4.3 Roof Downspout Disconnection

4.3.1 Overview

Description

Simple downspout disconnection involves directing flow from roof downspouts to a pervious area that drains away from the building (see Figure 4.3.1). This prevents stormwater from directly entering the storm sewer system or flowing across a "connected" impervious surface, such as a driveway, that drains to a storm sewer. Simple downspout disconnection requires a minimum flow path length across the pervious area of 5 metres. When the infiltration rate of the soil in the pervious area is less than 15 mm/hr (i.e., hydraulic conductivity of less than $1x10^{-6}$ cm/s), the area should be tilled to a depth of 300 mm and amended with compost to achieve an organic content in the range of 8 to 15% by weight or 30 to 40% by volume.

Figure 4.3.1 Examples of disconnected downspouts draining to a splash pad (left), a rain garden (centre) and an infiltration trench (right)

Source: City of Surrey (left); Riversides (centre); David Elkin (right)

Common Concerns

Some common concerns with downspout disconnection include:

- *On Private Property:* If stormwater management credit is given for roof downspout disconnection, property owners or managers will need to be educated on its function and maintenance needs, and may be subject to a legally binding maintenance agreement. An incentive program such as a storm sewer user fee based on the area of impervious cover on a property that is directly connected to a storm sewer (*i.e.*, does not first drain to a pervious area or LID practice) could be used to encourage property owners or managers to maintain existing practices.

- *Foundations and Seepage:* Discharge locations for roof downspouts should be a distance of 3 metres away from building foundations. This may not be necessary if the topography slopes 1 to 5% away from the building.

- *Compaction:* Compaction of soils in the pervious area to which downspouts are directed will significantly decrease the efficiency of the downspout disconnection. Vehicle traffic and high foot traffic should be prevented. Planting tall vegetation around the perimeter of the pervious area is one technique for preventing traffic in these areas.

- *Standing Water and Ponding:* Pervious areas should infiltrate roof runoff into the underlying native soil. Downspout disconnection is not intended to pond water, so any standing water should be infiltrated or evaporated within 24 hours of the end of each runoff event. If ponding for longer than 24 hours occurs, mitigation actions noted in the maintenance section (section 4.3.3) should be undertaken.

Physical Suitability and Constraints
Some key constraints for downspout disconnection include:

- *Available Space:* Simple downspout disconnection requires a minimum flow path length across the pervious area (at least 5 metres) and suitable soil conditions. If the flow path length is less than 5 metres and soils are hydrologic soil group (HSG) C or D, roof downspouts should be directed to another LID practice such as a rainwater harvesting system, soakaway, swale, bioretention area or perforated pipe system.

- *Site Topography:* Disconnected downspouts should discharge to a gradual slope that conveys runoff away from the building. The slope should be between 1% and 5%. Grading should discourage flow from reconnecting with adjacent impervious surfaces.

- *Soils:* If the infiltration rate of soils in the pervious area is less than 15 mm/hr (i.e., hydraulic conductivity less than $1x10^{-6}$ cm/s), as determined from measurements (see Appendix C for acceptable methods), they should be tilled to a depth of 300 mm and amended with compost to achieve an organic content in the range of 8 to 15% by weight or 30 to 40% by volume.

- *Drainage Area:* For simple downspout disconnection the roof drainage area should not be greater than 100 square metres.

- *Pollution Hot Spot Runoff:* Downspout disconnection can be used where land uses or activities at ground-level have the potential to generate highly contaminated runoff (*e.g.*, vehicle fueling, servicing and demolition areas, outdoor storage and handling areas for hazardous materials and some heavy industry sites) as long as the roof runoff is kept separate from runoff from ground-level impervious surfaces.

Typical Performance

The ability of downspout disconnection to meet stormwater management objectives is summarized in Table 4.3.1. Because of its partial ability to meet objectives, downspout disconnection will most likely be used in conjunction with soil amendments or another best management practice.

Table 4.3.1 Ability of Roof downspout disconnection to meet SWM objectives

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Downspout Disconnection	Partial – depends on soil infiltration rate	Partial – depends on soil infiltration rate and length of flow path over the pervious area	Partial – depends on combination with other practices

Downspout disconnection is primarily a practice used to achieve water balance benefits, although it can contribute to water quality improvement. Very limited research has been conducted on runoff reduction rates from roof downspout disconnection, so initial estimates are drawn from research on vegetated filter strips (Table 4.3.2), which operate in a similar manner. Research indicates that runoff reduction is a function of soil type, slope, vegetative cover and flow path length across the pervious surface.

A conservative runoff reduction rate estimate for roof downspout disconnection is 25% for hydrologic soil group[1] (HSG) C and D soils and 50% for HSG A and B soils. These values apply to disconnections that meet the physical suitability and constraints criteria outlined in this section.

Table 4.3.2 Volumetric runoff reduction achieved by vegetated filter strips

LID Practice	Location	Runoff Reduction	Reference
Filter Strip	Guelph, Ontario	20 to 62%[1]	Abu-Zreig et al (2004)
Filter Strip	California	40 to 70%[1]	Barrett (2003)
Runoff Reduction Estimate[2]		**50% on HSG A and B soils; 25% on HSG C and D soils**	

Notes:
1. Where a range is given, the first number is for a flow path length of 2 to 5 metres and the second is from 8 to 15 metres.
2. This estimate is provided only for the purpose of initial screening of LID practices suitable for achieving stormwater management objectives and targets.

[1] Hydrologic soil group (HSG) classification is based on the ability of the soil to transmit water. Soil groups are ranked from A to D with A group soils being the most permeable and D group soils being the least permeable. Group A soils are sand, loamy sand or sandy loam types. Group B soils are silt loam or loam types. Group C soils are sandy clay loam types. Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay types.

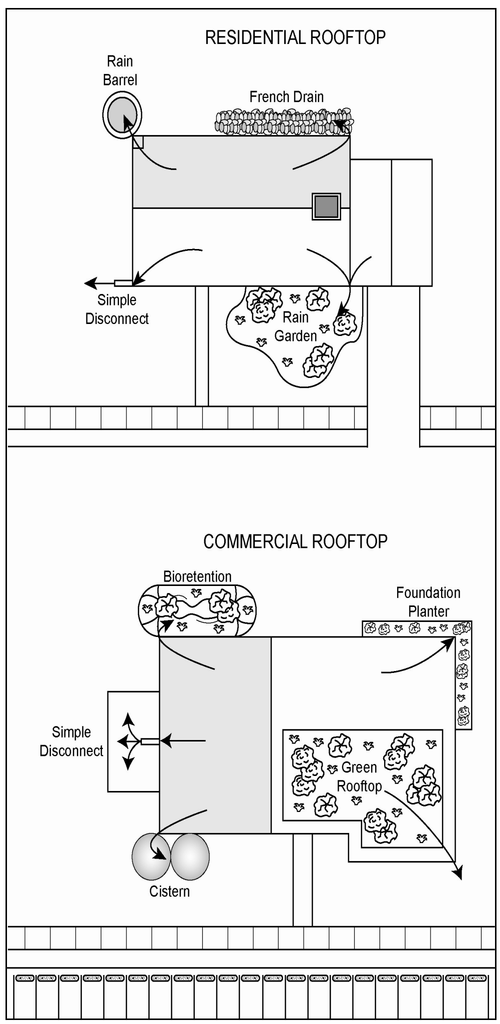
4.3.2 Design Template

Applications

There are many options for keeping roof runoff out of the storm sewer system (Figure 4.3.2). Some of the options are as follows:

- Simple roof downspout disconnection to a pervious area or vegetated filter strip, where sufficient flow path length across the pervious area and suitable soil conditions exist;
- Roof downspout disconnection to a pervious area or vegetated filter strip that has been tilled and amended with compost to improve soil infiltration rate and moisture storage capacity;
- Directing roof runoff to an enhanced grass swale, dry swale, bioretention area, soakaway or perforated pipe system;
- Directing roof runoff to a rainwater harvesting system (i.e., rain barrel or cistern) with overflow to a pervious area, vegetated filter strip, swale, bioretention area, soakaway or permeable pavement.

Figure 4.3.2 Roof downspout disconnection options



Typical Details
Typical design criteria are outlined in the Design Guidance section below.

Design Guidance
Roof downspout disconnections should meet the following criteria:

- Pervious areas used for downspout disconnection should be graded to have a slope of 1 to 5%;
- Pervious areas should slope away from the building or discharge location should be at least 3 metres from the building foundation;
- The flow path length across the pervious area should be 5 metres or greater;
- The infiltration rate of soils in the pervious area should be 15 mm/hr or greater (i.e., hydraulic conductivity of $1x10^{-6}$ cm/s or greater);
- If infiltration rate of the soil in the pervious area is less than 15 mm/hr, it should be tilled to a depth of 300 mm and amended with compost to achieve a ratio of 8 to 15% organic content by weight or 30 to 40% by volume;
- If the flow path length across the pervious area is less than 5 metres and the soils are HSG C or D, roof runoff should be directed to another LID practice (*e.g.*, rainwater harvesting system, bioretention area, swale, soakaway, perforated pipe system);
- The total roof area contributing drainage to any single downspout discharge location should not exceed 100 square metres; and,
- A level spreading device (*e.g.*, pea gravel diaphragm) or energy dissipating device (*e.g.*, splash pad) should be placed at the downspout discharge location to distribute runoff as evenly as possible over the pervious area.

Other Design Guidance

City of Toronto Downspout Disconnect Program
http://www.toronto.ca/water/protecting_quality/downspout.htm

Region of Peel – Conservation Peel
http://www.peelregion.ca/conservation/

Design Specifications
General design guidance for the disconnection of downspouts is provided above, and, depending on the soil conditions in the pervious area, may be designed in conjunction with tilling and amending of soils with compost to increase infiltration rate and moisture retention capacity.

Construction Considerations
The following recommendations should be considered during the construction of sites with planned downspout disconnection:

- *Soil Disturbance and Compaction:* Soil compaction should be limited in order to ensure infiltration. Only vehicular traffic necessary for construction should be allowed on the pervious areas to which roof downspouts will be discharged. If vehicle traffic is unavoidable, then the pervious area should be tilled to a depth of 300 mm to loosen the compacted soil.

- *Erosion and Sediment Control:* If possible, construction runoff should be directed away from the proposed downspout discharge location. After the contributing drainage area and the downspout discharge location are stabilized and vegetated, erosion and sediment control structures can be removed.

- *Soil Tilling and Amendment:* Where the post-construction infiltration rate of the soil at pervious areas to which roof downspouts will be discharged is less than 15 mm/hr, soils should be tilled to a depth of 300 mm and amended with compost to achieve an organic content ratio of 8 to 15% by weight or 30 to 40% by volume.

4.3.3 Maintenance and Construction Costs

Maintenance
Maintenance of disconnected downspouts for stormwater management will generally be no different than maintenance of lawns or landscaped areas. A maintenance agreement with property owners or managers may be required to ensure that downspouts remain disconnected and the pervious area remains pervious. For long-term efficacy, the pervious area should be protected from compaction. One method is to plant shrubs or trees along the perimeter of the pervious area to prevent traffic. On commercial sites, the pervious area should not be an area with high foot traffic. If ponding of water for longer than 24 hours occurs, the pervious area should be dethatched and aerated. If ponding persists, regrading or tilling to reverse compaction and/or addition of compost to improve soil moisture retention may be required.

Installation and Operation Costs
For new development, there is no added cost associated with simple roof downspout disconnections to pervious areas. Where post construction soil infiltration rate is less than 15 mm/hr or hydraulic conductivity under field saturated conditions (K_{fs}) is less than $1x10^{-6}$ cm/s, as determined from measurements, additional costs associated with soil tilling and amendment with compost will be incurred. Disconnecting roof downspouts from storm sewers in existing developments typically costs $100 per downspout, including materials (*e.g.*, splash pad and downspout extension) and labour.

4.3.4 References

Abu-Zreig, M. Rudra, M. Lalonde. H. Whitely and N. Kaushik. 2004. Experimental investigation of runoff reduction and sediment removal by vegetated filter strips. Hydrologic Processes. Vol. 18 pp. 2029-2037

Barrett, M., P. Walsh, J. Malina and R. Charbeneau. 1998. Performance of vegetative controls for treating highway runoff. *Journal of Environmental Engineering*. Vol. 124. No. 11 pp. 1121-1128.

Barrett, M. 2003. Roadside vegetated treatment sites study: final report. Caltrans Division of Environmental Analyses. CTSW.RT-03-028.