

STORM WATER MANAGEMENT PRELIMINARY ASSESSMENT

Delcan Inc. was retained by York Region in April 2008 to prepare a Stormwater Management and Bridge Hydraulics Report, including evaluation of the area hydrology, roadway hydrology, and evaluation of impacts of subway construction within the Yonge Street corridor between Highway 7 and Finch Avenue. This included analysis of alternatives for the reconfiguration of the existing embankment and culvert crossing of the East Don River north of Centre Street.

This report presents the Stormwater Management Strategy which will address the overall drainage scheme for the area that has been developed from the hydraulic and hydrologic analysis and work carried out in the field.

1 Storm Water Management Criteria

Storm water management criteria have been established based on the review of Ministry of Environment (MOE) guidelines, City of Toronto Wet Weather Flow Management Master Plan, Toronto and Region Conservation Authority (TRCA) comments and the background information compiled for the Yonge Street Corridor Public Transit Improvements EA, particularly the Natural Sciences Report prepared by LGL and dated September 2004. Ecoplans has produced a limited draft report in 2008 as an update to the Natural Sciences Report, and the Aquatic Habitat Assessment Summary Table from that report is appended to this report.

The storm water management criteria are summarized below:

- There are three main watercourses and associated tributaries that cross the Yonge Street corridor. The fish habitat characteristics of these watercourses are outlined in Table 1. While the fish habitat at the crossings ranges from warm water to cold water, all of the crossings have been designated as requiring Enhanced Level Treatment (80% total suspended solids removal) by TRCA.
- MOE's 2003 Storm Water Management Planning and Design Manual provides a table of storage volume requirements for storm water quality treatment based on the level of treatment and the level of imperviousness of the contributing drainage area. The storage volumes in the table have been used as the basis for sizing proposed facilities.
- Storm water management should treat the runoff from a total area of pavement equivalent in size to the additional pavement resulting from the subway aboveground facilities. Where possible and economically feasible, for watercourse crossings with a high sensitivity rating, runoff from paved surfaces that are currently untreated should be included in the storm water facilities in order to enhance the existing water quality.
- Oil/grit separators are unacceptable for linear transportation facilities, however, they are acceptable for commuter parking lots, terminals and maintenance facilities.
- Catchbasin based filtration measures are not acceptable because of the high potential for plugging resulting in flooding/icing and roadway accidents.

Storm water management criteria for the Don River watershed includes the following:

- Enhanced level water quality treatment (80% total suspended solids removal);
- Quantity control - 2 to 100 year post to pre-development for all areas south of Steeles. For sites north of Steeles Avenue that are less than 5 ha in area, the 2 to 100 year post to pre-development criteria applies. Any sites north of Steeles larger than 5 ha, Don River unit flow rate criteria applies.
- Erosion control - 25 mm events to be released over 48 hours for sites greater than 5 ha.
- Water balance - existing infiltration levels to be maintained or at a minimum, detail 5 mm across the site.

2 Selection of Storm Water Management Alternatives

Storm water management practices suitable for roadway drainage are passive practices that rely on gravity and settling as the primary mechanism to achieve storm water management objectives. These include:

- grassed swale;
- extended detention wet pond;
- extended detention dry pond;
- extended detention constructed wetland;
- infiltration basin; and
- oil/grit separator.

Each of these alternatives is described briefly in the following.

2.1 Grassed Swale

A literature review of highway runoff water quality (MTO, 1992) shows that grassed swales of at least 60 m in length are effective in reducing pollutant levels in runoff from typical paved roadways. Bioassay experiments showed that runoff discharging from a grassed swale was not toxic to trout. Grassed swales need to be well vegetated with a relatively flat gradient and a flat bottom to minimize flow velocity, maximize contact between the runoff and the vegetation, and maximize sedimentation.

Water quality treatment with grassed swales is based on the flow velocity in the swale being less than or equal to 0.5 m/s with a maximum depth of flow of approximately 0.25 m. In addition, vegetation should be allowed to grow higher than 75 mm to enhance the filtration of suspended solids. Grassed swales are generally suitable for drainage areas up to 2 ha.

Wide flat bottoms can be used to enhance the performance of a grassed swale. The wider bottom reduces the flow depth and velocity which are important factors in promoting the settlement of suspended particles. Permanent rock flow checks along the swale can be used to promote infiltration of storm water and the settling of pollutants. These flow checks reduce the effective slope of the swale where the slope is too steep to allow the maximum design velocity (0.5 m/s) to be achieved. The ponding behind the flow checks provides treatment for a larger

flow depth or rate than would be possible with a standard grassed swale. The rock flow checks can be sized to meet the specific storage criteria.

Where the overall swale slope is too steep, small drop structures or short steep sections of swale protected with rip rap can be used to flatten out the swale. Typically, a series of minor drops in the swale are better than a major structure.

2.2 Extended Detention Wet Pond

Extended detention wet ponds are a common end-of-pipe storm water management facility and are an effective means of providing water quality treatment. These facilities consist of a permanent pool and an extended detention (active) storage that fills during a runoff event. Treatment is provided by sedimentation during a runoff event and on-going sedimentation within the permanent pool between events. The water quality active storage can also be sized to provide erosion control active storage.

Wet ponds should generally be implemented for drainage areas >5 ha so there is sufficient runoff to sustain the permanent pool, provided the area consists of highly impervious surfaces. The preferred drainage area for wet ponds is ≥ 10 ha. Length to width ratios of 3:1 to 5:1 are preferred and the inlet should be at the “upstream” end with the outlet at the “downstream” end. Permanent pool depth can normally range from 1 m to 2 m. Sediment forebays facilitate maintenance, improve sediment/pollutant removal, and can be up to one-third of the total area of the pond.

Wet ponds can have a negative effect on receiving water temperature due to warming of the water within the permanent pool. Mitigative measures to minimize the impact would be:

- maximize the length to width ratio and plant vegetation around the permanent pool to provide shading;
- discharge water from the bottom (potentially cooler) portion of the permanent pool;
- discharge through a sub-surface outlet to allow cooling of the flow.

2.3 Extended Detention Dry Pond

An extended detention dry pond detains runoff during a storm event for approximately 24 hours. Water quality treatment is provided by sedimentation while the runoff is detained in the pond.

A minimum drainage area of 5 ha is generally required in order to provide an outlet orifice of sufficient size to minimize clogging. The length to width ratio should be in the order of 3:1 to 5:1 and the inlet and outlet should be at opposite ends of the facility.

Extended detention dry ponds that operate in a continuous mode are not as effective as extended detention wet ponds in removing storm water pollutants. Generally, dry ponds should only be used when wet ponds or wetlands cannot be implemented due to constraints such as temperature and land availability. Continuous flow dry ponds are only included in the MOE (2003) Design Manual for aquatic habitat basic protection level.

2.4 Extended Detention Constructed Wetland

Extended detention constructed wetlands are similar to wet ponds in that there is a permanent pool with extended detention storage for storm event runoff. The permanent pool depth ranges from 150 mm to 300 mm and a drainage area of 5 ha or more is normally required to sustain the permanent pool. The preferred drainage area for constructed wetlands is ≥ 10 ha.

The length to width ratio along the flow path between the inlet and outlet should be a minimum 3:1. A sediment forebay provides pre-treatment for the flow and can be up to 20% of the total permanent pool volume. The planting strategy would be more extensive than for wet and dry ponds. Due to the shallow permanent pool, wetlands require 2 to 3 times the surface area of a wet pond in order to provide similar levels of treatment.

Constructed wetlands also have similar environmental impacts to wet ponds related to increased downstream water temperature which may limit their application in certain areas.

2.5 Infiltration Basin

Infiltration basins are generally shallow ponds that have been constructed in highly pervious soils. Storm runoff infiltrates through the bottom of the basin and either recharges the groundwater system or is collected by a network of perforated pipes and discharges to a downstream outlet. Infiltration basins should be implemented for small drainage areas (<5 ha) and are most suitable for residential areas. Infiltration basins are not recommended for industrial and commercial land uses where there is a high potential for groundwater contamination from chemical spills and maintenance activities such as salting and sanding. Due to the sanding and salting of municipal roadways, infiltration basins are generally not suitable for transportation corridors.

Infiltration basins need to be located in soils with a percolation rate ≥ 60 mm/h such as loamy sand and sand. Water depth in the basin should be limited to a maximum of 0.6 m to minimize compaction of the bottom of the basin.

2.6 Oil/Grit Separator

Oil/grit separators (OGS) are used to trap and retain oil and sediment in detention chambers. These are flow through systems with no attenuation of flow. OGS are used to provide stand alone water quality treatment for small sites or as a pre-treatment device for runoff contributing to another facility such as a constructed wetland or infiltration basin. Oil/grit separators can also be sized to protect the receiving water from spills.

OGS are typically used for areas <2 ha and are suitable for commercial and industrial areas as well as large parking areas and transit facilities. Regular maintenance is required to remove accumulated sediment and oil.

TRCA does not give full water quality credit to oil/grit separators (OGS) as they do not achieve the required level of water quality control, regardless of manufacturer's claims. However, TRCA promotes the use of OGS units when forming part of a treatment train approach to storm water management, including source, conveyance and end of pipe controls. If the use OGS units is determined during the design stage, a treatment train approach to water quality will be utilized.

3 Evaluation Criteria

A number of criteria can be used to evaluate the various storm water management alternatives. The criteria considered for the study were:

- capital cost;
- level of treatment;
- maintenance requirements;
- space constraints;
- site specific requirements.

The best alternatives are those that are inexpensive, provide the required level of treatment, are easy to maintain and fit within the existing right-of-way lands.

The design phase of the Yonge Street Subway Extension will also follow the Low Impact Development Guidelines under preparation by the TRCA.

4 Other Studies

There are currently several drainage studies being undertaken by the local Municipalities as discussed below.

The City of Vaughan had recently completed a Municipal Class Environmental Assessment titled "Thornhill Storm Drainage Improvement Study". The study included field investigations and assessment of the existing drainage infrastructure. The analysis revealed that the Brooke Street trunk storm sewer, which outlets to the south-west side of the East Don River at the Yonge Street crossing, becomes severely surcharged during major rainfall events and poses a flood risk to the surrounding properties. The recommended alternative includes construction of a new Retention Stormwater Management facility within Gallanough Park. The City of Vaughan Engineering Department has informed that the study is currently in the implementation phase. The construction of this retention pond will reduce the current flow at the crossing.

Another study being undertaken by the City of Vaughan is a "Citywide Drainage Study". This study is currently in its first phase; consequently, no available information is expected before spring, 2009. However, the scope does not include issues that may affect the subway project.

Markham is currently evaluating the drainage of Thornhill east of Yonge Street, and drainage plans for the Yonge Street Subway Extension will reflect the findings of this study where appropriate.

During detail phase, the findings of these other drainage studies will be incorporated into design where applicable.

5 Screening

Grassed swales generally meet all the evaluation criteria, however, the level of treatment decreases with large drainage areas and/or steeper slopes. These limitations can be mitigated by using enhanced swales - wide flat bottom and/or rock flow checks - with an associated increase in initial cost and some additional maintenance requirements. As well as providing quality treatment, rock flow checks can also be sized to provide quantity control.

Grassed swales are generally associated with a rural type roadway cross-section. Grassed swales are not appropriate where the road has an urban cross-section and there is existing development adjacent to the right-of-way.

Wet ponds and constructed wetlands can provide similar water quality benefits, however, constructed wetlands typically require larger areas to accommodate the shallow ponding depths. Constructed wetlands and wet ponds have a much higher capital cost than grassed swales and generally require more on-going maintenance. In addition a drainage area of at least 5 ha, and preferably 10 ha, is required to sustain these facilities.

Due to the linear nature of transportation facilities, there is typically limited space within the right-of-way to accommodate a wet pond or constructed wetland. Where a large impervious area outlets to a watercourse, land outside of the right of way would be required for a wet pond or constructed wetland facility.

Dry ponds are generally not suitable for normal and enhanced protection levels. Where ponds are warranted a wet pond will provide consistent performance and can be sized for different levels of protection.

Similar to wet ponds and constructed wetlands, infiltration basins would need to be located outside the normal right-of-way. Infiltration basins also require highly pervious underlying soils such as loamy sand and sand. In addition, due to potential for contamination of the groundwater due to salt and oils from roadway runoff, infiltration basins are not appropriate for the Yonge Street corridor.

Oil/grit separators are appropriate for small commercial and industrial areas and would be suitable at locations of minor impervious area increases.

Based on the above general evaluations, the storm water management alternatives to be used in preparing the storm water management plan are as follows:

- grassed swales to be used to treat the runoff where the roadway has a rural cross-section and/or there is no existing development adjacent to the right-of-way;
- enhanced swale - flat bottom and rock flow check - to be used where a basic grassed swale does not meet the design criteria (velocity ≤ 0.5 m/s; depth ≤ 0.25 m) and/or to further enhance the water quality treatment;

- wet pond to be used where the contributing drainage area is greater than 5 ha and suitable space is available within the right-of-way or an adjacent undeveloped area; and
- oil/grit separator to be used for water quality treatment as appropriate.

6 Storm Water Management Concept Plan

6.1 General Approach

The existing roadway typically consists of the following:

- 36 m right-of-way;
- sidewalks on each side – each 2.0 m wide;
- outside curb and gutter – each 0.5 m wide;
- two traffic lanes in each direction – each 3.5 m wide;
- centre turning lane – 4.5 m wide; and
- right-of-way is 65% impervious.

There is a large storm water management facility located in the northeast quadrant of Yonge Street and Highway 7. The drainage area for this facility includes the location for the Intermodal Station and a 2.5 km section of Yonge Street from Garden Avenue northward to south of Weldrick Road. The site for the Intermodal Station is currently a paved parking area and construction of the terminal will not change the runoff to the storm water management facility.

There are no other existing storm water management facilities along the Yonge Street corridor. Current runoff discharges uncontrolled to the various watercourses that cross Yonge Street.

The proposed approach for treatment is outlined in Section 6.2. Any new storm water management facilities identified in that section will be further developed during the detail design phase.

It should be noted that the Yonge Street corridor is mostly urbanized and there are generally limited opportunities to provide storm water management for the Yonge Street/subway runoff **so the proposed Stormwater Management Plan may not achieve level 1 quality treatment as defined in MOE's Stormwater Management Planning and Design Manual at all locations (i.e. station locations) although MOE has indicated it believes that the implementing the best measures that are feasible in such locations is satisfactory.** In addition, only a small section of the overall corridor currently outlets to a storm water management facility.

6.2 Concept Plan

The storm water management options to be considered during detail design of the subway are identified in the following sections. With the exception of Langstaff/Longbridge station, all stations will construct at-grade structures in zones currently found to be impervious; there will therefore be no change to the runoff regime.

6.2.1 Cummer / Drywer Station (Yonge Street – Finch Street to Steeles Avenue)

The road way drains from north to south and the area is completely urbanized.

6.2.2 Steeles Station (Yonge Street – Steeles Avenue to north of Meadowview Avenue – Intermodal Station)

The road way drains from north to south and the area is completely urbanized.

Steeles Station will be an intermodal station for York Regional Transit, Viva, and TTC. A major bus facility is being proposed underground along Steeles Avenue; The access to this underground facility will imply widening of Steeles Avenue along the entrance and exit ramps which will produce some additional runoff. The additional quantity will be discharged to the existing storm water system. This will be detailed during the design phase of the project.

6.2.3 Clark Station (Yonge Street – North of Meadowview Avenue to Centre Street)

There are three low spots within this stretch of Yonge Street and the Yonge Street storm sewers connect to sewers on the cross roads. The area is completely urbanized.

6.2.4 Royal Orchard Station (Yonge Street - Centre Street to north of Bunker Road)

This section of Yonge Street section drains from both the south and the north to the East Branch of the Don River. Grassed swales, riprap lined channels and rock flow checks are proposed prior to the runoff outletting to the East Branch of the Don River.

6.2.5 Langstaff / Longbridge Station (Yonge Street and Langstaff Road - North of Bunker Road to Highway 7)

This section of Yonge Street drains northward and southward to the Pomona Mills Creek crossing located on Langstaff Road east of Yonge Street. Grassed swales are proposed along Langstaff Road for quality and quantity treatment of runoff from any expansion to Yonge Street.

Parking of approximately 15 ha is contemplated in the Hydro corridor west of Yonge Street. The drainage for the affected area is split, with some draining eastward to Pomona Mills Creek and the remainder draining west to the East Don River. Two separate quality and quantity treatment facilities will be implemented to capture, treat and release the runoff from the new parking lot. As well, alternative strategies for runoff attenuation, reduction and/or treatment will be investigated in the preliminary and detail design phase.

A rehabilitation project for Pomona Mills Creek is currently underway and is being administered by the Town of Markham. Any proposed work along Pomona Mills Creek will need to be incorporated into the Pomona Mills Creek Environmental Rehabilitation Project

6.2.6 Richmond Hill Station (Yonge Street and Highway 7 – Intermodal Station)

This section drains southward to an existing stormwater pond in the interchange between Yonge and Highway 7 (northeast quadrant) that outlets to Pomona Mills Creek. All new amenities shall be built within existing impervious (parking) areas; as with Steeles Station, below-grade structures are being contemplated. There will be no negative impact on the existing drainage system by any new station development.

6.3 Hydraulic Analysis of the East Don River Crossing of Yonge Street

An hydraulic analysis of the replacement of the existing East Don River crossing culvert at Yonge street with a bridge was carried out to discover what, if any, impacts on flooding would occur. The proposed conceptual bridge had a deck height of approx. 175, a soffit height of 165, and two two-metre piers. Analysis was carried out using HEC-RAS and the Toronto and Region Conservation Authority's existing updated Don River watershed model.

The embankment at station 25.33 was removed from the model and replaced with the aforementioned bridge. The only other change to the model was to reflect the change of the sections immediately upstream of the embankment, removing the areas of ineffective flow (ie that the areas now conveyed flow instead of simply providing water storage).

Results:

The existing floodplain downstream of the structure remains unchanged, as it should, given the nature of the model's approach.

The flood levels for storms under the regional remain unchanged – the existing culvert did not act as a significant barrier even for the 100 year storm. It was found that the 100 year storm flood level dropped 2-3 centimetres with the replacement of the culvert with a bridge. For none of the design storms (with the exception of the Regional storm) does the Don River spill outside its banks, and as such, there will be no change in the erosion regime.

For the regional storm, here is a comparative table:

River Station	Existing Conditions	Bridge Conditions	Difference
25.48	165.87	165.7	0.17
25.47	165.69	165.39	0.30
25.46	165.66	165.32	0.34
25.45	165.48	164.73	0.75
25.44	165.45	164.64	0.81
25.43	165.42	164.56	0.86
25.42	165.4	164.49	0.91
25.41	165.35	164.38	0.97
25.4	165.34	164.36	0.98
25.39	165.34	164.34	1.00
25.38	165.26	164.15	1.11
25.37	165.27	164.19	1.08
25.36	165.27	164.19	1.08
25.35	165.25	164.14	1.11
25.34	164.47	164.15	0.32
25.33	Culvert	Bridge	0
25.32	161.81	161.92	-0.11
25.31	161.56	161.56	0

It can be seen that even 1.3 km upstream of the bridge (approaching Highway 407), the flood level drops 30 cm; closer to the new structure, it's in excess of a metre in flood level drop. The golf course upstream of the existing crossing and associated valley will experience much lower flooding for the regional event.

The HEC-RAS model showing the performance of the conceptually proposed bridge crossing, as well as a comparative spreadsheet, is included on the CD in the back of this report.

These results will be refined in the detail design stage, which will also result in some storm sewer outfall reconfiguration at the East Don east of Yonge Street. The project will provide a copy of the detailed hydraulic analysis, stamped by a P.Eng., to the TRCA as part of the approvals process for the structure.