FACT SHEET

Sustainable Technologies
EVALUATION PROGRAM

Enhanced Swales

Inspection and Maintenance of Stormwater Best Management Practices

Enhanced swales are gently sloping vegetated open channels featuring a parabolic or trapezoidal cross-section and check dams, designed to convey and treat stormwater runoff (i.e., rainwater or snowmelt from roofs or pavements). The grading, Checkcheck dams and vegetation spreads out and slows down the flow of water, allowing suspended sediment and floatables (e.g., trash, natural debris, oil and grease) to settle out. A portion of the flowing water soaks into the soil and replenishes groundwater or is taken up by plant roots and evaporated back to the atmosphere. Runoff water is delivered to the practice through inlets such as curb-cuts, spillways or other concrete structures, sheet flow from pavement edges, or pipes connected to catchbasins or roof downspouts. The planting bed and side slopes are typically covered with grasses or a mixture of flood tolerant, erosion resistant vegetation and stone. They do not feature filter media soil and sub-drains like bioretention swales do. Water not ponded behind check dams or absorbed by the planting bed is conveyed to an adjacent drainage system (e.g., municipal storm sewer or other BMP) at the lowest downstream point by an outlet structure (e.g., ditch inlet catchbasin, culvert). Key components of enhanced swales for inspection and maintenance are described in Figure 2 and Table 1.

Enhanced swales typically require minimal maintenance after vegetation becomes established. Key components to pay particular attention to are inlets, areas immediately upstream of check dams and the overflow outlet. Trash, debris and sediment builds up at these locations and can prevent water from flowing into or out of the practice.

RELATED TERMS

Grassed or Vegetated Swale: A gently sloping open channel featuring a parabolic or trapezoidal cross-section and dense stand of grass or mixture of vegetation, but no check dams.

Roadside ditch: A gently sloping open channel draining a roadway, designed primarily for stormwater conveyance (not treatment) that features a triangular, parabolic or trapezoidal cross-section and dense stand of grass or mixture of vegetation, but no check dams.

BENEFITS

- Reduce the quantity of runoff and pollutants being discharged to municipal storm sewers and receiving waters (i.e., rivers, lakes and wetlands);
- Help to replenish groundwater resources;
- Easy to incorporate into landscaping and landscape maintenance programs;
- Best suited to roadways, parking lots, parks and yards in low or medium density developments and gently sloping topography (>6% slope);
- Can provide a convenient area for snow storage and snowmelt treatment; and
- Can provide aesthetic value as naturalized landscape features.

Figure 1. Enhanced swale with check dams (Image courtesy of M. Smith)

TIPS TO HELP PRESERVE BMP FUNCTION

- Maintain grading of the planting bed or grass filter strip at curb-cut inlets so at least 5 cm of the back of the curb is visible through regular sediment removal and regrading;
- To avoid over-compaction of the soil, any maintenance tasks involving vehicle (e.g., ride mower) or foot traffic on the planting bed should not be performed during wet weather;
- Maintain grass with a push mower or the lightest mulching ride mower available and core aerate and dethatch annually in the spring to help maintain permeability of the planting soil;
- Pruning of mature trees should be performed under the guidance of a Certified Arborist;
- Woody vegetation should not be planted or allowed to become established where snow will be piled/stored during winter; and
- Remove sediment from the planting bed surface with rake and shovel, or vacuum equipment to minimize plant disturbance. If a small excavator is used, keep it off the BMP footprint to avoid damage to side slopes/embankments and over-compaction of the soil.

KEY COMPONENTS AND INSPECTION AND MAINTENANCE TASKS

Figure 2. Generalized plan and cross-section view of an enhanced swale showing key components

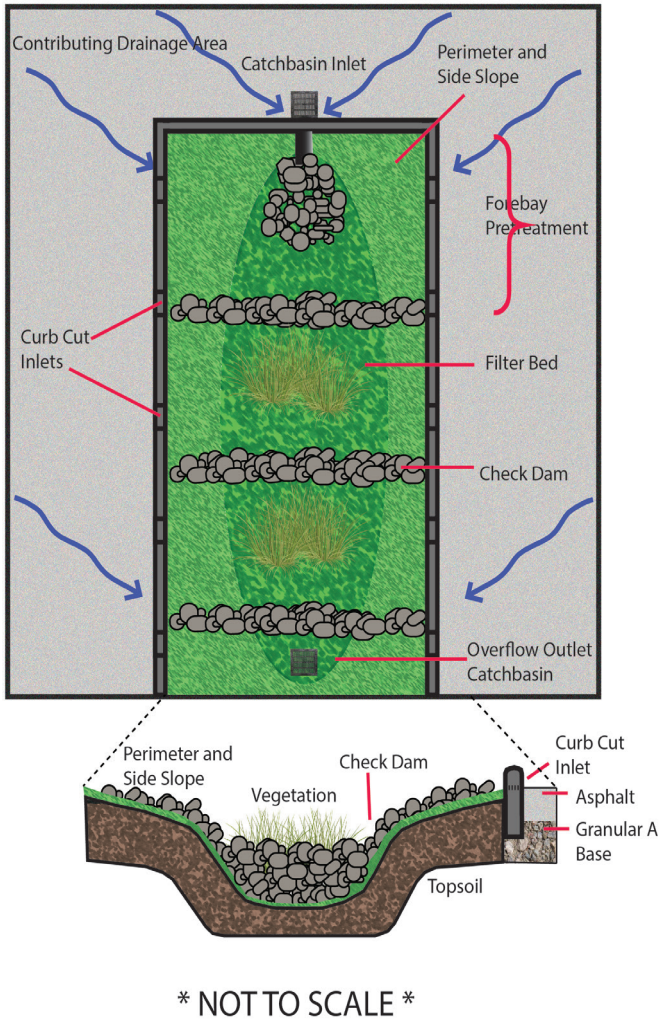


Figure 3. Enhanced swale with stone cover at inlets

Table 1. Key components, descriptions and routine inspection and maintenance tasks.

Component	Description	Inspection and Maintenance Tasks
Contributing drainage area (CDA)	Area(s) from which runoff directed to the BMP originates; includes both impervious and pervious areas.	• Remove trash, debris and sediment regularly from pavements (biannually to quarterly) and eavestroughs (annually); • Replant or seed bare soil areas as needed.
Pretreatment	Devices or features that retain trash, debris and sediment; help to extend the operating life cycle; such as eavestrough screens, catchbasin inserts and sumps, geotextile, gravel trenches and stone cover at inlets.	• Remove trash, debris and sediment annually to biannually or when the device sump is half full; • Measure sediment depth or volume during each cleaning, or annually to estimate accumulation rate and optimize frequency of maintenance.
Inlets and Overflow Outlet	Structures that deliver water to the BMP (e.g., curb-cuts, spillways, pavement edges, catchbasins, pipes) or convey flow that exceeds the storage capacity of the BMP to another drainage system.	• Keep free of obstructions; • Remove trash, debris and sediment biannually to quarterly; • Measure sediment depth/volume during cleaning or annually to estimate accumulation rate and optimize frequency of maintenance; • Remove woody vegetation from filter bed at inlets annually.
Perimeter	Side slopes that define the BMP footprint; may be covered by a mixture of vegetation and stone with slopes up to 3:1 (H:V).	• Confirm footprint area dimensions are within ±10% of the design and that the maximum surface ponding depth behind check dams meets design specifications; • Check for side slope erosion/damage from vehicular/foot traffic.
Filter bed	Linearly-oriented, gently sloping area (between 0.5 and 4% slope) where runoff is filtered and conveyed; parabolic or trapezoidal cross-section, lined with 20 to 30 cm of planting soil and covered with deep rooting perennial grasses or a mixture of vegetation and stone.	• Check for standing water, barren/eroded areas, sink holes or animal burrows; • Remove trash biannually to quarterly; • Rake regularly to remove thatch and prevent sediment crusts; • Mow grasses to maintain height of > 10 cm. • For sod or turf grass vegetation cover, aerate and dethatch annually to maintain soil permeability and dense grass cover; • Repair sunken areas when ≥ 10 cm deep and barren/eroded areas when ≥ 30 cm long; • Remove sediment when > 5 cm deep or time to drain water ponded behind check dams exceeds 48 hours.
Vegetation	Deep rooting perennial grasses or a mixture of wildflowers and shrubs, tolerant to both wet and dry conditions and salt; roots uptake water and return it to the atmosphere, provide habitat for organisms that break down trapped pollutants and help maintain soil structure and permeability.	• Routine maintenance is the same as a conventional lawn; • In the first 2 months of grass water plantings frequently (biweekly in the absence or rain) and as needed (e.g., bimonthly) over the remainder of the first growing season; • Remove weeds and undesirable plants biannually to quarterly; • Replace dead plantings annually to achieve 80% cover by the third growing season; • Do not apply chemical fertilizers.

Figure 2. Outlet (left) and ilnlets (middle and right) in need of maintenance

REHABILITATION

Table 2. Key components, typical problems and rehabilitation tasks.

Component	Problem	Rehabilitation Tasks
Inlets	Inlets are producing concentrated flow and causing filter bed erosion	Add flow spreading device or re-grade existing device back to level. Rake to regrade damaged portion of the filter bed and replant. If problem persists, replace some plant cover with stone.
Filter bed	Local or average sediment accumulation ≥ 5 cm in depth	At inlets remove stone and use vacuum equipment or rake and shovel to remove sediment. For large areas or BMPs, use of a small excavator may be preferable. Restore grades with planting soil that meets design specifications. Test surface infiltration rate to confirm it is > 15 mm/h. Replace stone and vegetation cover (re-use/transplant where possible). If problem persists, add pretreatment device(s) or investigate the source(s).
	Surface ponding remains for > 48 hours or surface infiltration rate is <15 mm/h.	Remove sediment as described above. Core aerate (for grass swales); or remove stone, sediment and plant cover and till 5 cm of yard waste compost into the exposed planting soil to a depth of 20 cm; or remove and replace the uppermost 15 cm of material with planting soil that meets design specifications. Test surface infiltration rate to confirm it has been restored to > 15 mm/h. Replace stone and plants (re-use/transplant where possible).
	Damage to filter bed or slide slope is present (e.g., erosion rills, animal burrows, sink holes, ruts)	Regrade damaged portion by raking and replant or restore stone cover. Animal burrows, sink holes and compacted areas should be tilled to 20 cm depth prior to re-grading. If problems persist, consider adding flow spreading device to prevent erosion or barriers to discourage foot or vehicular traffic.
Vegetation	Plants not thriving AND planting soil is low in organic matter (<5%) or available phosphorus (<12 mg/kg)	Remove stone and plant cover and uppermost 5 cm of planting soil, spread 5 cm of yard waste compost, incorporate into soil to 20 cm depth by tilling. Replace stone and plants (re-use/transplant where possible).

Figure 4. Inlets in need of maintenance due to sediment accumulation

TYPES OF INSPECTIONS

Routine Operation: Regular inspections (twice annually, at a minimum) done as part of routine maintenance tasks over the operating phase of the BMP life cycle to determine if maintenance task frequencies are adequate and determine when rehabilitation or further investigations into BMP function are warranted.

Maintenance and Performance Verification: Periodic inspections done every 5 years (Maintenance Verifications) and every 15 years (Performance Verifications) post-construction over the operating phase of the BMP life cycle to ensure compliance with maintenance agreement (e.g., Environmental Compliance Approval permit) conditions, evaluate functional performance and determine when rehabilitation or replacement is warranted.

INSPECTION TIME COMMITMENTS AND COSTS

Estimates are based on a typical partial infiltration bioretention design (i.e., includes a sub-drain); estimates for other designs (i.e., full infiltration and no-infiltration) are described in the Low Impact Development (LID) Stormwater Management Practice Inspection and Maintenance Guide available at https://sustainabletechnologies.ca.

Table 3. Time commitments and costs for inspection

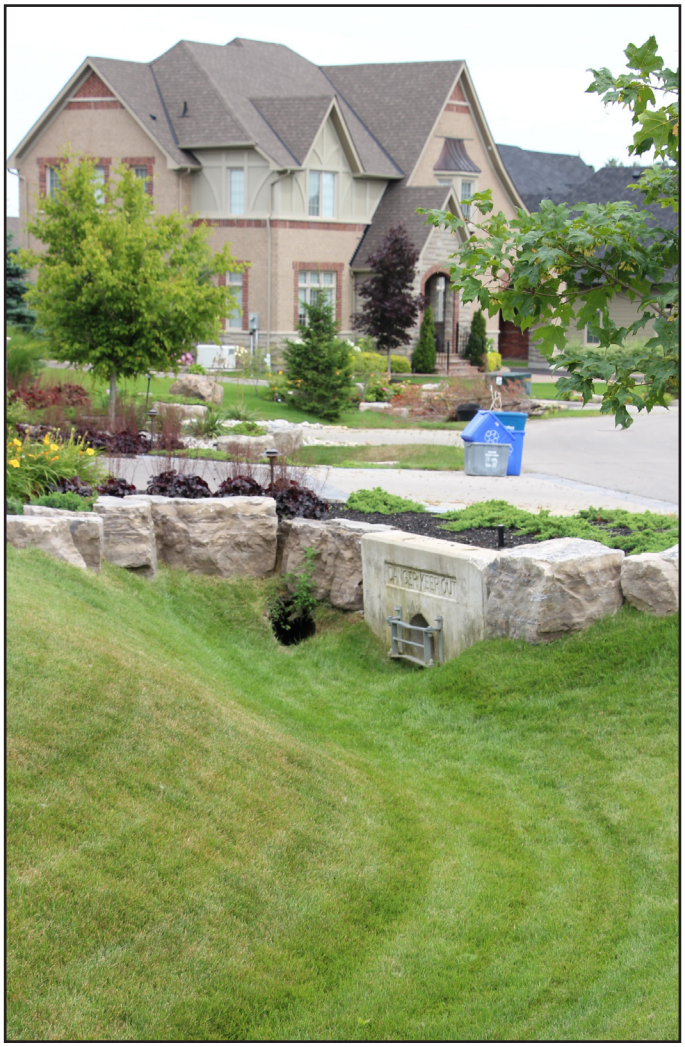
Enhanced Swales	Routine Operation	Maintenance Verification	Performance Verification
Tasks to complete	18	15	15
Visits (per year)	2	1 every 5 years	1 every 15 years
Time (hours per m^2 BMP area)	0.009	0.008	0.008
Cost	$1.01	$0.49	$1.78
Performance Verification Options ($ per m^2 BMP area)			
Surface infiltration rate testing: $5.75, 5 tests			
Simulated storm event testing: $10.47			
Natural storm event testing: 10.00, 2 months monitoring			

Figure 5. Sediment accumulation at the curb cut inlet to an enhanced swale

Table 4. Task cost estimates for maintenance and rehabilitation

Enhanced Swales	Costs per m^2 of BMP area	
Tasks	**Min.**	**High**
Watering - First year only	$6.43	$6.43
Watering - Second year only	$2.17	$2.64
Annual watering - Starts in year 3	$0.64	$1.29
Drought watering	$0.34	$0.34
Remove litter and debris	$0.33	$0.63
Mowing	$0.56	$1.12
Core aeration	$0.84	$0.84
Weeding	$0.54	$1.07
Pruning	$0.78	$0.78
Remove sediment - Starts in year 2	$0.90	$1.81
Replace sod - starts year 2	$0.35	$0.70

Figure 5. Enhanced swale in new subdivision



For a detailed description of construction, inspection, maintenance and rehabilitation cost assumptions see section 7.1.7 of the LID Stormwater Management Practice Inspection and Maintenance Guide. To generate BMP-specific cost estimates use the LID Life Cycle Costing Tool available at https://sustainabletechnologies.ca.

Table 2. Construction and life cycle cost estimates

Enhanced swales	**Costs per m^2 of BMP area + CDA**	
	Minimum	**High**
Construction	$8.32	
LIFE CYCLE COSTS		
25 year evaluation period		
Average annual maintenance	$0.55	$0.82
Maintenance and rehabilitation	$15.09	$22.14
50 year evaluation period		
Average annual maintenance	$0.70	$0.98
Maintenance and rehabilitation	$26.64	$39.41

Figure 6. Grass swale along major road

Figure 7. Grass swale draining a parking lot

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For more detailed information on inspection, testing and maintenance of enhances swales and a field data form (checklist) to use for collecting and recording inspection results, please refer to Appendix D of the Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide, available at **https://sustainabletechologies.ca**.

For more information about STEP and other resources and studies related to stormwater management, visit our website or email us at **STEP@trca.on.ca**.

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