

Stormwater Management

Storm Water Management

(3) Major Objectives:

- Water Quantity Control
- Water Quality Control (TSS)
- Water Balance (retain water on-site)
- <https://www.youtube.com/watch?v=NTbhyHNA1Vc&feature=youtu.be>

Detailed Objectives of Storm Water Management

- Prevent health hazards, loss of life, and property damage on site
- Minimize inconvenience from surface ponding and flooding on site
- Minimize alteration of the local groundwater system and the hydrology of receiving watercourses
- Minimize sediment pollution to watercourses

Detailed Objectives Cont'd

- Minimize downstream flooding, changes in natural stream channel geometry, and channel erosion
- Minimize sediment pollution of watercourses from Construction activities
- Minimize the total cost of the drainage system and related works by using the latest proven design and construction techniques.

Background for SWM

- Storm Water Management must be an integral part of the planning process and drainage facilities should not be superimposed on a development after it has been laid out.

Minor Drainage System

- Minor drainage system comprises of:
 - Streets (gutters)
 - Swales
 - Catch basins
 - Storm sewers
 - Downspouts
 - Foundation drains
 - Storage on the minor system
 - Outfalls
- Accommodates the runoff from the more frequent storms and the design frequency of the system
- Reduces impact to pedestrians and motorists

Minor Drainage System (Cont'd)

- Downspouts (in general) should be connected to the storm system. City of Toronto requires downspouts to sheet flow at surface.
- Foundation drains (weeping tile drains) in general, are to be connected to storm sewers.
- The basement floor shall be at least 1.0 metre above the obvert of the storm sewer

Minor Drainage System (Cont'd)

- Buildings located close to the point where the storm sewer discharges into the major system, the basement floor elevation must be above the 100 year flood elevation at the point of discharge.
- CB to be spaced and designed to ensure hydraulic capture capacity of basins does not exceed the design capacity of the storm sewer and therefore cause surcharging.

Minor Drainage System (Cont'd)

- CB leads shall be:
 - 200 mm for a single basin
 - 250 mm for a double basin
- CB located in sag points in road grades, shall have curb inlets
- If possible, CB shall be sited to avoid pedestrian crossing points and driveway depressions

Minor Drainage System (Cont'd)

- Depth of flooding permitted on the streets (part of the storage capacity) will be designed for 5 year storm as follows:
 - No curb overtopping
 - Local roads - the flow may spread to the crown
 - Collector roads – flow spread must leave 1 lane free of water
 - Arterial roads – flow spread must leave 1 lane in each direction free of water

Minor Drainage System (Cont'd)

- Depths of flooding permitted on streets and at intersections during 100 year storm:
 - No building shall be flooded at the ground line
 - The depth of water at the gutter shall not exceed 0.45 m - all class of roads
 - The depth of water at the crown for an arterial road shall not exceed 0.15 m
- Flow across intersections not permitted for 5 year storms

Minor Drainage System (Cont'd)

- Outfalls into major river to be designed to be not submerged by the 100 year storm
- Outfalls requiring drop structures must be designed to ensure bank stability
- Provide protection against entry by children
- If sewer velocities in excess of 6 m/s, then require suitable energy dissipator and outfall to be designed together

Major Drainage Systems

- Includes
 - The natural streams and valleys
 - The man-made channels
 - Ponds
- Accommodates the runoff from the least frequent storms (i.e. 100 year storms) and regional storms
- Eliminate the risk of loss of life and property damage due to flooding

1st Objective: Quantity Control

- Post-development peak flow shall not be greater than the corresponding pre-development peak flow (for each storm event, 2, 5, 10, 25, 50, and 100 year storms)
- If post-development peak flows that are greater than the corresponding pre-development flows, the proponent must be able to prove that an increase will have no adverse impact (downstream analysis)

1st Objective: Quantity Control

Storage Techniques (Minor Storm Events):

- Oversized pipes
- Storage tanks (cisterns)
- Soak-a-way pits / Infiltration Galleries
- Rooftop storage
- Surface (parking lot) storage

1st Objective: Quantity Control

Storage Techniques (MAJOR Storm Events):

- Detention ponds (DRY)
- Retention ponds (WET)

Should conform to the following:

- Located on or adjacent to watercourse where practical, in parks, playfields or school grounds
- 0.3m freeboard preferred
- Safe for children
- Allowance for maintenance (by Municipality)
- Storage capacity designed for 100 year storm

1st Objective: Quantity Control

- Detention ponds may be located in parks, playfields or school grounds
- Storage capacity designed for 100 year storm
- Use of grass swales on Municipal owned lands or on easements

2nd Objective: Quality Control

- Objectives:
 - Typically, to achieve 80% TSS (Total Suspended Solids) removal
- Techniques:
 - Grassed swales
 - Oil / Grit Separators
 - Media filtration (Jellyfish©)
 - Green Roof

3rd Objective: Quality Balance

Objectives:

- First 5mm of each rainfall event must be retained on-site for reuse

Practical Uses:

- Car wash
- Landscaping Irrigation
- Toilet Flushing (expensive)
- Infiltration
- Evaporation

Orifice Equation

$$Q = C_d \cdot A \sqrt{2 \cdot g \cdot h}$$

Where:

- C_d = coefficient of discharge
 - 0.60 for a sharp orifice
 - 0.80 for a tube
- A = area of orifice
- $G = 9.81 \text{ m/s}^2$
- H = head acting on centerline (m)

For a circular orifice, the equation can be re-arranged as follows:

$$Q = C_d \cdot \frac{\pi \cdot D^2}{4} \sqrt{2 \cdot g \cdot h}$$