GENERAL DESCRIPTION
Perforated pipe systems can be thought of as long infiltration trenches or linear soak-aways that are designed for both conveyance and infiltration of stormwater runoff. They are composed of perforated pipes installed in gently sloping granular stone beds that are lined with geomembrane fabric that helps control infiltration into the gravel bed and underlying native soil while it is being conveyed from source areas or other BMPs to an end-of-pipe facility or receiving water system. These systems can be used in place of conventional storm sewer systems, where topography, water table depth, and runoff quality conditions are suitable. They are installed as an alternative to treating runoff from roads, walkways, parking lots and low to medium traffic roads, with adequate pretreatment. Perforated pipe systems can also be referred to as pipe-in-pipe systems, infiltration systems, clean water collector systems and percolation drainage systems.

DESIGN GUIDANCE

SOIL CHARACTERISTICS
Perforated pipe systems can be constructed over any soil type, but hydraulic soil group A or B soils are best for achieving water balance objectives. If possible, facilities should be located in portions of the site with the highest native soil infiltration rates. Designers should consult the native soil infiltration rates at the proposed location and depth through measurement of hydraulic conductivity under field saturated conditions.

GEOMETRY AND SITE LAYOUT
Gravel beds in which the perforated pipes are installed are typically rectangular or square with a bottom width of 600 to 2400 mm. The gravel beds should have gentle slopes between 0.5 to 1.0%.

PRE-TREATMENT
It is important to prevent sediment and debris from entering infiltration facilities because they could contribute to clogging and failure of the system. The following pre-treatment devices are common:

• In ground devices: Devices placed between a conveyance pipe and the facility (e.g., oil and grit separators, sedimentation chambers, grass traps), that can be designed to remove both large and fine particulate from runoff. A number of proprietary filter designs are also available.

• Vegetated filter strips or grass swales: Road and parking lot runoff can be pretreated with vegetated filter strips or grass swales prior to entering the infiltration practice.

CONVEYANCE AND OVERFLOW
Collection and conveyance of runoff into the perforated pipe system can be accomplished through conventional catchbasins and non-perforated pipes leading from foundation drains and roof downspouts. Perforated pipes should be smooth walled to reduce the potential for clogging and facilitate drain flow. The gravel filled trench should be 75 to 150 mm deep above the perforated pipe. On clean-face, stable or plastic trench built facilities, the native soil can be installed across the gravel filled trench to reduce flow along the system, thereby increasing the capacity for infiltration. Overdrainage from the gravel filled trench should either back-up into manholes that are already connected to conventional storm sewers or be conveyed to a storm sewer or receiving waterbody by overflow systems.

FILTER MEDIA
• Gravel filled trench: Should be filled with uniform-sized, washed, 50 mm clear stone that provides 40% void space.

• Geotextile: A non-woven needle punched or woven nonwoven geotextile fabric should be installed around the stone reservoir of perforated pipe systems with a minimum overlap at the top of 300 mm.

COMMON CONCERNS
Risk of Groundwater Contamination
Most pollutants in urban runoff are well retained by infiltration practices and soils and therefore, have a low to moderate potential for groundwater contamination. To minimize risk of groundwater contamination, the following recommendations are recommended:

• infiltration practices should not receive runoff from high traffic areas where large amounts of de-icing salts are applied (e.g., busy highways), nor from pollution hot spots.

• pretreatment of infiltration from source areas that are comparatively less contaminated such as roads, low traffic roads and parking areas, and;

• apply sediment pretreatment practices (e.g., oil and grit separators) before infiltration of road or parking area runoff.

Standing Water and Mosquitoes
Complete drydown should occur within 72 hours after a storm event, before mosquitoes or standing water may form.

Winter Operation
Perforated pipe systems will continue to function during winter months if the ice pipe and top of the gravel bed is located below the local maximum frost penetration depth.

ABILITY TO MEET SWM OBJECTIVES
BMP Water Balance Benefit Water Quality Improvement Stream Channel Erosion Control Benefit
Perforated Pipe Systems Yes Yes Partial, depends on soil infiltration rate

CONSTRUCTION CONSIDERATIONS
Soil Disturbance and Compaction
Before site work begins, locations of facilities should be clearly marked. Only vehicular traffic used for construction of the infiltration facility should be allowed close to the facility location. Erosion Control
Erosion and sediment control measures should be performed to ensure the facility drains within the maximum acceptable length of time (typically 72 hours) after a storm event. The following general stormwater control measures should be performed after each storm event:

• Cleanout the perforated pipe by flushing. If allow drainage periods, the system may need removed at a specified time (e.g., 72 hours). Perforated pipe systems should be located below shoulders of roadways, previous bevels or grass swales where they can be readily excavated for servicing.

SITETOPGRAPHY
Facilities receiving runoff should be located outside other pervious areas.

Wellhead Protection
Facilities should be sited a minimum distance of at least one (1) metre to prevent groundwater contamination.

Pollution Hot Spot Runoff
To protect groundwater from possible contamination, source areas near facilities should be avoided. Facility discharges can have the potential to generate highly contaminated water through infiltration processes such as leaching and infiltration processes, resulting in contaminated runoff (e.g., vehicle fueling, outdoor storage and handling areas, etc.). Facilities should be located away from waterbodies and receiving waterbodies.

Setback from Buildings
Facilities should be setback a minimum distance of at least one (1) metre from building foundations.

Proximity to Underground Utilities
Facilities should be sited far enough from existing utility lines to avoid any contact with the lines. It is recommended that the designer consult with local utilities to determine the distance of setback required in this area.

CONTACT INFORMATION
For further guidance see: CVC/CTRC/JD SWM Guide Planning and Design Guide, Table 4-10.4

GENERAL SPECIFICATIONS
Material Specification Quantity

Perforated Pipe
Pipe should be continuously perforated, smooth surface, with a minimum inside diameter of 200 millimetres.

Perforated pipe should run lengthwise through the facility at least 600 mm above the bottom of the gravel filled trench. Non-perforated pipe should be used for conveyance in the facility at least 600 mm above the bottom.

Stone
The trench in which perforated pipes are installed should be filled with washed 50 mm clear stone with a 40% void ratio.

GEOtextile
Material specifications should conform to Ontario Provincial Standard Specification (OPSS) 1880 for Class I geotextile fabrics. Should be woven monofilament or non-woven needle punched fabrics. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging.

Primary considerations are:

• Selecting appropriate opening size (AOS) for non-woven fabrics, or percent open area (POA) for woven fabrics, to maintain maximum flow even with sediment and microbial film build-up.

• Maximum forces that will be exerted on the fabric (i.e., what tensile, tear and puncture strength ratings are required?).

• Load-bearing ratios of the underlying native soil (i.e., is geotextile needed to prevent downward migration of aggregate into the native soil?).

• Texture (i.e., grain size distribution) of the underlying native soil; filter media soil or aggregate material; and;

• Permeability of the native soil.

For further guidance see: CVC/CTRC/JD SWM Guide Planning and Design Guide, Table 4-10.4