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Green Roof

Description

A green roof is a conventional roof with a veneer of drainage and growing media that supports living vegetation.

Green roofs with a relatively shallow growing medium thickness are generally called 'Extensive Green Roofs'. These are often designed for stormwater, insulation and climate amelioration functions, and usually have no public access. Vegetation is selected for its ability to withstand harsh conditions and its ability to maintain itself over the long-term.

'Intensive Green Roofs' are usually designed with public access and use in mind, and have deeper growing medium depths to support larger plants and trees. Intensive green roofs also have stormwater benefits, but are heavier and more expensive to develop, and therefore less affordable for the large flat roof expanses that are common in industrial/commercial developments.

This section is focused on the stormwater aspects of Extensive Green Roofs.

Applications

- Suitable for many rooftop situations – industrial and warehousing, commercial buildings, municipal office complexes, hospitals, schools, institutional/administrative buildings and offices, residential developments and garages.
- Suitable for flat roofs and, with proper design, roofs of 20° slope or more (Peck & Kuhn, 2001). These may be inverted or traditional roofing systems. Shingle and tile roofs are not suitable for greening (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V (FLL), 2002).

Photo Credit: Goya Ngan

Extensive green roof – Halle Zoo, Germany

Photo Credit: Lanarc Consultants

Extensive green roof – Amsterdam

- Green roofs provide multiple benefits, including:
  - Reduction in stormwater peak flows.
  - Reduction in rainfall volume leaving the roof due to evaporation and evapo-transpiration. A typical extensive green roof of about 75mm in growing media can be designed to reduce annual runoff by more than 50% (Miller, 2001b; FLL, 2002).
  - Mitigation of the urban heat island effect, which is raising the temperatures of cities and increasing energy use as well as increasing the effects of air pollution (Peck & Kuhn, 2001).
  - Air filtration, removing fine particulates from the air (Peck & Kuhn, 2001).
  - Reduction in heat gain and the need for air conditioning in the summer – modeled savings are as high as 25% (Peck & Kuhn, 2001).
  - Reducing heat loss in the winter; studies show that with 30 cm of growing medium, roof temperatures do not drop below 0°C even when outside temperatures are -20°C (Peck & Kuhn, 2001).
  - Roof membrane protection and life extension. European studies have revealed that green roof installation can double the life span of a conventional roof, by helping to protect the membrane from extreme temperature fluctuations, ultraviolet radiation, and mechanical damage (Peck & Kuhn, 2001).
  - Sound insulation – tests show that 12 cm of growing medium can reduce sound by 40 db (Peck & Kuhn, 2001).
  - Increasing biodiversity in urban areas by providing habitat for birds, insects, native plants, and rare or endangered species.
  - Aesthetic value and increased urban green space.

Limitations

- Green roofs must be designed with an awareness of the loading of the roof on the underlying structure. However, use of lightweight growing media has created solutions where saturated growing media can be installed without structural upgrading beyond the standard requirements, especially in concrete buildings or new construction. (Peck & Kuhn, 2001).
- Canada does not have official green roof standards. Until such standards are published, the German FLL guidelines and test procedures represent the only comprehensive standards for green roof design, installation and maintenance. Green roofs, as extensions of the roofing system, should comply with the BC Building Code.

Extensive Green Roof Types

Extensive green roofs can be one of following designs:

- Multiple layer construction (Drawing 5A and 5B) - consists of either: i) a three-layer system including separate drainage course, filter layer and growing medium or; ii) a two layer system where the growing medium is sized to not require a filter between it and the underlying drainage layer. Extensive Green Roof may be installed over either a conventional or an inverted roof system.
- Single layer construction (Drawing 5B) - consists of a growing medium which includes the filter and drainage functions.

Design Guidelines

1. Start the design of the green roof at the same time as the design of the building or retrofit project, so that the structural load of the green roof can be balanced with the structural design of the building. From the outset, involve all design disciplines – structural, mechanical and electrical engineers, architects and landscape architects – and include roofing design professionals in a collaborative and optimization effort (Oberlander *et al.*, 2002).

2. Provide construction and maintenance access to extensive green roofs. Access through a 'man door' is preferable to access through a small roof hatch (Peck & Kuhn, 2001). Provide areas of storage for maintenance equipment. Review Workers Compensation Board requirements for safety of maintenance workers – can gardeners working near the edge of the roof use the same harness fastenings as window washers? (Oberlander *et al.*, 2002) Provide a

hose bib for manual watering during establishment if no automatic irrigation system is planned.

3. Roofs with less that 2% slope require special drainage construction so that no part of the growing medium is continuously saturated. As the slope increases, so does the rate of rainfall leaving the roof. This can be compensated for by using a medium with high water storage capacity. Roofs with over 20° require special precautions against sliding and shearing (FLL. 2002). If inverted roof systems are used with exterior insulation, good drainage needs to be provided to prevent continuous saturation of the insulation, and subsequent damage (Peck & Kuhn, 2001). With inverted roofs, the green roof components must allow moisture to move upwards from the insulation and to eventually evaporate (Krupka, 1992).

4. Provide plant free zones to facilitate access for inspections and maintenance and prevent plants from spreading moisture onto exposed structural components. They can also function as a measure against fire and wind-uplift. They should be at least 50 cm wide and located along the perimeter, all adjacent facades and covered expansion joints, and around each roof penetration.

Photo Credit: Lanarc Consultants Ltd.

Newly planted extensive green roof showing plant-free zones at drain and edges – White Rock Operations Building

5. Fire breaks of non-combustible material, such as gravel or concrete pavers, 50 cm wide, should be located every 40 m in all directions, and at all roof perimeter and roof penetrations (FLL, 2002). Other fire control options include use of sedums or other succulent plants that have a high water content, or a sprinkler irrigation system connected to the fire alarm (Peck & Kuhn, 2001).

6. There are several choices of waterproof membranes. Thermoplastic membranes, such as PVC (polyvinyl choride) or TPO (thermal polyolefin) using hot air fusion methods are commonly used for green roof applications. Elastomeric membranes like EPDM (ethylene-propylene rubber materials) have high tensile strength and are well-suited to large roof surfaces with fewer roof penetrations. Modified bitumen sheets are usually applied in two layers and are commonly available. Liquid-applied membranes are generally applied in two liquid layers with reinforcement in between. The quality is variable. A factor in choosing a waterproofing system is resistance to root penetration (see point 7 below).

7. Provide protection against root penetration of the waterproof membrane by either adding a root barrier or using a membrane that is itself resistant to root penetration

(more cost efficient). Resistance to root penetration is not being tested in Canada at time of writing[1]. Thermoplastic and elastomeric membranes in suitable thicknesses are usually resistant to root penetration. Roofing membranes, existing or new, which contain bitumen or other organic materials are susceptible to root penetration and micro-organic activity. These types of roofing membranes need to be separated from the growing medium by a continuous root barrier unless they contain an adequate root repelling chemical or copper foil (Ngan, 2003).

8. Chemically incompatible materials such as bitumen and PVC require a separation layer (FLL, 2002).

9. When the roofing membrane installation is complete, but prior to installing layers above the waterproof membrane, it should be tested by flooding and thorough inspection. Any leaks should be repaired prior to installing materials above the membrane (Ngan, 2003).

10. Install a protection layer to protect the waterproof membrane/root barrier from physical damage caused by construction activities, sharp drainage materials such as lava rock or broken expanded clay, and subsequent levels of stress placed on the roof (Ngan, 2003).

11. The drainage layer may be drain rock, but is often a lightweight composite such as lava, expanded clay pellets, expanded slate or crushed brick. If weight is a concern, rigid plastic materials that allow rapid lateral drainage may be used. The drainage layer may also function to store water and make it available to the vegetation during dry periods. The top of the drainage layer is normally separated from the growing medium by non-woven filter cloth.

[1] Check with the manufacturer to determine if the membrane is resistant to root penetration according to the German FLL Root Penetration Test, 2002.

Table 5-1: Weights of Common Building Materials (Oberlander *et al.,* 2002: 26)

Material	Kg/m^3
Light weight concrete	1298-1622
Precast concrete	2108
Reinforced concrete	2433
Gravel	1946
Timber – hardwood (av.)	730
Timber –softwood (av.)	568
Sand (dry)	1460-1784
Sand (wet)	1784-2108
Water	1013
Light-weight growing medium (moist condition)	884-1121

12. Light weight growing medium is often a combination of pumice, lava rock, expanded clay or other lightweight absorbent filler, with a small amount of organic matter. The FLL recommends between 6 and 8% organic matter. When properly sized (see Figure 11), a mineral-based growing medium is able to retain stormwater as effectively as soil high in organic matter without the disadvantage of compacting and breaking down over time. For additional detailed information on the properties of green roof growing media, refer to the FLL guidelines(2002):

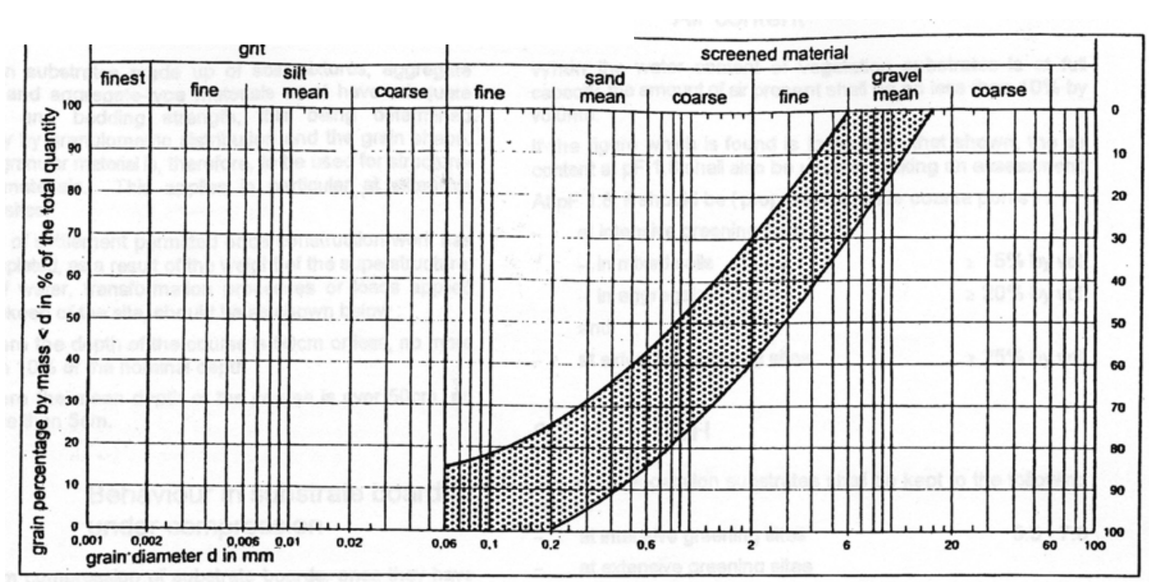


Figure 5-1: Particle (grain) size distribution range for substrates used in multiple layer extensive green roofs (FLL, 1995: 34)

13. In calculating structural loads, always design for the saturated weight of each material (Oberlander *et al.*, 2002). See Table 5-1 for weights of common building materials.

14. Light weight growing medium can be subject to wind erosion when dry. If planting is delayed through a dry weather season, provide a wind erosion control blanket over the growing medium.

15. Plant choices for extensive green roofs are limited to plants that can withstand the extremes of temperature, wind, and moisture condition on a roof. Typically, extensive green roofs use a variety of mosses, sedums, sempervivums, alliums, other bulbs and herbs, and grasses.

16. Avoid specifying or allowing volunteer plant materials with aggressive root systems (e.g. bamboo, couch grass, tree seedlings). Supply and install growing medium that is free of weeds (Ngan, 2003).

17. Design planting to respect microclimate and sun/aspect conditions. Collaborate with mechanical engineers on placement of exhaust vents, and design plantings accordingly (Oberlander *et al.*, 2002).

18. Avoid swaths of one species. The chances of creating a self-maintaining plant community are increased when a wide mix of species is used.

19. Planting methods include seeding, hydroseeding, spreading of sedum sprigs, planting of plugs or container plants, and installing pre-cultivated vegetation mats.

20. If automatic irrigation is required, low volume and rainwater reuse systems are preferred.

21. Provide intensive maintenance for the first two years after the plant installation – including watering in dry periods, removal of weeds, light fertilization with slow release complete fertilizers, and replacement of dead plants. It is recommended that the maintenance contract for the first 3-5 years be awarded to the same company that installed the green roof and that the service be included in the original bid price (Peck & Kuhn, 2001). Once established, a typical extensive green should require only one or two annual visits for weeding of undesired plants, clearing of plant-free zones and inspecting of drains and the membrane.

Photo Credit: Goya Ngan

Green roof test plots - Saskatoon

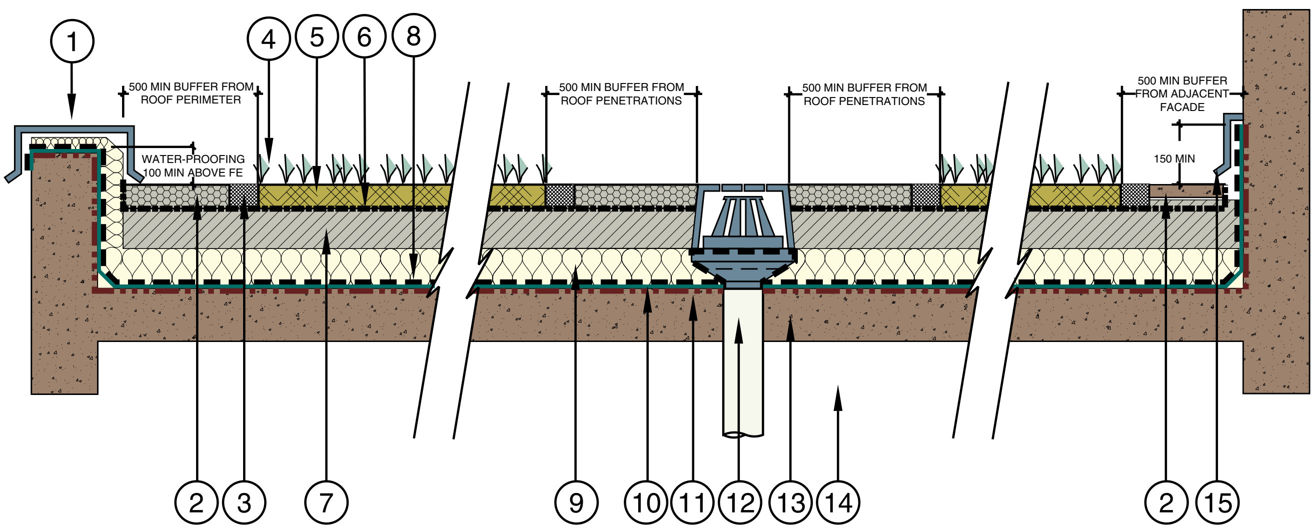
22. Installers should have experience with green roof systems. It may be preferable to have one company handle the entire project from roofing to planting to avoid scheduling conflicts and damage claims (Peck & Kuhn, 2001). If it is not possible, make a clear separation between the responsibilities of the roofing contractor and those of the green roof contractor (Krupka, 1992).

23. Although green roof membranes will last longer than others, leaks can still occur at flashings or through faulty worksmanship. Some companies are recommending an electronic leak detection system to pinpoint the exact location of water leaks, thus allowing easy repair (Peck & Kuhn, 2001).

24. Consider the environmental impact of each green roof material. How much energy was required to extract, manufacture and deliver the material? Is there a suitable material derived from local recycled products? What effect does the material have on water quality? How often must it be replaced? How will it be disposed of? Is it recyclable?

25. Several companies provide the GVRD with complete green roof service, and offer a range of long-term guarantees on the entire assembly. This type of comprehensive installation may be more expensive than comparable 'off the shelf' products not specifically designed for green roof use. The decision on risk management is with the owner (Peck & Kuhn, 2001).

1. WALL CAP FLASHING
2. DRAIN ROCK, PAVING SLAB, OR OTHER BUFFER EQUIVALENT
3. WOOD, STEEL OR CONCRETE CURB/EDGING (OPTIONAL)
4. PLANTING
5. GROWING MEDIUM
6. FILTER LAYER
7. DRAINAGE LAYER
8. PROTECTION LAYER AND ROOT BARRIER
9. THERMAL INSULATION
10. WATERPROOF MEMBRANE
11. VAPOUR BARRIER
12. AREA DRAIN
13. STRUCTURAL SLAB
14. BUILDING INTERIOR
15. WALL FLASHING



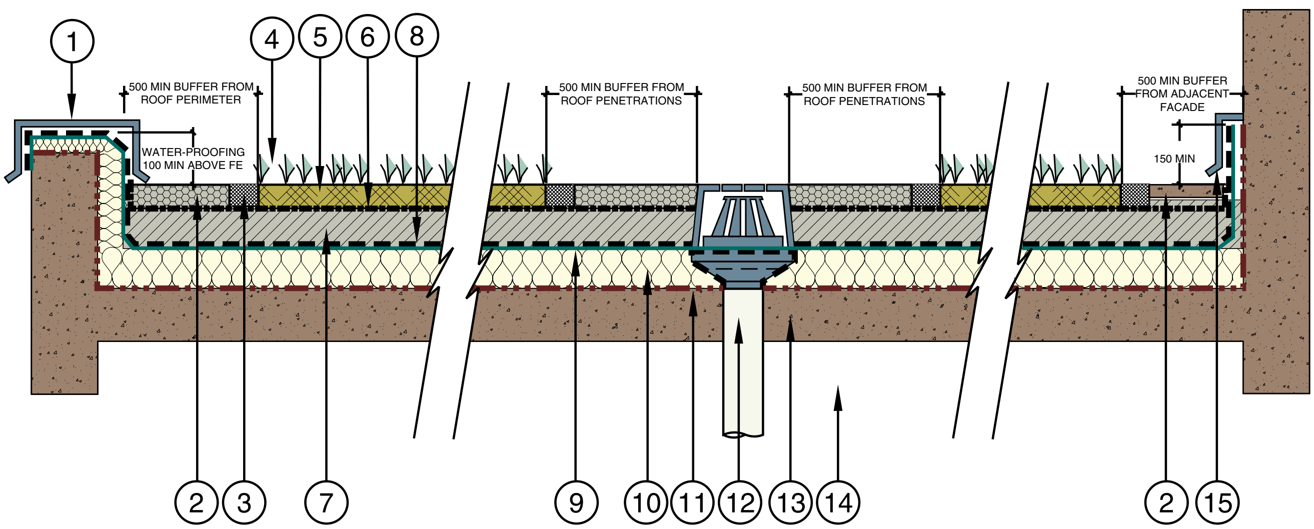
NOTE: UNLESS THE WATERPROOF MEMBRANE IS RESISTANT TO ROOT PENETRATION, A ROOT BARRIER IS REQUIRED BETWEEN THE PROTECTION LAYER AND WATERPROOF MEMBRANE. A SEPARATION LAYER MAY BE REQUIRED BETWEEN CHEMICALLY INCOMPATIBLE MATERIALS.

5/A

MULTIPLE LAYER EXTENSIVE GREEN ROOF

Not To Scale — Section

1. WALL CAP FLASHING
2. DRAIN ROCK, PAVING SLAB, OR OTHER BUFFER EQUIVALENT
3. WOOD, STEEL OR CONCRETE CURB/EDGING (OPTIONAL)
4. PLANTING
5. GROWING MEDIUM
6. FILTER LAYER
7. DRAINAGE LAYER
8. PROTECTION LAYER AND ROOT BARRIER
9. WATERPROOF MEMBRANE
10. THERMAL INSULATION
11. VAPOUR BARRIER
12. AREA DRAIN
13. STRUCTURAL SLAB
14. BUILDING INTERIOR
15. WALL FLASHING



NOTE: UNLESS THE WATERPROOF MEMBRANE IS RESISTANT TO ROOT PENETRATION, A ROOT BARRIER IS REQUIRED BETWEEN THE PROTECTION LAYER AND WATERPROOF MEMBRANE. A SEPARATION LAYER MAY BE REQUIRED BETWEEN CHEMICALLY INCOMPATIBLE MATERIALS.

5
B

MULTIPLE LAYER EXTENSIVE GREEN INVERTED ROOF

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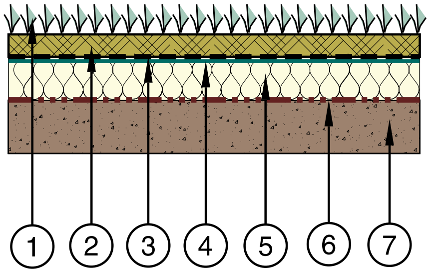
Section



1 PLANTING

2 GROWING MEDIUM (SPECIAL COARSE COMPOSITION)

3 PROTECTION LAYER

4 WATERPROOF MEMBRANE

5 THERMAL INSULATION

6 VAPOUR BARRIER

7 STRUCTURAL SLAB

5 / C

SINGLE LAYER EXTENSIVE GREEN ROOF

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Infiltration Trench & Soakaway Manhole

Description

An **Infiltration Trench** System includes an inlet pipe or water source, catch basin sump, perforated distribution pipe, infiltration trench and overflow to the storm drainage system. Although commonly in a linear trench shape, the same principles apply to underground drain rock infiltration devices of any shape (See Drawing 6D).

An **Soakaway Manhole** System includes an inlet pipe, a sedimentation manhole, and one or more Soakaway Manholes with connecting pipes (See Drawings 6A, 6B, 6C).

Other common terms used are *Infiltration Sump, Dry Well, or Infiltration Shaft*.

Photo Credit: Lanarc Consultants Ltd.

Perforated pipe over drain rock reservoir at infiltration trench under construction in Maple Ridge.

Photo Credit: Lanarc Consultants Ltd.

Same infiltration trench as above, before backfill, showing filter cloth wrap, and showing trench dam of native material between infiltration trench 'cells'.

Application

- Infiltration Trenches are often used to allow roof runoff to soak away into the ground. With water quality pre-treatment, they can be used for infiltration of other surface waters. Although ideally located under surface soils that will allow some evaporation, there are applications where an infiltration trench can be installed under pavement, provided that structural design of pavement is appropriate.
- Provision of underground overflow allows use of the technique in most soils, including clay with infiltration rates as low as 0.6mm/hr.
- Suitable for clean, unpolluted runoff from many development situations – residential areas, municipal office complexes, rooftop runoff, parks and greenspace, golf courses (Stephens *et al.*, 2002). Not suited for parking and heavy traffic roadway runoff unless there has been water quality pre-treatment to remove hydrocarbons and heavy metals.

Limitations

Use of Infiltration Trench or Soakaway Manhole will be limited by hydro-geotechnical conditions in much of GVRD.

- To avoid groundwater pollution, do not direct un-treated polluted runoff to Infiltration Trench or Soakaway Manhole:
  - Direct clean runoff (roof, non-automobile paving) to Infiltration Trench or Soakaway Manhole.

Photo Credit: Lanarc Consultants Ltd.

Infiltration facilities near urban structures should only be installed in neighbourhoods that have footing drains or other methods to protect basements from flooding.

- For polluted runoff (roads > 1000 vehicles / day, parking areas, other pollution sources), provide upstream source control for pollutant reduction prior to release to Infiltration Trench or Soakaway Manhole.

- Use Infiltration Trench or Soakaway Manhole only in areas with footing drains. If steep slopes or drinking water wells exist within 200m horizontally from the proposed Infiltration Trench or Soakaway Manhole, provide a hydro-geotechnical report to analyze site-specific risks and determine setbacks. Guidelines for setbacks to steep slopes are 60m from the tops of slopes more than 3m high and steeper than 2h:1v. Setbacks to drinking water wells should at least equal the BC Ministry of Health setback from well to septic field (30.5 m at time of writing).
- Minimum depth from base of drain rock reservoir to water table 600 mm.
- Identify pollutant sources, particularly in industrial/commercial hotspots, that require pre-treatment or source control upstream of this BMP. (Maryland Dept. Environmental Resources Program, 2000).
- Design should provide for drain rock reservoir to drain in 96 hours to allow aerobic conditions for water quality.

Design Guidelines

Infiltration Trench System:

1. Locate Infiltration Trench at least 3m from any building, 1.5m from property lines, and 6m from adjacent infiltration facilities (or as recommended by a geotechnical engineer).
2. If any surface water is to enter the system, provide pre-treatment erosion control to avoid sedimentation in the Infiltration Trench. Provide non-erodable material and sediment cleanout basins at point-source inlets (Maryland Dept. Environmental Resource Programs, 2001).
3. Provide vegetated erosion control along any surface water conveyance swales (e.g. between rain water leader and sump inlet). Swale planting is typically sodded lawn. Low volume swales can be finished with a combination of grasses, shrub, groundcover and tree planting to provide a 100% vegetated cover within 2 years of planting.
4. Sump: Concrete, plastic, or other non-degradable box with strength suitable to withstand surface loads. Provide a lid for periodic inspection and cleanout. Include a T-inlet pipe to trap oils, sediments and debris. Provide weep holes to dewater the sump, for mosquito management.

5. Infiltration Trench: installation of perforated distribution pipe and bottom of drainrock to be level. If more than one section of infiltration trench is required, design so that underground water is temporarily 'ponded' in each infiltration section, using underground weirs of undisturbed native material or constructed ditch blocks designed to create underground pooling in the reservoir sufficient for infiltration performance.
6. Infiltration Trench bottom width - 600mm minimum, 2400mm maximum.
7. Install the Infiltration Trench in native ground, and avoid over-compaction of the trench sides and bottom, which reduces infiltration.
8. Observation well for each Infiltration Trench (optional): vertical standpipe, with perforated sides, and locking lid, to allow the monitoring of water depth.
9. Size the Infiltration Trench or Soakaway Manhole system by continuous flow modelling. For single family areas, check with local governments to see if there are sizing guidelines for your watershed or neighbourhood.
10. A non-erodible outlet or spillway must be established to discharge overflow (Maryland Dept. Environmental Resource Programs, 2001).
11. Avoid utility or other crossings of the Infiltration Trench. Where utility trenches must be constructed crossing below the Infiltration Trench, install trench dams to avoid infiltration water following the utility trench.

Photo Credit: Lanarc Consultants Ltd.

Infiltration trench can be in any plan shape – the photo shows a rectangular 'soakaway' under construction at a single family subdivision in BC.

Soakaway Manhole System:

1. Provide a report from a geotechnical engineer including on-site test data of infiltration rates at the depth of the proposed infiltration. The bottom of the Soakaway Manhole shall be at least 600mm above the seasonal high water table or bedrock, or as recommended by the engineer.
2. Provide a sedimentation manhole, and a maximum of two Soakaway Manholes in series, unless otherwise approved. Minimum distance between Soakaway Manholes shall be 8m.
3. Provide an overflow from Soakaway Manhole to the storm drainage system or major storm flow path.
4. Size the Soakaway Manhole system by continuous flow modelling.

Guideline Specifications

Photo Credit: Lanarc Consultants Ltd.

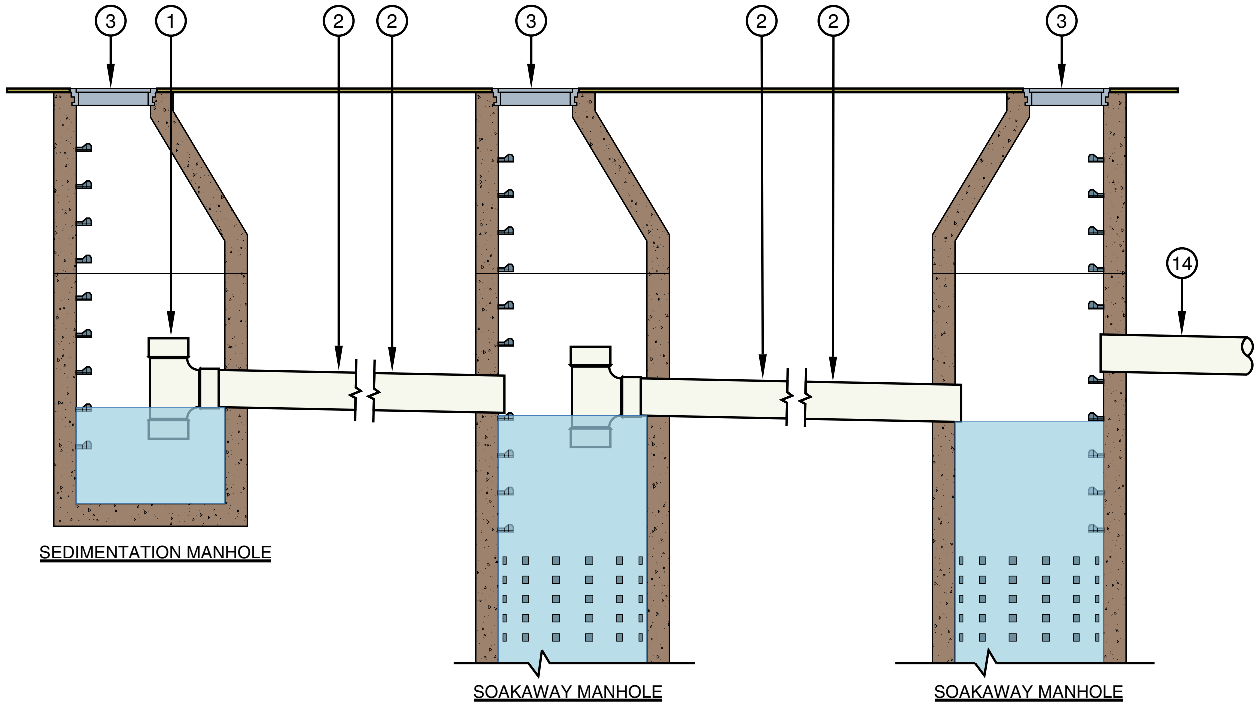
Infiltration trench with catch basin inlet at Silver Maples Subdivision in Maple Ridge, prior to surface cover with filter cloth and growing medium.

Materials shall meet Master Municipal Construction Document 2000 requirements, and:

1. Infiltration Drain Rock: clean round stone or crushed rock, 75mm max, 38mm min, 40% porosity (Maryland Dept. Environmental Resource Programs, 2001).
2. Pipe: PVC, DR 35, 100 mm min. dia. with cleanouts.
3. Geosynthetics: as per Section 02498, select for filter criteria or from approved local government product lists.
4. Sand: Pit Run Sand as per Section 02226.
5. Growing Medium over trench: As per Section 02921 Topsoil and Finish Grading, Table 2.
6. Seeding: to Section 02933 Seeding or 02934 Hydraulic Seeding (note – sodding will be required for erosion control in most swales, subject to the erosion control professionals decision).
7. Sodding: to Section 02938 Sodding.
8. All precast sections shall conform to the requirements of ASTM C 478.
9. Invert shall be level and smooth.
10. Soakaway Manhole barrel shall not be perforated within 1200mm of the cone.

Construction Practices shall meet Master Municipal Construction Document 2000 requirements, and:

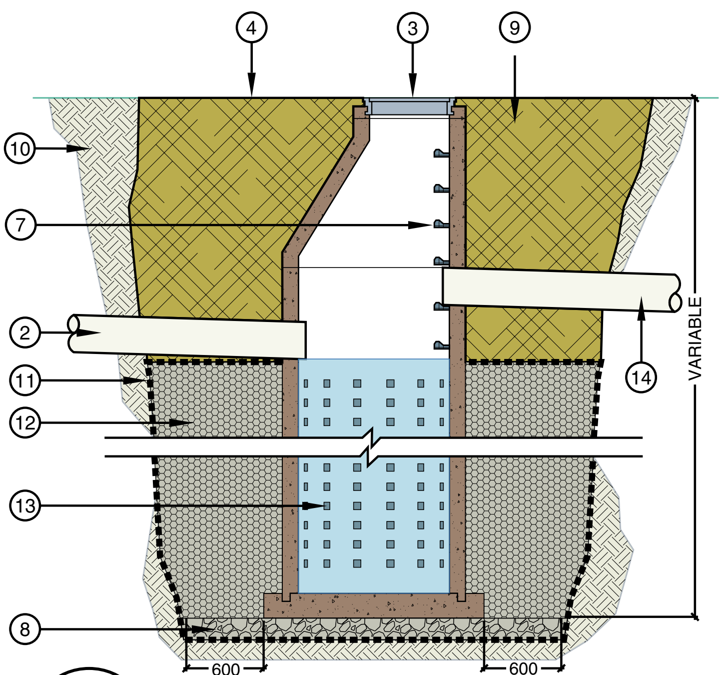
1. Isolate the infiltration site from sedimentation during construction, either by use of effective erosion and sediment control measures upstream, or by delaying the excavation of 300mm of material over the final subgrade until after all sediment-producing construction in the drainage area has been completed (Maryland Dept. Environmental Resource Programs, 2001).
2. Prevent natural or fill soils from intermixing with the Infiltration Drain Rock. All contaminated stone aggregate must be removed and replaced (Maryland Dept. Environmental Resource Programs, 2001).
3. Infiltration Drain Rock shall be installed in 300mm lifts and compacted to eliminate voids between the geotextile and surrounding soils (Maryland Dept. Environmental Resource Programs, 2001).
4. Provide a min. of 150mm of 25mm or 19mm clean crushed rock under all pipes.



6 A SEDIMENTATION MANHOLE AND SOAKAWAY MANHOLES

Not To Scale — Section

NOTES:
ALL PRECAST SECTIONS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C 478.
PROVIDE A MIN. OF 150mm OF 25mm OR 19mm CLEAN CRUSHED ROCK UNDER ALL PIPES.
INVERT SHALL BE LEVEL AND SMOOTH.
SUMP BARREL SHALL NOT BE PERFORATED WITHIN 1200mm OF THE CONE.



6 B SOAKAWAY MANHOLE

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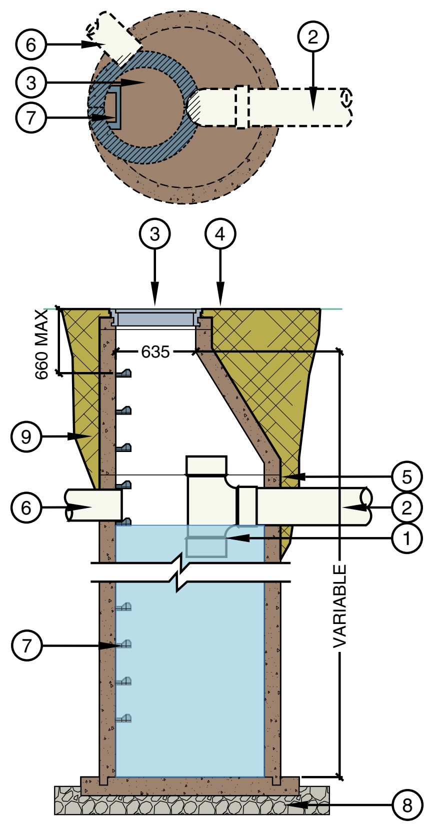
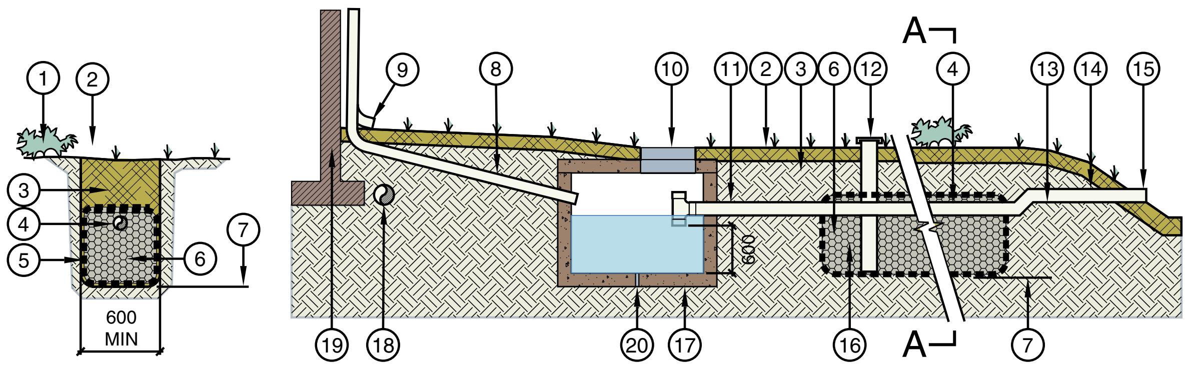


1. PVC SOLID PIPE C/W INLET TEE
2. INTERCONNECTING PVC SOLID PIPE
3. STANDARD MANHOLE FRAME AND COVER
4. FINISH GRADE
5. SEAL JOINTS WITH CEMENT GROUT OR APPROVED MASTIC
6. STREET INLET CONNECTION
7. LADDER RUNG
8. 25mm CRUSH GRAVEL OR DRAIN ROCK BASE
9. NATIVE SOIL BACK FILL
10. UNDISTURBED GROUND
11. GEOTEXTILE BETWEEN DRAIN ROCK AND NATIVE SOIL
12. 50mm DRAIN ROCK
13. 1200mm PERFORATED BARREL (LANGLEY CONCRETE OR EQUAL)
14. OVERFLOW TO STORM DRAINAGE SYSTEM

6 C SEDIMENTATION MANHOLE

Not To Scale — Section

1. GRASS OR OTHER PLANTING
2. FINISH GRADE
3. GROWING MEDIUM BACKFILL
4. 100mm DIA PVC DR28 PERFORATED PIPE
5. LIGHT NON-WOVEN GEOTEXTILE C/W MIN. 400mm LAPS
6. 50mm DRAIN ROCK OR ROCK OF EQUAL POROSITY
7. MAXIMUM GROUNDWATER ELEVATION
8. NON-POLLUTED DRAINAGE FROM BUILDING OR TERRACE
9. ALTERNATE SURFACE ROUTE - WITH SPLASH PAD AND VEGETATED SWALE TO CB
10. CB LID / ACCESS HATCH FOR CLEANOUT, INSPECTION AND INFLOW / OVERFLOW FROM SUMP
11. 100mm DIA PVC SOLID PIPE C/W INLET TEE
12. OBSERVATION WELL (OPTIONAL)
13. INVERT TO TOP OF INFILTRATION PIPE (APPROX.)
14. 100mm DIA PVC SOLID PIPE
15. DISCHARGE TO STORM DRAINAGE SYSTEM. ENSURE DRAINAGE DOES NOT IMPACT NEIGHBOURING USES. DIRECT DISCHARGE TO ROAD RIGHT-OF-WAY IF NECESSARY
16. INFILTRATION TRENCH WITH LEVEL BOTTOM
17. CATCH BASIN
18. BUILDING FOOTING DRAIN (NOT CONNECTED TO INFILTRATION FACILITY)
19. BUILDING
20. 50mm DIA MIN. DRAIN HOLE



SECTION A-A

SECTION FROM WATER SOURCE TO INFILTRATION TRENCH

6/D INFILTRATION TRENCH

Not To Scale

Section