr>
<td>Inlet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion</td>
<td>Minor erosion that doesn’t pose public safety risk and would not worsen if left unattended</td>
<td>No erosion</td>
<td>Minor erosion</td>
<td>Major erosion</td>
<td>Clear minor sediment from sediment forebay and clean out sediment sump</td>
</tr>
<tr>
<td>Blockage</td>
<td>No blockage</td>
<td>No blockage</td>
<td>Partial blockage of inlet causing some bypass of flows or restricted inflows</td>
<td>Blockage of inlet causing significant bypass or restriction of inflows</td>
<td></td>
</tr>
<tr>
<td>Damage or removal of structures</td>
<td>No damage, erosion or issues / removal of structures</td>
<td>Stable structures</td>
<td>Minor damage</td>
<td>Major damage, poses risk to structural integrity, public safety or asset function</td>
<td></td>
</tr>
</tbody>
</table>
## Audit - inlet

### Sediment accumulation

<table>
<thead>
<tr>
<th>Inlet</th>
<th>Condition rating</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Civil</strong></td>
<td><strong>Erosion</strong></td>
<td>Minor erosion that doesn't pose public safety risk and would not worsen if left unattended</td>
</tr>
<tr>
<td><strong>Civil</strong></td>
<td><strong>Blockage</strong></td>
<td>No blockage</td>
</tr>
<tr>
<td><strong>Civil</strong></td>
<td><strong>Damage or removal of structures</strong></td>
<td>No damage, erosion or issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minor damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Major erosion</td>
</tr>
</tbody>
</table>

1. Clear minor sediment from sediment trap and clean out sediment trap.
Audit – permeable vegetated base

Lack of extended detention depth
Plant cover is poor
### Audit – permeable vegetated base

<table>
<thead>
<tr>
<th>Category</th>
<th>Civil</th>
<th>Landscape</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediment accumulation</strong></td>
<td>No accumulated sediment</td>
<td>Some accumulated sediment (covering &lt;50% of surface)</td>
<td>Causing some restriction of flows through the system</td>
</tr>
<tr>
<td><strong>Erosion</strong></td>
<td>No erosion</td>
<td>Minor erosion</td>
<td>Does not pose risk to structural integrity, public safety or asset function (e.g. limited short circuiting of flows)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Major erosion</td>
<td>Posing risk to structural integrity, public safety or asset function (e.g. short circuiting of the majority of flows)</td>
</tr>
<tr>
<td><strong>Permeability and clogging</strong></td>
<td>Infiltration / hydraulic capacity of the system is preserved</td>
<td>Dry Conditions: Water ponding (100 - 300mm) for bioretention systems is drawn down over 1 - 2 hrs after inflow to the system has stopped following rainfall.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No surface with no depressions or mounds</td>
<td>Some small depressions or mounds present</td>
<td>Limited impact on flows through the asset</td>
</tr>
<tr>
<td><strong>Vehicle or pedestrian damage</strong></td>
<td>No compaction, plant loss, vandalism impacting system function</td>
<td>Minor compaction, plant loss</td>
<td>Does not pose risk to structural integrity or asset function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Significant compaction, plant loss</td>
<td>Posing risk to structural integrity, public safety or asset function</td>
</tr>
<tr>
<td><strong>Surface levels</strong></td>
<td>Even surface with no depressions or mounds</td>
<td>Level of surface is impacting flows through the asset (e.g. short circuiting flows, blocking flows and/or reduced extended detention depth)</td>
<td>Bolstered pools created in the surface</td>
</tr>
<tr>
<td><strong>Extended detention depth</strong></td>
<td>Design extended detention depth provided</td>
<td>At least 50% of design extended detention provided</td>
<td>Less than 50% of design extended detention provided</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large amount of litter present</td>
<td>Mostly impacting aesthetics and/or blocking flows</td>
</tr>
<tr>
<td><strong>Rubbish</strong></td>
<td>No litter present</td>
<td>Some litter present</td>
<td>Diminished aesthetics and/or causing some visible blockage</td>
</tr>
<tr>
<td><strong>Leaf litter</strong></td>
<td>No accumulated leaf litter causing blockages or impeding flows or vegetation growth</td>
<td>Minimal litter present or covers less than 20% of surface</td>
<td>Some wet and decaying leaf matter present (covering 20-40% of surface)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aesthetic issue</td>
<td>Some obstruction of flow paths</td>
</tr>
<tr>
<td><strong>Plant health</strong></td>
<td>Good vegetation health</td>
<td>Vegetation is stressed</td>
<td>Poor health (signs of disease, pests) in less than 20% of plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Poor health (signs of disease, pests) in more than 20% of plants</td>
</tr>
<tr>
<td><strong>Plant cover</strong></td>
<td>Good vegetation density covering &gt;80% of the planted surfaces</td>
<td>Moderate vegetation cover in planted areas (50-70% cover)</td>
<td>Poor vegetation cover in planted areas (&lt;40% cover)</td>
</tr>
<tr>
<td></td>
<td>Limited weed cover with no declared non-weed species</td>
<td>Low/Moderate weed cover (20-30%) and no declared weed species</td>
<td>High weed cover (&gt;50%) and/or declared weed species present</td>
</tr>
<tr>
<td><strong>Weeds</strong></td>
<td>Limited weed cover (&gt;10%) and no declared weed species</td>
<td>Low/Moderate weed cover (20-30%) and no declared weed species</td>
<td>High weed cover (&gt;50%) and/or declared weed species present</td>
</tr>
<tr>
<td><strong>Nuisance fauna</strong></td>
<td>No nuisance fauna</td>
<td>Some nuisance fauna but limited impact on aesthetics, water quality and/or vegetation growth</td>
<td>Significant nuisance fauna issues (heavily impacting aesthetics, vegetation growth and/or water quality)</td>
</tr>
</tbody>
</table>

**Note:** Scrape surface 100mm from surface and regrade batters to provide an extended detention depth of 100mm.
Identify works
Identify works required

Planned maintenance

Regular planned activities to maintain system function

4.2 LEAF LITTER REMOVAL

Leaf litter accumulation on a significant scale was observed at a number of sites within the City of Port Phillip. Where leaf litter posed a threat to WSUD asset function, it was primarily from Plane Trees (both overhead trees as well as from leaves washing in from the upstream catchment). Leaf litter can accumulate and become saturated within a WSUD asset. Breakdown of the leaves in saturated conditions can produce fine organic matter that can cause clogging of the filter media surface (eventually) and leach nutrients into waterways. A heavy leaf litter load can impede drainage through the filter media as well as restricting the growth and spread of desired plants in the WSUD asset.

INSPECTION
Check the following for leaf litter:

- On the filter media surface
- Across the canopy of the plants within the WSUD asset
- Surrounding kerbs and channels
- Inlet (where water enters the raingarden from kerb or pipe)
- Outlet/overflow structures

TRIGGER

- Wet and decaying leaf matter present
- Aesthetic issue
- Obstructing flow paths

MAINTENANCE ACTION
Remove leaf litter from the surface of the filter media (including around inlet areas and between plants) using rakes or other appropriate hand tools. Remove leaf litter from hard surfaces using appropriate hand tools. Leaf litter must be removed from the site and composted or disposed of appropriately.

Rectification

One-off activities to restore system function

5.3 LARGE SCALE PLANT LOSS

ISSUE: Plants are a critical component of the functional performance of raingardens, especially in terms of stormwater treatment performance. They are also critical for long term raingarden aesthetics - an important factor for inner city and suburban streetscape raingardens. High plant densities significantly reduce the impacts (and therefore maintenance requirements) of leaf litter accumulation, weed growth and clogging as a result of clay or fine sediment build-up.

LIKELY CAUSES: Unsuitable species selection, inadequate planting, poor establishment phase maintenance, unsuitable filter media material (low water holding capacity), monoculture design, poor quality plant stock.

POSSIBLE MITIGATION MEASURES:

- Replanting and providing establishment phase program including monitoring, weeding, infill planting and irrigation if required
- Amendment of filter media to increase water holding capacity where soil moisture is identified as being deficient (the most common cause of large scale plant loss)
- Redesign of outlet structures to create a submerged zone, increasing water available to plants
- Review of plant species selection for given site conditions and hydrology
- Increase plant species diversity to provide a more robust design.
Identify works required

**Planned maintenance**

- Repair damaged bluestone kerb stones in surrounds
- Clear minor sediment from sediment forebay and clean our sediment sump

**Rectification**

- Scrape surface 100mm from surface and regrade to provide an extended detention depth of 100mm
- Remove, replace and infill planting with suitable species
Condition rating:

**Good**
- All WSUD elements are in good condition
- No maintenance required
  - No maintenance is required on this WSUD asset. Continue to inspect as planned.

**Good / Moderate**
- WSUD elements are in a mix of good / moderate condition
- Maintenance required
  - Simple maintenance which can be undertaken at the time of inspection or planned.

**Good / Moderate / Poor**
- WSUD elements are in a mix of good / moderate / poor condition
- Rectification required
  - Comprehensive works are required. This will typically require detailed investigations to be undertaken.

Single / obvious issue:
- Some rectification works can be planned without extensive investigations.
  - For example: continued vehicle damage can be addressed by installing bollards

Multiple / complex issues:
- If there are multiple or complex issues to be addressed, detailed investigations are required to identify the cause and identify suitable actions.
  - For example: mass plant failure should not just be addressed by replanting as it is likely the plants will die again. Instead investigations are required to identify the cause of plant die-off so this can be addressed before plants are revegetated.

Plan for rectification works to be undertaken

Plan for investigations to be undertaken
Prioritise works
Prioritisation of works

- Audit
- Audit items
- Condition factor

\[ \text{Asset score} = \text{Condition factor} \times \text{Asset factor} \]

- Asset database
- Asset details

- Function and water quality treatment
- Risk (public health and safety, continued damage, flooding, local environment)
- Amenity
- Significance of asset
- Catchment and downstream environment
- Visibility

Amenity
Prioritisation of works

Prioritisation guided by:

- Asset score
- What was the determining factor?
  - Condition factors
  - Asset factors
- Potential to improve outcomes (function, risk, amenity)
- Estimated costs and resources available
## Allocation of budgets

- Template spreadsheet for budgeting
- First pass overall budget estimate
- Costing of identified works

### Table

<table>
<thead>
<tr>
<th>Asset No.</th>
<th>Asset Name</th>
<th>Asset Type</th>
<th>Condition score</th>
<th>Priority of works (1-3)</th>
<th>Corrective Actions Required</th>
<th>Time Req'd Task</th>
<th>Staff</th>
<th>Rate</th>
<th>Area</th>
<th>Volume</th>
<th>Rate</th>
<th>Labour cost</th>
<th>Materials cost</th>
<th>Cost Estimate/Task</th>
<th>Timing of works</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Sediment pond A</td>
<td>Sediment ponds</td>
<td></td>
<td></td>
<td>Stabilise steep slope near outlet between footpath and culvert with concrete</td>
<td>16</td>
<td>2</td>
<td>$200</td>
<td>$300</td>
<td>$6,400</td>
<td>$6,400</td>
<td>$6,400</td>
<td>$6,400</td>
<td>$6,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scrape surface 50 mm to remove accumulated sediment including site setup</td>
<td>32</td>
<td>2</td>
<td>$200</td>
<td>$400</td>
<td>$12,800</td>
<td>$10,000</td>
<td>$22,800</td>
<td>$22,800</td>
<td>$22,800</td>
<td>$22,800</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace filter media as needed</td>
<td>16</td>
<td>2</td>
<td>$200</td>
<td>$400</td>
<td>$6,400</td>
<td>$5,000</td>
<td>$11,400</td>
<td>$11,400</td>
<td>$11,400</td>
<td>$11,400</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bioretention</td>
<td>Bioretention</td>
<td></td>
<td></td>
<td>Replant with recommended species at density of 8 plants/m²</td>
<td>500</td>
<td>4</td>
<td>$4</td>
<td>$16,000</td>
<td>$16,000</td>
<td>$16,000</td>
<td>$16,000</td>
<td>$16,000</td>
<td>$16,000</td>
<td>$50,200</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Wetland A</td>
<td>Wetland and sediment pond</td>
<td></td>
<td></td>
<td>Install an outlet pit, pipe and headwall to replace the porous rock weir while retaining the existing structure as an overflow weir, see Melbourne Water's Constructed Wetlands Design Manual, Part A2, 2016 for details on the design of this type of connection. The decision to recommend a submerged weir is based on consideration of minimizing litter flow through to the wetland and lake.</td>
<td>80</td>
<td>2</td>
<td>$200</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
<td>$32,000</td>
</tr>
</tbody>
</table>
Products of systematic audit process

/ Prioritised works programs
/ Documentation of condition
/ Budget planning
/ Database of issues and works
/ Learnings and feedback
  – Design
  – Construction and handover
  – Continual improvement of audits and works
Concluding comments

- The next step in the evolution of WSUD asset management
  - Guidance on effectively managing WSUD assets
  - New set of audit templates – consistent and systematic
  - Initial guidance on prioritisation
  - Time to recognise WSUD as assets

- Better results for less long term cost
Thank you
dale@E2Designlab.com.au