8.0 Selection of the Preferred Stormwater Management Strategy

The preferred SWM strategy provides site specific recommendations on a Secondary Plan basis where development is proposed to occur as part of the City's 2031 growth strategy. The following sections detail the evaluation and selection of a preferred SWM strategy within the approved Secondary Plan Areas and provide recommendations for future developments and intensification corridors. It is noted the recommendations provided are indicative of the Master Plan process and that future developments require detailed analysis of existing site conditions and approval by the TRCA and other approval agencies before implementing any recommendations described herein.

8.1. Secondary Plan Areas to be Approved

This study has investigated the preferred SWM strategy for four (4) approved Secondary Plans within the City for which the ultimate build-out, anticipated land-use and municipal servicing requirements were considered. The following section summaries the preferred SWM strategy for the Secondary Plan Areas described in **Section 7.0**. The detailed evaluation of the SWM controls for each Secondary Plan Area can be found under **Appendix B**.

8.1.1. Yonge Steeles Secondary Plan Area

The preferred SWM strategy for the Yonge-Steeles Secondary Plan Area as determined through the evaluation criteria is an at source / conveyance / lot level controls strategy. The detailed evaluation matrix demonstrating how this servicing strategy was selected as the preferred alternative can be found in **Appendix B**. Detailed calculations can be found in the functional SWM Plan located in **Volume II** of the MPCEA document.

8.1.1.1 Design Criteria

Design criteria for the Municipal services will be in accordance with the City, TRCA and the MOE.

- **Quantity**: Post-development peak flows for all events from the site should be controlled to the peak flow resulting from existing conditions;
- **Quality**: Stormwater should be treated to Enhanced Protection (Level 1) as defined in the MOE SWM Planning & Design Manual (2003);
- **Erosion**: On-site retention (reuse and/or infiltration) of the first 5 mm of a storm event; and,
- **Water Balance**: Best efforts to maintain the pre-development water balance (i.e. maintain existing hydrologic cycle with regards to infiltration, runoff and evapotranspiration).

8.1.1.2 Existing Conditions

The site consists of two (2) Study Areas:

1) The North Study Area; and,
2) The South Study Area.

The North Study Area is 9.7 ha with an estimated imperviousness of 53% and the South Study Area is 45.8 ha with an estimated imperviousness of 86%. The existing land use consists of low-rise employment and medium density mid-rise residential in the form of apartment buildings, industrial pockets in the vicinity of the CN Rail line as well as low density residential land uses. There are no known SWM controls in place for the existing area. Major storm drainage is conveyed by the road right of ways and minor system storm drainage is conveyed by a network storm sewers. Soil conditions within the Yonge-Steeles Secondary Plan Area are primarily clay loam which is considered as a Hydrologic Soils Group (HSG C).

8.1.1.3 Proposed Conditions

The Secondary Plan proposes significant intensification of uses for the area and will consist of a combination of high-rise, mid-rise and low-rise mixed-use, low-rise and mid-rise residential, parks and private open spaces. Under post-development conditions, the North Study Area is expected to increase in imperviousness to 60% whereas the South Study Area is expected to decrease in imperviousness to 74%.

8.1.1.4 Proposed Stormwater Management Strategy

Quantity control storage will be required in order to maintain existing peak flow rates under post-development conditions for the North Study Area. Quantity Control can be achieved through rooftop storage, surface / parking lot storage as well as underground storage.

5 mm of on-site retention is required for erosion control and additional infiltration storage will be required to maintain the sites water balance. Typically infiltration would be the preferred approach as it is relatively easy to implement and is economically feasible. However, according to the Ontario Soils Survey, the soils in this area are predominantly clay loam which would not be ideal for infiltration-based controls. The feasibility of infiltration-based controls for the area should be confirmed in subsequent design stages through a detailed geotechnical investigation.

Aside from infiltration-based controls, there exist an opportunity to implement other LIDs such as green roofs, cisterns or water reuse systems. These runoff capture systems can be incorporated to meet the onsite retention requirements for the site.

With respect to quality control, it was determined through the evaluation that the most practical and affordable method to meet the MOE's requirement of Enhanced Level 1 – 80% TSS removal would be through the implementation of a treatment train approach for quality control, which includes the use of mechanical systems, such as OGS units, as well as BMPs. The number of OGS units required and the opportunity to implement other BMPs for quality control such as swales, filter strips and permeable pavement will be determined on an individual site plan basis, at the detailed design stage.

Due to the decrease in imperviousness in the South Study Area, the peak flows under post-development conditions are lower than the existing peak flows. As a result, there are no SWM controls required to meet the quantity control criteria for the overall development. Each individual development must ensure that the post-development peak flows do not exceed the existing peak flows and there is sufficient capacity in the downstream drainage system and existing infrastructure prior to development. The decrease in overall imperviousness not only meets but exceeds the pre-development water balance requirements without the implementation of additional SWM controls.

Onsite storage is required in order to meet the TRCAs requirement for 5 mm of onsite detention for erosion protection.

As the soils in this area are predominantly clay loam, with poor infiltration rates, it is recommended that methods such as green roofs, cisterns or water reuse systems be incorporated to meet this requirement. The feasibility of infiltration based controls is to be determined through geotechnical investigations specific for each site.

As with the North Study Area, it is recommended that BMPs be implemented in combination with OGS units to provide a treatment train approach for water quality protection. The number of OGS units required and the opportunity to implement other BMPs for quality control such as swales, filter strips and permeable pavement will be determined on an individual site plan basis, at the detailed design stage. **Figure 8-1** shows the preferred SWM Strategy.

8.1.1.5 Costing

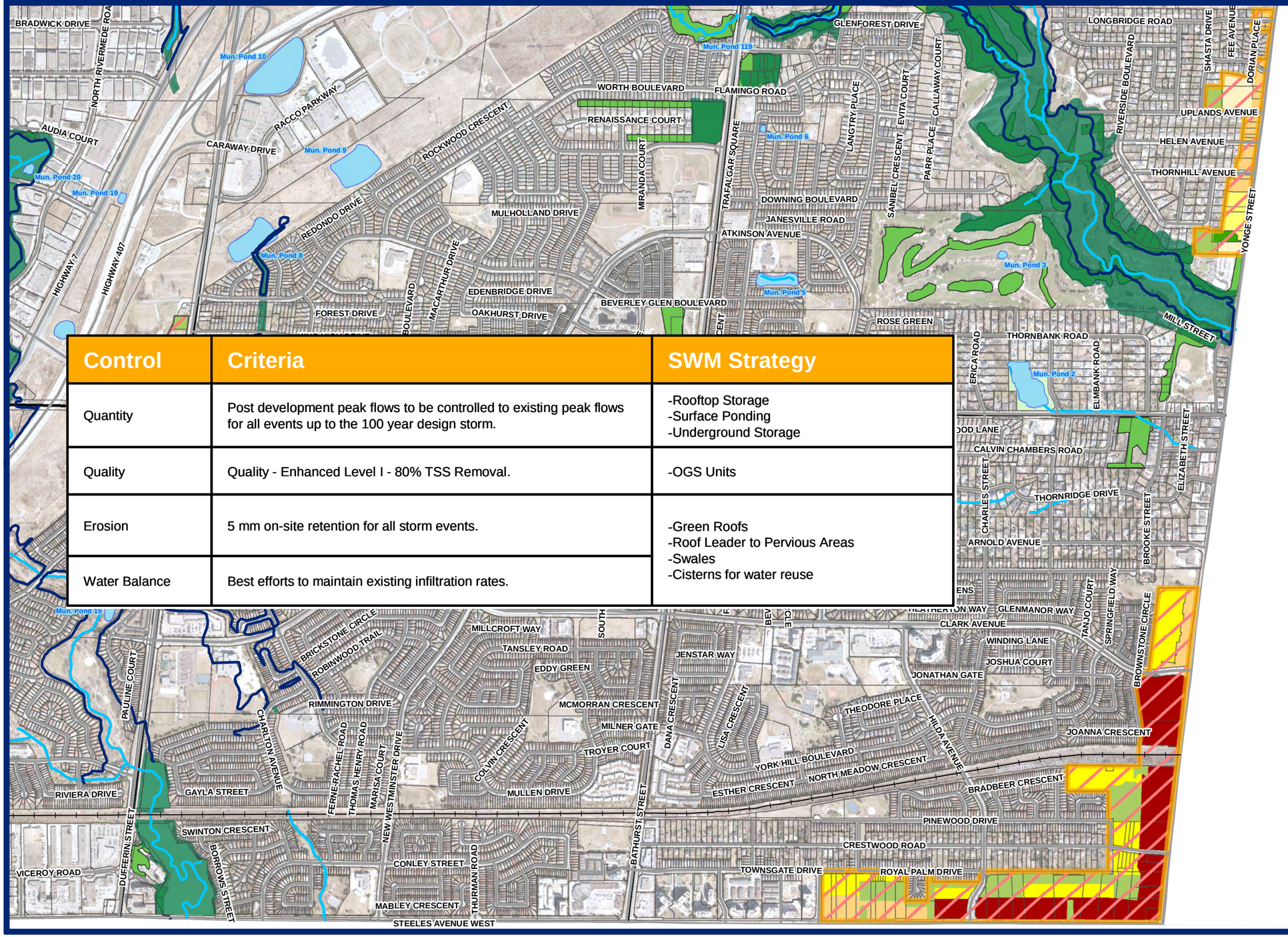
Post-development drainage from the Secondary Plan Area will not negatively impact the existing public storm infrastructure therefore, it is anticipated that the City will not require to upgrade / retrofit any existing SWM and storm drainage infrastructure. It is anticipated that the capital as well as operational and maintenance costs associated with preferred SWM controls would be borne by the individual developments. **Table 8.1** summarises the estimated capital and operational costs associated with some of the preferred SWM strategy.

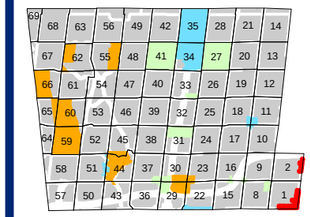
Table 8.1 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for Yonge-Steeles Secondary Plan Area

Control	Method	Capital Costs	Operation and Maintenance
Quantity	Surface / parking lot storage, rooftop storage	No additional capital costs	Minimal
	Cisterns or underground storage	$300/$m^3$ of underground storage	
Quality	OGS units	OGS units = $30,000/ha of impervious area. Number of OGS units will need to be confirmed at detailed design stage	OGS units are recommended to be cleaned out every 12 – 15 months
	Swales, filter strips	Swales – $50,000/ha of impervious area	Filter strips / swales – low level after vegetation has become established
Water balance / erosion	Green roofs	Green roofs: $65 – 230/$m^2$	Green roofs should be maintained at least twice per year which includes weeding as well as debris and dead vegetation removal.
	Cisterns / underground storage	$300/$m^3$ of underground storage	Minimal
	Water reuse systems / rainwater harvesting systems	Rainwater harvesting systems $6000 – $14000	Rainwater harvesting systems have relatively low maintenance requirements provided they are used for supplemental irrigation as opposed to indoor uses.

Preferred SWM Strategy | Yonge-Steeles Secondary Plan Area

Control	Criteria	SWM Strategy
Quantity	Post development peak flows to be controlled to existing peak flows for all events up to the 100 year design storm.	-Rooftop Storage -Surface Ponding -Underground Storage
Quality	Quality - Enhanced Level I - 80% TSS Removal.	-OGS Units
Erosion	5 mm on-site retention for all storm events.	-Green Roofs -Roof Leader to Pervious Areas -Swales -Cisterns for water reuse
Water Balance	Best efforts to maintain existing infiltration rates.	





Legend

- TRCA Existing Floodlines
- Watercourse
- Secondary Plan Area
- Areas with Lot Level Controls
- Existing SWM Ponds
- Natural Areas
- TRCA Property
- Forested Area

Proposed Land Use

- Parks
- Private Open Spaces
- Low-Rise Residential
- Low-Rise Mixed-Use
- Mid-Rise Residential
- Mid-Rise Mixed-Use
- High-Rise Mixed Use

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Preferred SWM Strategy

SCALE 1:16,000
0 55 110 220 330 440 Meters

FIGURE
8-1

8.1.1.6 Recommendations

There are additional site-specific studies which are recommended as part of the planning process. The studies required will be requested at the time of the development application, prior to obtaining the required approvals.

These studies include but are not limited to:

- A detailed capacity assessment on downstream conveyance / receiving system (North Study Area – Yonge Street and South Study Area – Steeles Avenue);
- Percolation and hydrogeological water budget analyses;
- Geotechnical investigation; and,
- Environmental impact assessment on proposed developments to identify natural features, significant vegetation, species at risk, etc.

The recommended studies are engineering-based studies – additional studies and/or investigations may be required by the TRCA and/or the City.

It is noted that the City is currently conducting a City-Wide drainage study which focuses on specific flooding locations as result of the storm event experienced on August 19, 2005. Approximately three (3) of the 20 identified flood vulnerable locations are located in the vicinity of the Yonge-Steeles Secondary Plan Area. Recommendations from the City-Wide Drainage Study with respect to how to mitigate flooding in the area should be considered when determining the final SWM servicing strategy for the Yonge-Steeles Secondary Plan Area. This would occur at later stages in the planning process and at the detailed design stage

8.1.2. Woodbridge Core Secondary Plan Area

The preferred SWM strategy for the Woodbridge Core Secondary Plan Area as determined through the evaluation criteria will be combination of at source / conveyance / lot level controls to address water quantity, quality, water balance and erosion control for the Secondary Plan Area. The detailed evaluation matrix demonstrating how this servicing strategy was selected as the preferred alternative can be found in **Appendix B**. Detailed calculations can be found in the functional SWM Plan located in **Volume II** of the MPCEA document.

8.1.2.1 Design Criteria

Design criteria for the municipal services will be in accordance with the City, TRCA and the MOE.

- **Quantity**: Post-development peak flows for the 2-year event must match existing 2-year peak flows, post-development peak flows for all other events from the site should be controlled to the 5-year peak flow resulting from existing conditions;
- **Quality**: Stormwater should be treated to Enhanced Protection (Level 1) as defined in the MOE SWM Planning & Design Manual (2003);
- **Erosion:** On-site retention (reuse and/or infiltration) of the first 5 mm; and,
- **Water Balance**: Best efforts to maintain the pre-development water balance (i.e. maintain existing hydrologic cycle with regards to infiltration, runoff and evapotranspiration).

8.1.2.2 Existing Conditions

The total Secondary Plan Area is approximately 271 ha. The current drainage pattern of Woodbridge has runoff conveyed from north to south conveyed through storm sewers and road right of ways to the nearest watercourse. The east and main branches of the Humber River run through the Plan Area and converge just upstream of Highway 7. Due to the age of the developments, it is likely that most properties within the Plan Area have no SWM practices in place to provide quality, quantity or erosion control. Developments within the existing area consists mainly of low rise detached residential units, mid rise residential units along Islington Avenue, and a commercial downtown core along Woodbridge Avenue.

Soils within the Woodbridge Core are primarily sandy loam (HSG A), with the exception of lands west of Wallace Street which have clay soil (HSG C). There are currently no existing SWM ponds within Woodbridge Core. It is noted that a large number of buildings within Woodbridge have been built below the top of the river bank. These areas have been designated as special policy areas, due to flooding risks associated with development within the floodplain, and any re-development in these areas will require additional approvals from the City and the TRCA. The lack of existing SWM controls exacerbates the flooding risks to these properties.

According to the TRCA's Humber River Watershed Hydrology Update, there are no quantity control requirements for storm water drainage from the Woodbridge Core. However, existing flooding has been identified as part of the City-Wide Drainage and SWM Criteria Study, which identifies certain areas within the Woodbridge Core which are attributed to major system overland drainage. The specific redevelopment areas as part of this Secondary Plan are not subject to flooding, however; it was determined that the design criteria to be implemented for the proposed development was to include quantity controls so that all drainage is conveyed through the storm sewer system in an effort to reduce the risk of surface flooding in the area.

8.1.2.3 Proposed Conditions

There are two (2) specific areas which are subject to intensification and redevelopment within the Secondary Plan, 1) an area of approximately 5.6 ha Woodbridge Avenue and, 2) an area of approximately 5.0 ha on Islington Avenue.

The land use along parts of Woodbridge Avenue will change from low rise residential to low and mid-rise mixed use and on Islington Avenue from detached residential homes to townhouses. Intensification along these two (2) corridors will increase the peak flow and volume of stormwater runoff to the Humber River.

In order to meet the 5-year pre-development peak flow rates under post-development conditions for the intensification occurring along Woodbridge Avenue and Islington Avenue, 198 m^3/ha and 312 m^3/ha of storage would be required respectively. Quantity control can be achieved through rooftop storage, surface / parking lot storage, and underground storage.

With respect to quality control, it was determined through the evaluation that the most practical and affordable method of to meet the MOE's requirement of Enhanced Level 1 – 80% TSS removal would be through the implementation of a treatment train approach for quality control, which includes the use of mechanical systems, such as OGS units, as well as BMPs.

The number of OGS units required and the opportunity to implement other BMPs for quality control such as swales, filter strips and permeable pavement will be determined on an individual site plan basis, at the detailed design stage.

To meet the water balance requirements of 197 m^3/ha for both intensification areas of Woodbridge Avenue and Islington Avenue, different techniques have been considered with the focus on infiltration. Infiltration techniques are encouraged under good soil conditions as they are economically viable and, by making use of landscaped and open space areas, have no need for additional infrastructure. Additionally, they have the ability to replenish the ground water resources. The recommended methods to achieve pre-development infiltration rates in addition to landscaped areas and open space include, roof leader disconnection, infiltration trenches, pervious pipe systems, rain gardens and/or permeable pavement. Green roofs, cisterns and other water reuse systems can also be utilized for on-site retention but their applicability must be determined on an individual site plan basis. The preferred SWM servicing strategy can be found in **Figure 8-2**.

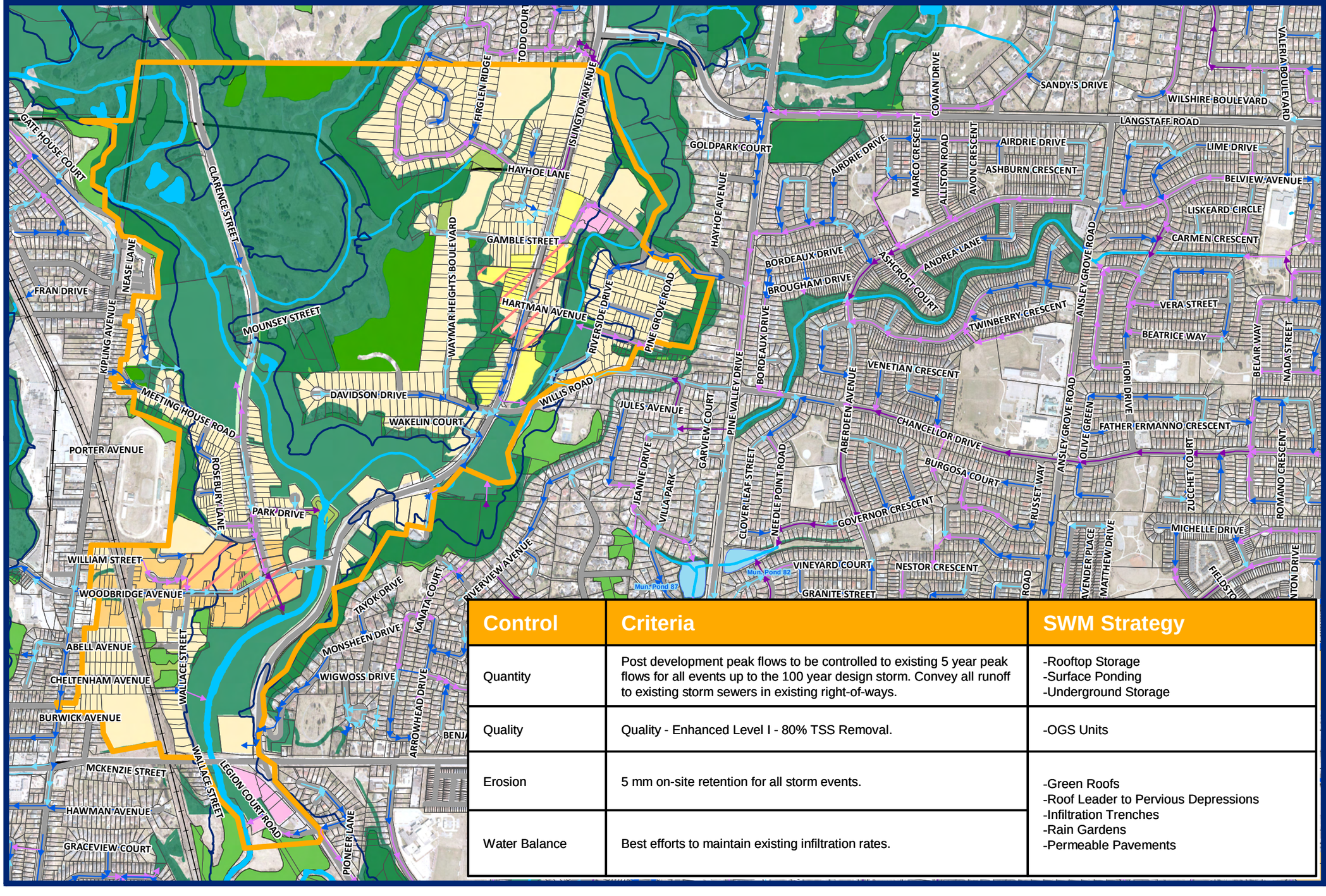
8.1.2.4 Costing

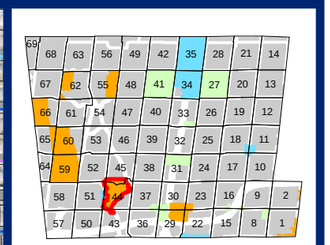
With the implementation of the preferred SWM Plan, post-development drainage from the Secondary Plan Area is not expected to negatively impact the existing public storm infrastructure therefore it is anticipated that the City will not require to upgrade / retrofit any existing SWM or storm drainage infrastructure.

It is anticipated that the capital as well as operational and maintenance costs associated with preferred SWM controls would be borne by the developments.

Table 8.2 summarises the estimated capital and operational costs associated with each component of the preferred SWM strategy.

Preferred SWM Strategy | Woodbridge Core





Legend

- TRCA Existing Floodlines
- Areas with Lot Level Controls
- Watercourse
- Existing SWM Pond
- Natural Areas
- TRCA Property
- Forested Area

Proposed Land Use

- Parks
- Private Open Spaces
- Low-Rise Residential
- Low-Rise Mixed-Use
- Mid-Rise Mixed-Use
- Commercial Mixed-Use

Storm Sewers

Diameter (mm)

- 0 - 375
- 375 - 600
- 600 - 1200
- 1200 - 3660

Control	Criteria	SWM Strategy
Quantity	Post development peak flows to be controlled to existing 5 year peak flows for all events up to the 100 year design storm. Convey all runoff to existing storm sewers in existing right-of-ways.	-Rooftop Storage -Surface Ponding -Underground Storage
Quality	Quality - Enhanced Level I - 80% TSS Removal.	-OGS Units
Erosion	5 mm on-site retention for all storm events.	-Green Roofs -Roof Leader to Pervious Depressions -Infiltration Trenches -Rain Gardens -Permeable Pavements
Water Balance	Best efforts to maintain existing infiltration rates.	

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SCALE 1:12,000
0 37.5 75 150 225 300 Meters

FIGURE
8-2

Table 8.2 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for the Woodbridge Core Secondary Plan Area

Control	Method	Capital Costs	Operation and Maintenance Costs
Quantity	Surface / parking lot storage, rooftop storage	No additional capital costs	Minimal
	Cisterns or underground storage	$300/m^3 of underground storage	
Quality	OGS units	OGS units = $30,000/ha of impervious area. number of OGS units will need to be confirmed	OGS units are recommended to be cleaned out every 12 – 15 months
	Swales, filter strips	Swales – $50,000/ha of impervious area	Filter Strips / swales – low level after vegetation has become established
Water balance / erosion	Landscaped areas, open space, roof leader disconnection,	No additional capital costs	Standard maintenance associated with landscaped areas therefore, there are no anticipated additional operation and maintenance costs.
	Green roofs	Green roofs: $65 – 230/m^2	Green roofs should be maintained at least twice per year which includes weeding as well as debris and dead vegetation removal.
	Rain gardens	Rainwater harvesting systems $6000 – $14000	Rainwater harvesting systems have relatively low maintenance requirements provided they are used for supplemental irrigation as opposed to indoor uses.
	Permeable pavement	Permeable pavement – varying costs	Infiltration trenches, pervious pipe systems and permeable pavement – varies depending on pretreatment. Typically, maintenance consists of cleaning out leaves, debris and accumulated sediment on an annual basis or as needed.
	Infiltration trenches, Pervious pipe systems,	Pervious pipe systems – comparable to infiltration trenches or dry swales	

It should be noted that Woodbridge Avenue Intensification areas falls within one (1) of the City's Special Policy Areas which states that all developments or redevelopments occurring in the Special Policy Areas outlined in Schedule 8 of the OPA have to propose flood reduction measures prior to any works to the satisfaction of both the City and the TRCA.

"The Provincial Floodplain Planning Policy generally prohibits development or redevelopment below the Regulatory Flood as determined by the TRCA. However, the Provincial Floodplain Planning Policy also recognizes that parts of certain urban areas have historically developed within floodplains. In accordance with the Special Policy Area provisions of the Provincial Floodplain Planning Policy, certain lands within the Regulatory Floodplain of the Humber River in the Woodbridge Community have been identified as "Special Policy Area" on Schedule 8. The continued viability of these areas depends on a reasoned application of the Provincial standards for floodplain management. The Provincial Floodplain Planning Policy recognizes the concept of special policy area status as a possible option for flood prone communities or portions thereof where the Province, TRCA and the City agree to accept a higher level of risk to floodplain management. The implementation of flood proofing measures will be a condition of development approval by the City in co-operation with the TRCA."

8.1.2.5 Recommendations

There are additional site-specific studies which are recommended as part of the planning process. The studies required will be site specific and requested at the time of the development application, prior to obtaining the required approvals.

These studies include but are not limited to:

- Flood Remediation and Drainage Study into the causes of previous flooding identified from the August 19, 2005 storm event within the Secondary Plan Area;
- Geotechnical investigation;
- Percolation and hydrogeological water budget analyses;
- Environmental impact assessment on proposed development to identify natural features, significant vegetation, species at risk, etc.; and,
- Capacity Assessment – Storm drainage will be through existing minor system however, a capacity assessment will be required.

The recommended studies are engineering-based studies – additional studies and/or investigations may be required by the TRCA and/or the City.

8.1.3. West Vaughan Employment Area

The preferred SWM strategy for the WVEA, as determined through the evaluation criteria, is end-of-pipe controls in combination with lot level / at source and conveyance controls. The detailed evaluation matrix demonstrating how this servicing strategy was selected as the preferred alternative can be found in **Appendix B**. Detailed calculations can be found in the functional SWM Plan located in **Volume II** of the MPCEA document. Recommendations of the WVEA were also determined through the Rainbow Creek Subwatershed Master Plan Update included as **Volume III** of the MPCEA.

8.1.3.1 Design Criteria

Design criteria for the Municipal services will be in accordance with the City, TRCA and the MOE.

- Post-development peak flows for all events from the site should be controlled to the unit flow rates as specified by the TRCA's SWM criteria for sub-basin 36 within the Humber Watershed;
- Stormwater should be treated to Enhanced Protection (Level 1) as defined in the MOE SWM Planning & Design Manual (2003);
- On-site retention (reuse and/or infiltration) of the first 5 mm of run-off; and,
- Best efforts to maintain the pre-development water balance (i.e. maintain existing hydrologic cycle with regards to infiltration, runoff volumes and evapotranspiration).

8.1.3.2 Existing Conditions

The total Secondary Plan Area is approximately 572 ha. The current drainage pattern is generally in a south-easterly direction along two (2) main branches of the watershed: Robinson Creek and Rainbow Creek. Robinson Creek outlets through a box culvert on Highway 27 just north of Sanremo Court and Rainbow Creek outlets underneath a single span bridge located at Langstaff Road east of Huntington road. The existing land use consists primarily of agricultural, rural and industrial lands. Soil within West Vaughan is primarily peel clay (HSG D), with the exception of a small pocket of Berrien sandy loam (HSG AB) which is present along the CP railway, between Martin Grove Road and McGillivray Road. There is no known SWM infrastructure within the WVEA.

8.1.3.3 Proposed Conditions

It is expected that the majority of the proposed development will be for employment uses. Employment lands will consist of prestige employment lands and general employment lands which require a minimum of 15% and 10% of landscaped area respectively. The entire Secondary Plan Area will have an imperviousness of approximately 90%, including roadways, under proposed conditions.

8.1.3.4 Proposed Stormwater Management Strategy

Quantity Control

It is proposed that quantity control for the site be provided through centralized end-of-pipe SWM facilities. Post-development flow rates will be controlled to the unit flow rates as defined in the Humber River Watershed. It is noted that some areas do not drain to proposed SWM facilities. These areas will need to be controlled to the target unit flow rates using lot level / at source and conveyance controls such as rooftop storage, surface / parking lot storage, and underground storage.

Quality Control

With respect to quality control, it was determined through the evaluation that the most practical and affordable method of to meet the MOE's requirement of Enhanced Level 1 – 80% TSS removal would be through centralised end-of-pipe facilities. These would be combined with the proposed quantity control requirements in a single facility.

In the areas where drainage is not directed to end-of-pipe facilities, it is recommended that a treatment train approach for quality control be implemented which includes the use of mechanical systems such as OGS units as well as BMPs such as swales, filter strips and permeable pavement. The specific techniques will be determined on an individual site plan basis.

Erosion

Traditionally SWM ponds have been designed to provide erosion mitigation through extended detention, thus reducing the peak flows for more frequent rain event. This methodology can help mitigate erosion if release rate is bellow the erosion threshold for the receiving watercourse. However, the extended detention component does not provide erosion mitigation in terms of volume or hydrologic timing. Through erosion analysis for the Rainbow Creek Subwatershed Update that was conducted as part of this Master Plan EA, it was determined that the peak flow rates required to provide extended detention for 24, 48 or 72-hours in fact exceed the erosion thresholds downstream. As such it was not recommended that an extended detention component be included in end-of-pipe facilities. Through the evaluation of alternatives in Rainbow Creek it was determined that in order to mitigate downstream erosion the first 5 mm of a storm event be retained onsite. Refer to **Sections 4** and **5** of **Volume III** of this report for a detailed discussion of the modeling efforts to determine the recommended erosion control criteria for Rainbow Creek.

Water Balance

The WVEA is located in an area classified as a low volume recharge area by the TRCA, therefore meeting pre-development water balance may not be feasible or required. Due to the clay soils present on site it may be difficult to implement infiltration-based controls. The feasibility of infiltration controls are to be determined through geotechnical investigations.

Other methods which can be considered to achieve the pre-development water balance include green roofs, grassed / dry swales, cisterns, water reuse systems / rainwater harvesting systems. Site-specific water balance criteria are to be confirmed through consultation with the TRCA for all lands within the WVEA.

The preferred SWM servicing strategy can be found in **Figure 8-3**.

8.1.3.5 Costing

It is anticipated that the capital costs associated with preferred SWM controls would be borne by the developments. However, with the inclusion of additional end-of-pipe SWM facilities, the City will be required to operate and maintain these facilities.

Post-development drainage from the Secondary Plan Area will not negatively impact the existing public storm infrastructure therefore it is not anticipated that the City will require to upgrade / retrofit any existing SWM or storm drainage infrastructure however, the proposed SWM facilities will be eventually be assumed by the City at which time the City will be responsible for the operation and maintenance.

Table 8.3 summarizes the estimated capital and operational costs associated with each component of the preferred SWM strategy.

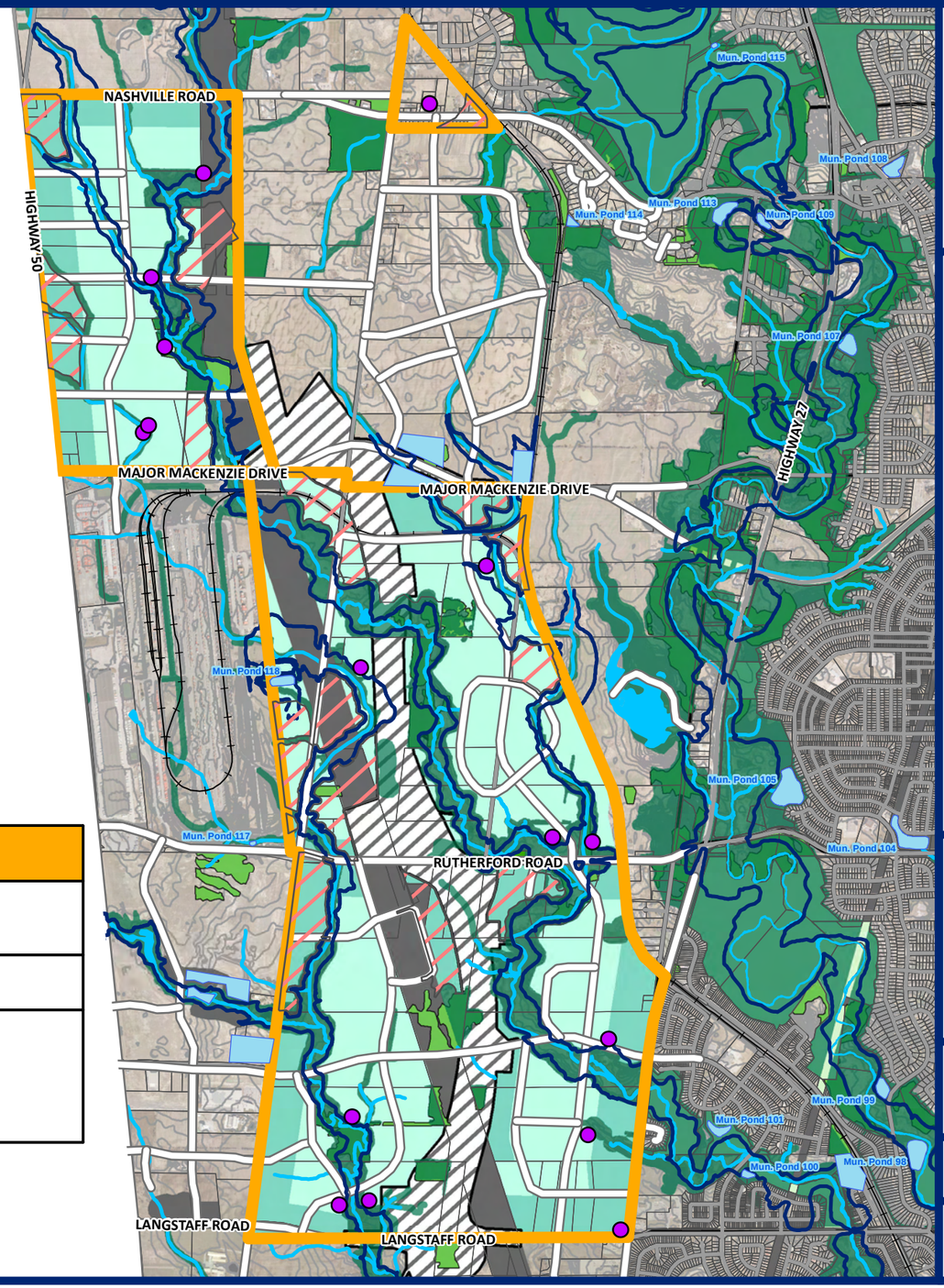
Table 8.3 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for West Vaughan Employment Area

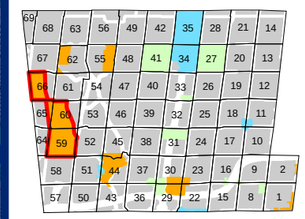
Control	Method	Capital Costs	Operation and Maintenance Costs
Quantity	SWMF– wet ponds – active Storage	Six (15) SWMF– $20,803,500 (quantity, quality and water balance / erosion)	SWMF – approximately $309,000 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
Quality	SWMF– wet ponds – permanent pool	-	Wet ponds are typically cleaned out once every 13 – 15 years.
Water balance / erosion	Green roofs	Green roofs: $65 – 230/$m^2$	Green roofs should be maintained at least twice per year which includes weeding as well as debris and dead vegetation removal.
	Cisterns, underground storage	$300/$m^3$ of underground storage	Minimal
	Water reuse systems / rainwater harvesting systems	Rainwater harvesting systems $6000 – $14000	Rainwater harvesting systems have relatively low maintenance requirements provided they are used for supplemental irrigation as opposed to indoor uses.

Preferred SWM Strategy | West Vaughan Employment Area

Control	Criteria	SWM Strategy
Quantity	Post Development Peak flows to be controlled to the Unit Flow Rate targets for Humber River Sub-basin 36.	-SWM Ponds -Rooftop Storage (restricted) -Surface Ponding
Quality	Quality - Enhanced Level I - 80% TSS Removal.	-SWM Ponds
Erosion	5 mm on-site retention for all storm events.	-Green Roofs -Roof Leader to Pervious Areas -Swales -Cisterns for water reuse
Water Balance	Best efforts to maintain existing infiltration rates.	

Note: The locations of proposed SWM ponds are preliminary in nature and are subject to other relevant legislation and location criteria.





Legend

- TRCA Existing Floodlines
- Watercourse
- Existing and Approved SWM Ponds
- Proposed SWM Ponds
- Areas with Lot Level Controls
- Proposed Roads
- Natural Areas
- TRCA Property
- Forested Area

Proposed Land Use

- Private Open Spaces
- General Employment
- Prestige Employment
- Infrastructure and Utilities
- Hwy 427 Planned Extension

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SCALE 1:12,000
0 90 180 360 540 720 Meters

FIGURE
8-3

There are additional site-specific studies which are recommended as part of the planning process. The studies required will be requested at the time of the development application, prior to obtaining the required approvals.

These studies include but are not limited to:

- Geotechnical investigation;
- Percolation and hydrogeological water budget analyses;
- It is noted that the Secondary Plan Area falls completely within the Humber Watershed. The TRCA is currently evaluating the need for Regional Controls for the watershed. Depending on the outcome of the assessment, the facilities within the WVEA may need to account for the Regional Storm; and,
- Master Environmental and Servicing Plans will be required for each of the individual developments prior to subdivision or site plan approvals.

The recommended studies are engineering-based studies – additional studies and/or investigations may be required by the TRCA and/or the City.

8.1.4. Kleinburg-Nashville Secondary Plan Area

The Secondary Plan Area of Kleinburg-Nashville includes three (3) distinct development areas of Huntington Road Community, Kipling Avenue Community and the Village of Nashville. The preferred SWM servicing strategy for the Huntington Road community includes at source / conveyance / lot level controls. Kipling Avenue Community and the Village of Nashville will utilise both end-of-pipe and lot level controls for SWM servicing. A practically achievable design criteria established through the detailed evaluations is as follows:

8.1.4.1 Design Criteria

Quantity Control:

- Village of Nashville – Post-development peak flows to the south should be controlled to target flow rates for Block 61W SWM Pond 2; and,
- Post-development flows to the wetland east of site should be maintained at existing levels.
- Huntington Road Community – Post-development peak flow to the Rainbow Creek Subwatershed to be controlled to unit flow rates for sub-basins 36 as per TRCA's SWM Criteria for the Humber River Watershed; and,
- Post-development flows to the Main Humber River do not require quantity control;
- Kipling Road Community –Areas draining directly to the East Humber River do not require quantity control; and,
- Sites draining to the tributary of the East Humber River must control post-development peak flows to unit flow rates for sub-basins 19A as per TRCA's SWM Criteria for the Humber River Watershed.

Quality Control:

- Enhanced Level 1 – 80% TSS removal.

Water Balance:

- Maintain the existing water balance within each development area.

Erosion :

- End-of-Pipe Controls – Runoff volume from 25 mm, 4-hour Chicago Design Storm is to be detained on site for a minimum of 24 to 48-hours and onsite retention of the first 5mm of each storm event;
- For Sites in the Rainbow Creek Watershed – On-site retention of the first 5 mm of each storm event; and,
- On Site Controls – On-site retention of the first 5 mm of each storm event.

The detailed evaluation matrix demonstrating how this servicing strategy was selected as the preferred alternative for each of the three (3) areas can be found in **Appendix B**. Detailed calculations can be found in the functional SWM Plan located in **Volume II** of the MPCEA document. Recommendations for portions of the Huntington Road Community area were also determined through the Rainbow Creek Subwatershed Master Plan Update included as **Volume III** of the MPCEA.

Currently, all three (3) development areas within the Secondary Plan do not have any stormwater drainage infrastructure or SWM practices in place to provide quality, quantity or water balance / erosion control to the site.

The proposed minor system drainage from each of the three (3) development areas will be designed to convey the 5-year storm event as specified in the City's Design Criteria. The major system flows will be conveyed by predefined overland flow routes within road allowances or through walkways and easements. Both minor and major drainage patterns and layouts will be confirmed upon the completion of site grading.

The preferred SWM Strategy for each area is described in the following sections.

8.1.4.2 Village of Nashville

The existing site consists of a few single family residential homes with no SWM controls for water quantity or quality. The soil in this area consists of primarily Brighton sandy loam and pasture with some row crops.

The proposed land use for the Village of Nashville includes low-rise residential and low-rise mixed use. Drainage from the site will be split into two (2) directions: 13.0 ha draining southwards towards Block 61 and 2.5 ha draining to the south east towards an existing wetland located just upstream of the Main Humber River. Through discussions with the TRCA, flow to the existing wetland feature should be maintained under post-development conditions.

In order to meet the quantity control requirements of Block 61 storage and attenuation of peak flows will be provided through a combination of a SWM facility for the residential areas and on-site controls for the proposed mixed-use areas. The on-site quantity control measures that can be implemented on the low-rise mixed use areas include rooftop storage and surface / parking lot ponding. The size of the pond block for the SWM facility will need to be confirmed at the detailed design stage and will depend on the feasibility and amount of storage achievable through the implementation of on-site controls.

Quality control for the site will be provided by the SWM facility for the residential areas and by implementation of a treatment train approach for quality control, which includes the use of mechanical systems, such as OGS units, as well as BMPs for the drainage towards the existing wetland.

Erosion control for the site will be provided through the onsite retention of the first 5 mm of rainfall from each storm event.

Due to the well-draining soil within the Village of Nashville, infiltration measures can be utilized to mitigate the water balance deficit created through development of the site. It may be possible to combine the erosion control criteria to serve a dual purpose of reducing erosion potential and promoting infiltration. The TRCA requires a minimum of 5 mm on-site retention of runoff from all storm events in order to provide erosion control.

It is proposed that the first 5 mm of rainfall be directed to infiltration controls, which would reduce the erosion potential as well as improve the water balance of the site. During the detailed design stage, geotechnical investigations will be required along with consultation with the TRCA to refine the site specific water balance requirements. It is anticipated that the capital as well as operational and associated with preferred SWM controls would be borne by the development community.

Post-development drainage from the Secondary Plan Area will not negatively impact the existing public storm infrastructure therefore it is not anticipated that the City will require to upgrade / retrofit any existing SWM or storm drainage infrastructure however, the proposed SWM facilities will be eventually be assumed by the City at which time the City will be responsible for the operation and maintenance.

Table 8.4 summarizes the estimated capital and operational costs associated with each component of the preferred SWM strategy.

Table 8.4 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for Village of Nashville

Control	Method	Capital Costs	Operation and Maintenance Costs
Quantity	SWMF – wet pond – active storage	SWMF – $600,000 (quantity, quality and water balance / erosion)	SWMF – approximately $13,100 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	On-site controls: rooftop, surface / parking lot ponding	On-site controls – implemented as part of site grading therefore no additional capital costs	-
Quality	SWMF – wet pond – permanent pool	SWMF – $600,000 (quantity, quality and water balance / erosion)	SWMF – approximately $13,100 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	OGS unit	OGS unit = $40,000 for drainage area towards existing wetland	OGS unit – $20,000/year
Water balance / erosion	SWMF – wet pond – extended detention	SWMF – $600,000 / pond (quantity, quality and water balance / erosion)	SWMF – approximately $13,100 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs

Recommended studies:

- Ecological study of the watercourses west of Huntington Road to determine the corridor size and volume of drainage to be maintained;
- Conveyance study on Block 61 to determine if drainage from village of Nashville can be conveyed to pond; and,
- Retrofit study for the Block 61 Pond 2 to see if it can be modified to accommodate uncontrolled runoff from the Village of Nashville.

8.1.4.3 Huntington Road Community

The Huntington Road Community currently consists of single family residential homes with no SWM controls for quantity or quality. Similarly to the Village of Nashville, the soil in this area consists of primarily Brighton sandy loam and pasture with some row crops.

The Huntington Road Community has been divided into two (2) major drainage areas. Approximately 15.6 ha drain westwards towards Huntington road and ultimately discharging to Rainbow Creek. The land use consists of mixed-use, residential, institutional and commercial areas.

The flow from this area ultimately discharges to Rainbow Creek. Approximately 48 ha, consisting mostly of low-rise residential units, drain towards the Main Humber River.

According to the TRCA's SWM criteria, there are no quantity control requirements for discharge to the Main Humber River. The proposed SWM strategy must meet the quantity control requirements for the drainage area discharging to Rainbow Creek, which is within Sub Basin 36 of the Humber River Watershed. In order to meet the quantity control requirements, storage will be provided through on-site lot level controls including rooftop, parking lot / surface storage and underground storage. The quantity control measures will be implemented on the mixed use and institutional areas of the proposed development and the practicality of the different proposed techniques will be determined on an individual site plan basis. As previously mentioned, there are no quantity requirements for the 48 ha draining towards the Main Humber River.

Quality Control for the area draining to Rainbow Creek will be provided through by implementation of a treatment train approach for quality control, which includes the use of mechanical systems, such as OGS units, as well as BMPs. Based on the proposed land use and soil conditions, BMPs could include, but are not limited to grassed / dry swales and vegetated filter strips. The practicality of these measures will be confirmed at the detailed design stage. For the area draining to the Main Humber River it is recommended that water quality protection be provided by a wet pond sized to achieve enhanced level protection for the proposed site conditions.

In order to maintain water balance and reduce the occurrence of downstream erosion on-site measures such as green roofs, infiltration trenches, rain gardens, permeable pavement, cisterns and other water re-use systems could be incorporated. **Table 8.5** shows the capital and operational associated with the preferred SWM strategy.

Table 8.5 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for Huntington Road Community

Control	Method	Capital Costs	Operation and Maintenance Costs
Quantity	SWMF – wet pond – active storage	SWMF – $2,140,000 (quantity, quality and water balance / erosion)	SWMF – approximately $16,600 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	On-site controls: rooftop, surface / parking lot ponding	On-site controls – implemented as part of site grading therefore no additional capital costs	
Quality	SWMF – wet pond – permanent pool	SWMF– $2,140,000 (quantity, quality and water balance / erosion)	SWMF– approximately $16,600 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	OGS unit	OGS unit = $40,000 for drainage area towards existing wetland	OGS unit – $20,000/year
Water balance / erosion	Water reuse systems / rainwater harvesting systems	Rainwater harvesting systems $6000 – $14000	Rainwater harvesting systems have relatively low maintenance requirements provided they are used for supplemental irrigation as opposed to indoor uses.

Recommended studies:

- Hydraulic capacity assessment on culverts along Huntington Road.

8.1.4.4 Kipling Avenue Community

The storm drainage from the Kipling Avenue Community outlets at two (2) different locations. Under post-development conditions, approximately 14.2 ha discharges to the Main Humber River and approximately 67 ha discharges towards the East Humber River. The proposed land use will predominantly low-rise residential with a small portion of low-rise mixed use. Similarly to the proposed development in the Huntington Road Community, according to the TRCA's SWM criteria, there are no quantity control requirements for the discharge directly to the Main Humber.

The proposed SWM strategy must meet the quantity control requirements for the drainage area discharging to the East Humber which is within Sub basin 19A in the Humber Watershed. In order to meet the quantity control requirements for the area, storage and peak flow attenuation is required. The proposed quantity control measures will be provided by SWM ponds and on-site controls. A total of three (3) facilities are proposed and provide the required storage volumes.

On-site controls such as rooftop controls, surface / parking lot storage and underground storage tanks can be implemented on the low-rise mixed use areas to reduce the size of the proposed pond block.

It is noted that there is a portion of land included in the Kipling Road Community which is designated as a "Special Study Area". The Secondary Plan defines this as lands which may have some development potential, subject to a detailed Environmental Impact Study prepared to the satisfaction of the City, in consultation with the Conservation Authority, and any other agency having jurisdiction.

It should also be noted that a portion of the Special Study Area located in the northwest quadrant of the site drains uncontrolled to an existing swale. The proposed SWM facility for the Special Study Area has been over controlled to account for this small area.

It is proposed that quality control for the site is also achieved though SWM facilities. These facilities will be wet facilities with the permanent pool volume addressing the quality component and the active storage volume determined from the VO2 model addressing the quantity component as previously mentioned. The two (2) drainage areas which drain uncontrolled will not be directed towards the ponds therefore; quality control will be provided though a treatment train approach which includes OGS units and other BMPs.

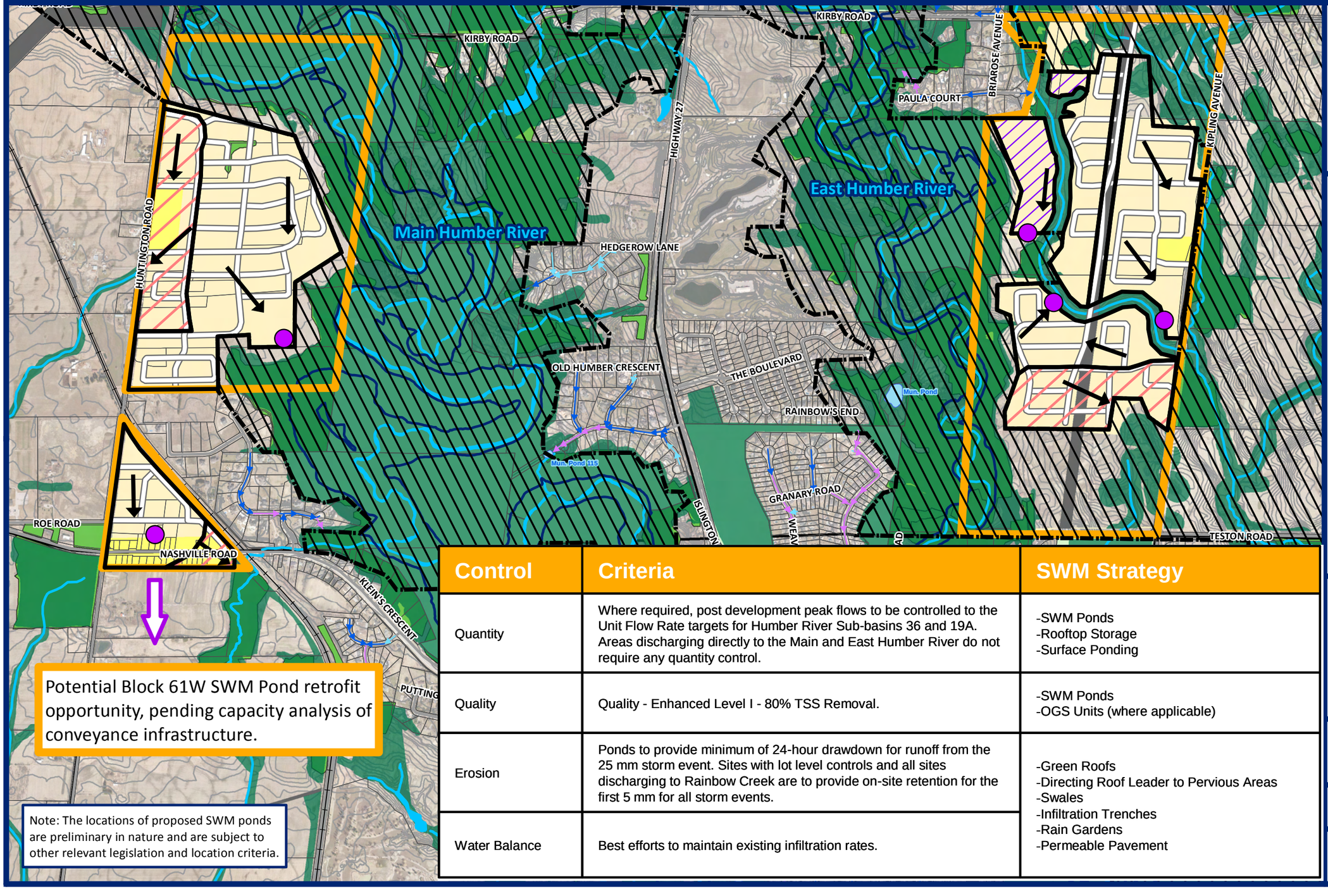
The erosion requirement for areas of the site which drain to SWM facilities will be achieved by providing a 24-hour drawdown time in the SWM facilities for the 25 mm event in addition to the required retention of the first 5 mm of each rainfall event. In areas which do not drain to end-of-pipe facilities, on-site retention of the first 5 mm of a storm event is required for erosion control. Methods for achieving onsite retention for low-rise residential sites include rain gardens, infiltration basins / swales, and cisterns. Mixed use areas may use also use rooftop storage to evaporation / infiltration, pervious depression storage in addition to the methods mentioned for residential areas. The specific techniques for water balance and erosion control will be confirmed on an individual site plan basis. **Table 8.6** shows the capital and operational associated with the preferred SWM strategy.

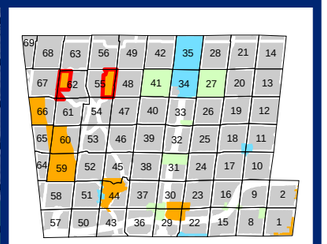
Table 8.6 – Capital and Operational Costs of Preferred Stormwater Management Servicing Strategy for Kipling Avenue Community

Control	Method	Capital Costs	Operation and Maintenance Costs
Quantity	Three (3) SWMF –wet pond – active storage	Three (3) SWMF – $2,961,000(quantity, quality and water balance / erosion)	Three (3) SWMF – approximately $39,000 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	On-site controls: rooftop, surface / parking lot ponding	On-site controls – implemented as part of site grading therefore no additional capital costs	
Quality	SWMF – wet pond – permanent pool	Three (3) SWM – $2,961,000 (quantity, quality and water balance / erosion)	Three (3) SWM – approximately $39,000 / year Based on a clean out time period of 13 years + annual inspection, regular maintenance, and repairs
	OGS unit	OGS unit = $100,000 for drainage area towards East Humber	OGS unit – $12,000/year
Water balance / erosion	Water reuse systems / rainwater harvesting systems	Rainwater harvesting systems $6000 – $14000	Rainwater harvesting systems have relatively low maintenance requirements provided they are used for supplemental irrigation as opposed to indoor uses.

Figure 8-4 shows the preferred SWM strategy for the Village of Nashville, Huntington Road Community and the Kipling Avenue Community, all of which are part of the Kleinberg-Nashville Secondary Plan Area.

Preferred SWM Strategy | Kleinburg-Nashville





Legend

- Green Belt Plan Area
- TRCA Existing Floodline
- Watercourse
- Special Study Area
- Existing and Approved SWM Ponds
- Proposed SWM Ponds
- Areas with Lot Level Controls
- Proposed Roads
- Natural Areas
- TRCA Property
- Forested Area
- Infrastructure and Utilities

Proposed Land Use

- Parks
- Private Open Spaces
- Low-Rise Residential
- Low-Rise Mixed Use

Storm Sewers

Diameter (mm)

- 0 - 375
- 375 - 600
- 600 - 1200
- 1200 - 3660

Control	Criteria	SWM Strategy
Quantity	Where required, post development peak flows to be controlled to the Unit Flow Rate targets for Humber River Sub-basins 36 and 19A. Areas discharging directly to the Main and East Humber River do not require any quantity control.	-SWM Ponds -Rooftop Storage -Surface Ponding
Quality	Quality - Enhanced Level I - 80% TSS Removal.	-SWM Ponds -OGS Units (where applicable)
Erosion	Ponds to provide minimum of 24-hour drawdown for runoff from the 25 mm storm event. Sites with lot level controls and all sites discharging to Rainbow Creek are to provide on-site retention for the first 5 mm for all storm events.	-Green Roofs -Directing Roof Leader to Pervious Areas -Swales -Infiltration Trenches -Rain Gardens -Permeable Pavement
Water Balance	Best efforts to maintain existing infiltration rates.	

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November 2013

Preferred SWM Strategy

SCALE 1:15,000
0 55 110 220 330 440 Meters

FIGURE
8-4

8.2. Future Secondary Plan Areas Stormwater Servicing Strategy

Secondary Plans are currently being prepared for several areas throughout the City for which the ultimate build-out, anticipated land-use and municipal servicing requirements are being considered. These areas include:

- Block 27;
- Block 41;
- Vaughan Mills;
- Highway 7 and Weston Road;
- Concord Center;
- Vaughan Health Campus of Care (VHCC);
- Dufferin Street and Center Street, and;
- Promenade Mall.

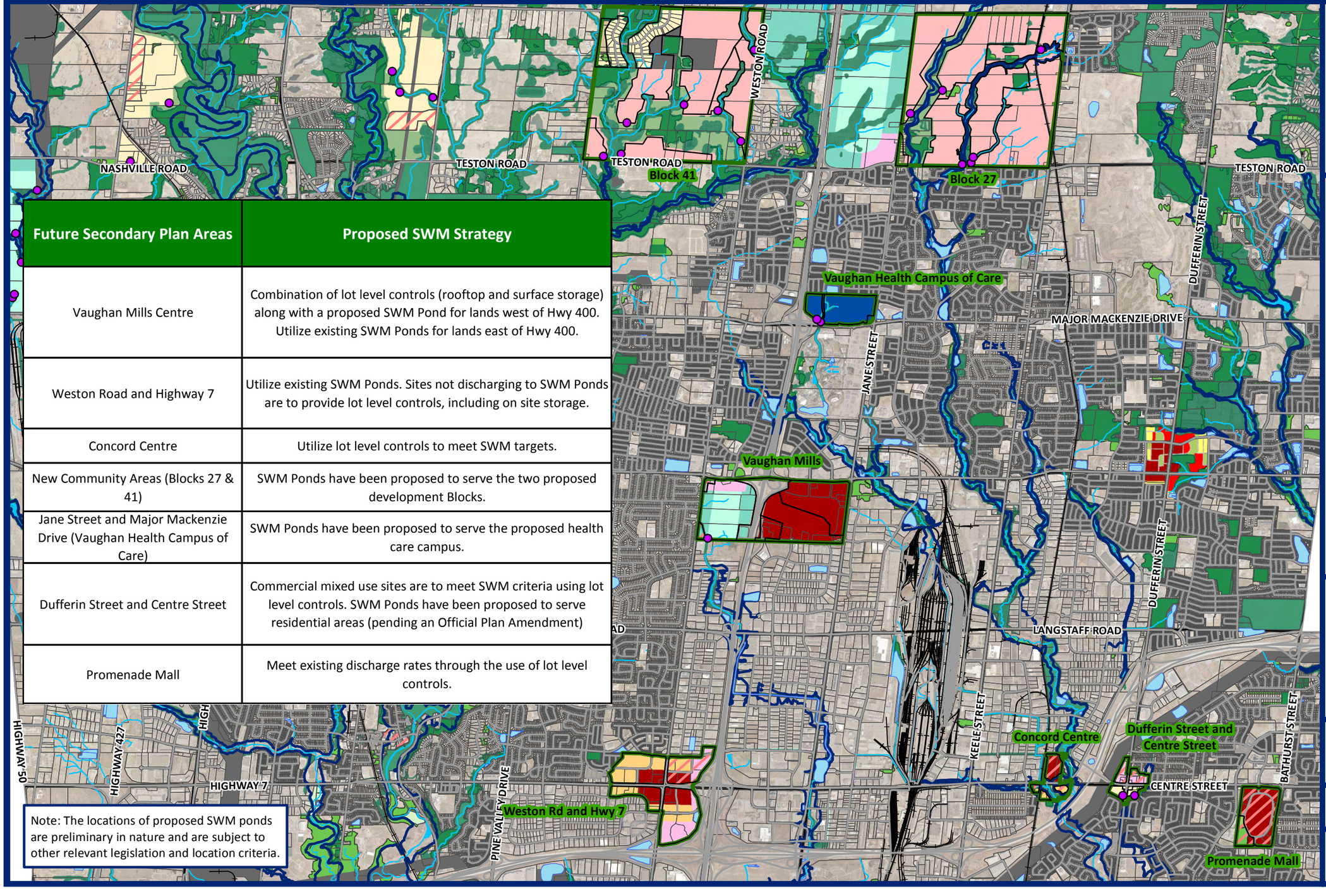
As was the case for the Approved Secondary Plan Areas, different servicing strategies with respect to storm drainage and SWM were considered for each of the Secondary Plan Areas. The following section summaries the preferred SWM strategy to service these areas. The detailed evaluation of the SWM controls for each Secondary Plan Area can be found under **Appendix B**. Detailed calculations can be found in the functional SWM Plan located in **Volume II** of the MPCEA document.

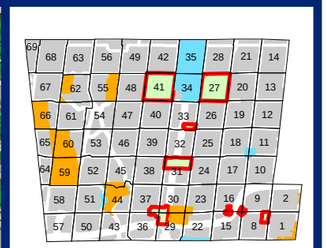
Figure 8-5 shows the preferred SWM servicing strategy for all future Secondary Plan Areas.

Preferred SWM Strategy | Future Secondary Plan Areas

Future Secondary Plan Areas	Proposed SWM Strategy
Vaughan Mills Centre	Combination of lot level controls (rooftop and surface storage) along with a proposed SWM Pond for lands west of Hwy 400. Utilize existing SWM Ponds for lands east of Hwy 400.
Weston Road and Highway 7	Utilize existing SWM Ponds. Sites not discharging to SWM Ponds are to provide lot level controls, including on site storage.
Concord Centre	Utilize lot level controls to meet SWM targets.
New Community Areas (Blocks 27 & 41)	SWM Ponds have been proposed to serve the two proposed development Blocks.
Jane Street and Major Mackenzie Drive (Vaughan Health Campus of Care)	SWM Ponds have been proposed to serve the proposed health care campus.
Dufferin Street and Centre Street	Commercial mixed use sites are to meet SWM criteria using lot level controls. SWM Ponds have been proposed to serve residential areas (pending an Official Plan Amendment)
Promenade Mall	Meet existing discharge rates through the use of lot level controls.

Note: The locations of proposed SWM ponds are preliminary in nature and are subject to other relevant legislation and location criteria.





Legend

- Proposed SWM Ponds
- TRCA Existing Floodlines
- Watercourse
- Existing and Approved SWM Ponds
- Areas with Lot Level Controls
- Future Secondary Plan Area Boundary
- Natural Areas
- TRCA Property
- Forested Area

Proposed Land Use

- Parks
- Private Open Spaces
- Agriculture
- Rural Residential
- Low-Rise Residential
- Low-Rise Mixed-Use
- Mid-Rise Residential
- Mid-Rise Mixed-Use
- High-Rise Residential
- High-Rise Mixed Use
- Commercial Mixed-Use
- General Employment
- Prestige Employment
- Major Institutional
- New Community Areas
- Infrastructure and Utilities

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Stormwater Management Master Plan
November 2013

Preferred SWM Strategy
Future Secondary Plan Areas

SCALE 1:50,000
0 170 340 680 1,020 1,360 Meters

FIGURE
8-5

8.2.1. New Community Areas within Blocks 27 and 41

The Block 27 Future Secondary Plan Area is located in an area bounded by Keele Street to the east, Teston Road to the south, Jane Street to the west, and Kirby Road to the north in the City. In its current condition, Block 27 consists primarily of agricultural crop lands, with several rural residential units scattered around its perimeter. The GO Railway runs from the north to the south within the area, west of Keele Street. There are several sizable woodlots located on the southwest and northeast quadrants of the Block, some of which are protected under the Green Belt or under the City's Natural Heritage feature.

Block 27 almost entirely drains south across Teston Road into the Maple community area, as part of the West Don River Subwatershed. An area of approximately 30 ha located at the northwest corner of the Block drains west into the East Humber River. Drainage features consists solely of natural channels and drainage ditches. There is currently one SWM pond (Municipal Pond 60) in the Secondary Plan Area; however there is no design information available for this pond.

There are significant external drainage areas flowing into Block 27 from Blocks 20, 21, and 28. These external drainage areas total approximately 324 ha, of which 42 ha drains into the East Humber River, and the remainder to West Don River.

The Block 41 Future Secondary Plan Area is located in an area bounded by Weston Road to the east, Teston Road to the south, Pine Valley Drive to the west, and Kirby Road to the north. Block 41 consists primarily of agricultural lands, with the exception of the northwest corner of the Block which has an existing residential subdivision. Drainage within the Block is generally to the south, draining to Block 40 through a set of culverts along Teston Road. Drainage features within the Future Secondary Plan Area consists primarily of natural channels and drainage ditches. There are currently no SWM ponds in Block 41. The Block is part of the East Humber Watershed.

The new community areas of Blocks 27 and 41 will consist of a variety of land uses including residential and mixed use land. It is recommended that SWM quantity control for the New Community Areas with Blocks 27 and 41 be provided by SWM Facilities, along with a combination of parking lot / surface, rooftop and underground storage where feasible. The feasibility of parking lot / surface, rooftop and underground storage will be determined upon finalizing the development form. Post-development discharge rates from the site are to meet the target unit flow rates as specified by the TRCA for both the Humber and Don River Watersheds. A treatment train approach is to be taken to provide quality control for the site, using a combination of SWM Ponds and BMPs. With respect to erosion control, SWM ponds can help mitigated potential downstream erosion by providing a specified extended detention volume and drawdown time as prescribed by the MOE SWM Planning and Design Manual. Various BMPs will also be implemented to address water balance and erosion control on site. Applicable BMPs for Blocks 27 and 41 include rain gardens, roadside swales, and permeable pavements.

The sizing, selection, and design of all required controls are to be completed at the site plan stage. **Figure 8-5** shows the preferred SWM servicing strategy for Within Blocks 27 and 41.

8.2.2. Vaughan Mills Centre

The Vaughan Mills Future Secondary Plan Area is located in an area bounded by Bass Pro Mills Drive to the south, Weston Road to the west, Rutherford Road to the north, and Jane Street to the east. The existing lands east of Highway 400 have been developed into a commercial complex more commonly referred to as the Vaughan Mills Mall. Lands west of the highway have a flat topography, draining towards the south and west and discharging to Black Creek. A retail complex has been developed on the southeast corner of Rutherford Road and Weston Road. Properties fronting Rutherford Road are residential, while properties fronting Weston Road are used for commercial purposes with large outdoor storage yards. Remaining lands are currently used for agricultural purposes.

The current drainage pattern of The Vaughan Mills Centre is split into three (3) main drainage areas. Lands west of Highway 400 are largely undeveloped and drain south and west to Black Creek. Highway 400 lands drain to a SWM Pond at the Highway 400 on-ramp from Bass Pro Mills Drive. Lands east of Highway 400 drain into three (3) different SWM ponds.

As there are currently no plans to re-develop the existing Vaughan Mills Mall, development in this Future Secondary Plan Area will take place on properties west of Highway 400. Properties fronting Rutherford Road will be developed to commercial mixed-use, while properties fronting Weston Road and Highway 400 will be developed to prestige employment. Remaining lands will be developed as general employment.

It is recommended that quantity controls for new development lands within the Vaughan Mills Centre Plan Area be provided by a combination of parking lot / surface, rooftop, underground storage, as well as a proposed SWM pond in order to meet the applicable unit flow rates for the Humber River Watershed. The proposed SWM pond is to be located adjacent to Black Creek, and will be sized to provide quantity control for 49.9 ha of land west of Highway 400. Quantity control for the existing garden center, should it be re-developed, will be provided by a combination of parking lot / surface, rooftop, underground storage. Existing mixed use developments and any new development located east of Highway 400, including the Vaughan Mills Mall, will continue to outlet to one of three (3) existing ponds, at the existing discharge rate.

A treatment train approach is to be taken where feasible to provide quality controls for the western portion of the site through the use of BMPs prior to discharging to the proposed SWM Pond. Due to its proximity to Black Creek, which has a history of flooding problems further downstream of the site, it is recommended that BMP practices be implemented to the extent feasible to reduce runoff, improve runoff quality, reduce downstream erosion and provide water balance for the site.

As runoff from the garden center will not be directed to a centralised SWM facility, water quality protection will be through a treatment train approach, using a combination of an OGS unit and lot level and conveyance BMPs. Quality control for the lands east of Highway 400 will continue to be provided by the existing SWM ponds. Applicable BMPs which include green roofs, rooftop storage, and permeable pavement could be implemented should the lands be redeveloped. The sizing, selection, and design of required controls are to be confirmed at the detailed design stage.

Water balance and erosion control for the site could be provided through green roofs, rain gardens / swales and other water reuse systems. Based on the Ontario Soils Survey, the soil present on site may limit the effectiveness of infiltration-based techniques. However, geotechnical investigations are to be conducted to confirm the feasibility of infiltration controls for Vaughan Mills Centre.

The sizing, selection, and design of all required controls are to be completed at the site plan stage. **Figure 8-5** shows the preferred SWM servicing strategy for the Vaughan Mills West Center.

8.2.3. Weston Road and Highway 7

The Highway 7 and Weston Road Future Secondary Plan Area is located in an area roughly bounded by Ansley Grove Road to the west, Chrislea Road to the north, and Highway 400 to the east. The southern boundary for the Plan Area is Highway 407 for sites east of Weston Road, and Winges Road and Rowntree Dairy Road for sites west of Weston Road. The area is highly urbanised and has been fully built out with commercial buildings, including gas stations, a movie theatre, and a variety retail stores. A number of large parking lots are present in the area. Drainage from the site discharges into one (1) of two (2) SWM facilities or a ditch running southwards along Highway 400 eventually discharging on the east side of Hwy 400.

The proposed development will consist of high-rise mixed use, mid-rise mixed use and commercial mixed use. Properties located west of Weston Road currently discharge to a pond south of Highway 407 and east of Pine Valley Drive, while properties located southeast of the intersection drain to a pond just east of Highway 400 and south of Colossus Drive. These sites are to maintain drainage to their respective SWM ponds, at a discharge rate matching existing rates and pond design criteria. It is recommended that quantity controls for these areas be provided using a combination of lot-level controls prior to outletting to the existing SWM facilities. It is likely that runoff from all these sites were controlled to 180 L/s/ha before discharging to the pond. However, the controlled discharge rate from properties in the Plan Area must be confirmed prior to redevelopment of the site.

Properties located northeast of the intersection currently discharge to a roadside drainage ditch running southwards along Highway 400 eventually discharging to the east side of Highway 400. These sites are to meet unit flow rate targets for Humber River Sub-basin 46. For all properties located within the area, the large flat roofs and large parking lots characteristic to commercial areas are to be utilized for lot-level stormwater quantity control.

Quality and erosion control will be through the existing SWM facilities as well as lot level / source controls for the areas which currently do not drain to ponds. Lot level controls will also promote water balance for the redevelopment of the site. Lot level controls for water quality, erosion and water balance that can be used include but are not limited to green roofs, roof leader disconnection, swales and rain gardens.

The sizing, selection, and design of all required controls are to be completed at the site plan stage.

Figure 8-5 shows the preferred SWM servicing strategy for within the Weston Road and Highway 7 Secondary Plan Area.

8.2.4. Concord Centre

The Concord Centre Future Secondary Plan Area is a small area located near the GO Railway crossing over Highway 7, between Keele Street and Dufferin Street. The Plan Area covers several properties fronting Highway 7 between the railway and the West Don River. It also includes several small properties on the south side of Highway 7, between Baldwin Avenue and the railway.

The main branch of West Don River converges with two (2) tributaries immediately south of Concord Centre. One (1) tributary flows south along the west side of GO Railway tracks and crosses Highway 7 on the east side of the tracks, where it meets the second tributary which flows east on the south side of Highway 7. The area is currently being used for a mix of employment uses, including a garden centre, a storage facility, an RV sales centre, and a large greenhouse facility on the north side of Highway 7. There are likely little to no SWMFs in the area, and runoff is conveyed uncontrolled to the West Don River.

The proposed development consists of high-rise mixed use and mid-rise mixed use. Post-development peak flow rates are to be controlled to existing conditions peak flow rates for the 2 to 100 year storms, using the 12-hour SCS distribution. Sites larger than 5.0 ha must control post-development peak flow rates to unit flow rate targets specified for the Don River Sub-basin 6. Due to the relatively small size of the Future Secondary Plan Area and the fragmented nature of the developable lands, quantity control for the site will be provided through a combination of parking lot / surface, rooftop and underground storage. Sites south of Highway 7 will discharge to the West Don River or one (1) of its tributaries, at a post-development rate that matches its existing conditions peak flow rate. However, because the property north of Highway 7 is larger than 5.0 ha, sites north of Highway 7 must control post-development peak flows to the unit flow rate targets specified for the Don River Sub-basin 6.

Quality control is to be achieved using a treatment train approach, using a combination of OGS along with different BMPs and lot level controls. In addition to quality control, lot level controls will be used to provide water balance and erosion control. Lot level controls include but are not limited to green roofs, roof leader disconnection, infiltration trenches, swales and rain gardens.

The sizing, selection, and design of all required controls are to be completed at the site plan stage.

Figure 8-5 shows the preferred SWM servicing strategy for the Concord Center.

8.2.5. Jane Street and Major Mackenzie Drive (Vaughan Health Campus of Care)

The property is located on the northeast quadrant of Highway 400 and Major Mackenzie Drive in the City. The property is bounded by Jane Street to the east, Major Mackenzie Drive to the south, Highway 400 to the west, and Melia Lane to the north. An existing watercourse flows through the site from the SWM pond located north of the site to the existing culvert under Major Mackenzie to the south. This watercourse divides the site into two (2) drainage areas.

The site currently serves as an entrance for Canada's Wonderland located to the south. There is a watercourse to the west of the existing entrance road that conveys flows from an external drainage area to the north of the site, to an existing culvert under Major Mackenzie at the southwest corner of the property. There is an external drainage area to the north of the site which is controlled by three (3) existing SWM ponds.

According to the SWM and Floodplain Analysis Report (Cole Engineering, 2010), the capacity of the existing 2100 mm culvert crossing Major Mackenzie Drive was determined to be 8.6 m^3/s. This limits the amount of storm flow that could be conveyed off-site, and would create a floodplain within the Future Secondary Plan Area for the 100-year and Regional Storm events.

The Vaughan Health Campus of Care SWM and Floodplain Analysis Report (Cole Engineering, 2010) has determined that the preferred solution to remove the flood plain on the site is to replace the existing culvert with twin 3.0 m x 2.1 m concrete box culverts. With a proposed slope of 1.0%, the capacity of the preferred crossing will be 39.0 m^3/s, allowing flows from the 100-year and Regional Storms to pass through the culvert safely without creating flooding hazards on the site.

It has also been proposed to realign the existing drainage channel as part of development of the site. This realignment is reflected in the post-development hydrology model.

Stormwater quantity control will be provided through the use of orifice control devices installed in the storm sewer system, roof top storage, green roof technology, and/or underground storage and two (2) SWM ponds. SWM controls for the site must control post-development peak flows to the pre-development unit flow rate for the Don River Sub-basin 1, as specified by the TRCA.

Quality control will be achieved by a treatment train approach, using a combination of LID measures, OGS units and SWM ponds. Water balance and erosion control can be accomplished through lot level or conveyance controls such as absorbent landscaping, rainwater harvesting, green roof technology, rain gardens or bio-swales. Where SWM ponds are to be implemented, extended detention of runoff from the 25 mm 4-hour erosion-control storm event would be detained within the proposed ponds for a minimum of 24-hours.

The sizing, selection, and design of all required controls are to be completed at the site plan stage.

Figure 8-5 shows the preferred SWM servicing strategy for the Vaughan Health Campus of Care.

8.2.6. Dufferin Street and Centre Street

The area is located in between the highly urbanized neighbourhood of Thornhill and Highway 407, roughly bounded by the hydro corridor to the west and Westminster Creek to the east. The southern boundary of the Plan Area is the property limits of the existing subdivision south of the Plan Area. Based on the topography of the area and engineering drawings provided by the City, the area drains to Westminster Creek, a tributary of the West Don River. Commercial properties on the northeast corner of the intersection discharge to Westminster Creek west of Richbell Street. Remaining lands drain to a drainage ditch running south from the northwest portion of the Plan Area, crossing south across Centre Street, then east across Dufferin Street. The drainage ditch joins Westminster Creek at the southern boundary of the Secondary Plan Area. There is very little information with regards to existing SWM for the area.

The proposed land use is expected to consist of low-rise residential units on the south side of Highway 7 and commercial mixed units on the north side of Highway. 7. The preferred SWM strategy for the Future Secondary Plan Area with respect to quantity control will be provided by a combination of parking lot / surface storage, rooftop storage, underground storage for the commercial developments and a SWM pond if necessary. The feasibility of the SWM pond will be determined by the development form for the lands south of Highway 7. The sites are located in a Special Policy Area, an area where the land use designation is subject to change to a higher density land use. Should the area be developed with low-rise residential buildings, then a SWM pond is to be constructed on the south portion of the site. However, higher density land uses would be able to utilize rooftop and parking lot storage, eliminating the need for a SWM pond.

Quality control is to be achieved using a treatment train approach, using a combination of SWM pond (if applicable) along with OGS units and different BMPs where feasible.

Sizing and design of SWM features for the site are to be completed at the site plan stage of development. Discharge to the Westminster Creek is to be controlled to the Don River unit flow rates specified by the TRCA.

New developments and redevelopments cannot occur within Westminster Creek's floodplain and the 15 m development buffer. TRCA's floodplain mapping shows a spill location within the Plan Area where Westminster Creek crosses Centre Street. The spill flows west from the crossing, and the extents of the spill is not known. It is recommended that a floodplain analysis study be conducted in the area prior to development. The study should confirm the existing flood elevations, delineate the extent of ponding at the spill location, and analyse alternatives to remove properties from the floodplain in order to maximize space for development.

Water balance on-site can be addressed through LID techniques such as green roofs, cisterns or other water reuse systems.

It is noted that the City is currently conducting a City-Wide Drainage Study which focuses on specific flooding locations as result of the storm event experienced on August 19, 2005. There is an area downstream of Dufferin and Centre Street, along Charlton Avenue just north of the train tracks, which experienced flooding during this particular event. Recommendations from the City-Wide Drainage Study with respect to how to mitigate flooding in the area should be considered when determining the final SWM servicing strategy for the Dufferin-Centre Street Secondary Plan Area. This would occur at later stages in the planning process and at the detailed design stage.

The sizing, selection, and design of all required controls are to be completed at the site plan stage. **Figure 8-5** shows the preferred SWM servicing strategy for within the Dufferin and Center Street Secondary Plan Area.

8.2.7. Promenade Mall

The area is located in a highly urbanized area within Thornhill neighbourhood, on the southwest corner of Centre Street and Bathurst Street. The Plan Area is bounded by Centre Street to the north, Bathurst Street to the east, and Clark Avenue West to the south. It is bounded in the west by Saint Elizabeth Catholic High School and existing townhouse developments fronting New Westminster Drive. Most of the area has been fully built out with commercial and high-rise residential buildings, with the exception of a park and a 3.5 ha woodlot on the southwestern corner of the area.

Based on the storm sewer data and engineering drawings provided by the City, runoff from the site has been controlled on-site to peak flows for the 5-year return storm. A storm sewer system from the Promenade Mall drains south to Clark Avenue and connects into the City's storm sewer network, flowing west along Clark Avenue and discharges to the West Don River at the west end of Clark Avenue.

It is expected that Promenade Mall be redeveloped as high-rise mixed-use in the future, however the large woodlot (6.0 ha), on the southwest corner of the Plan Area will remain undeveloped. It is recommended that quantity control for the development be provided by a combination of parking lot, surface, and rooftop storage as well as underground storage. Peak flows are to be controlled to existing combined discharge rate of 5.34 m^3/s for the site.

Quality control is to be achieved using a treatment train approach, using a combination of OGS along with various BMPs. Applicable BMPs for this site include rooftop storage, green roofs, and parking lot storage.

With respect to water balance and erosion control, BMPs such as green roofs, cisterns or other water reuse systems can be incorporated to help maintain the hydrological cycle and help reduce downstream erosion.

The sizing, selection, and design of all required controls are to be completed at the site plan stage. **Figure 8-5** shows the preferred SWM servicing strategy for the Promenade Mall Secondary Plan Area.

8.2.8. Intensification Corridors

In addition to the development occurring in designated Secondary Plan Areas, the City will also be intensifying through infill and re-development along regional and local corridors. These "Intensification Corridors" have been established to make efficient use of underutilized sites served with a high-level of existing or planned transit. They will be developed to accommodate a mix of uses and appropriate densities to support transit use and promote pedestrian and cycling traffic.

8.2.8.1 Alternative 1: Do Nothing

If development within the existing urban area of Vaughan along intensification corridors proceeds without any form of SWM controls, there would be a greater risk of increased flooding, degraded water quality and potential downstream erosion. This is would have negative impacts on natural features, terrestrial and aquatic habitat, and public and private properties within the area of intensification and potentially downstream. Although there are no costs associated with SWM controls, the cost of doing nothing will increase the risk of potential issues related to flooding, water quality and erosion.

8.2.8.2 Alternative 2: Lot Level / At Source Controls

Lot level controls will have the ability to provide quantity control, quality control, water balance and erosion control. The implementation of lot level SWM will not have a negative impact on natural features, terrestrial or aquatic habitat. Lot level controls typically have lower capital costs than end-of-pipe facilities and also have lower operating and maintenance costs over the long term.

As lot level controls are typically considered "small scale" their implementation on an individual site plan basis in an existing urban area is often more practical than providing a centralized end-of-pipe SWM facility. SWM facilities would require additional area / space which is often limited in existing intensification areas.

8.2.8.3 Alternative 3: End-of-Pipe Controls

End-of-pipe SWM facilities would be able to provide quantity control, quality control, and erosion protection in a centralized end-of-pipe facility. There would be minimal impacts to natural features, terrestrial and aquatic habitats. There will be reduced flooding risk to public and private properties however, end-of-pipe controls can be located on public or private lands.

It is generally not practical to provide SWM controls at a single end-of-pipe facility (ie. pond) on an individual lot basis due to the space limitations of the site. That being said, many of the proposed developments within the intensification corridors have been accounted for in an existing SWM plan for which ponds located further downstream have accounted for the drainage from these specific intensification areas.

Corridors which will be subject to development through intensification include:

- Major Mackenzie Drive;
- Rutherford Road;
- Highway 7;
- Centre Street;
- Steeles Avenue West;
- Jane Street; and,
- Bathurst Street.

Different sections along each one (1) of these corridors will have to meet different design criteria based on their existing drainage. With respect to quantity control requirements, each intensification corridor is to be controlled to one of the following design criteria:

- Post-development peak flows to match existing peak flows from site;
- Post-development peak flows to match existing downstream infrastructure capacity (ie. channels, storm sewers, culverts);
- Post-development peak flows to match 5-year existing peak flow;
- Post-development peak flows to meet unit flow rates as specified by the TRCA; and,
- Post-development peak flows to conform to existing SWM plan.

Each intensification corridor has been evaluated per the criteria established in **Section 6.2.5**. **Table 8.7** summarizes the preferred servicing strategy for each of the intensification corridors. **Figure 8-6** shows an overview of the preferred servicing strategy for each intensification corridor. The detailed evaluation criteria can be found under **Appendix B**.

Table 8.7 – Summary of Preferred Servicing Strategy for Intensification Corridors

	Intensification Corridor	Do Nothing	Lot Level Controls	End-of-Pipe Controls	Lot Level with Existing SWM Infrastructure
Major Mackenzie Drive					
1	Starling Boulevard – Hwy. 400 (North Side)	○	◑	◑	●
1A	Starling Boulevard – Hwy. 400 (South Side)	○	◑	◑	●
2	Jane Street – West Don River (North Side)	○	◑	◑	●
2A	Jane Street – West Don River (South Side)	○	◑	◑	●
3	West Don River – Gram Street (North Side)	○	◑	◑	●
4	West Don River – Netherford Rd. (South Side)	○	●	◑	n/a
4A	Netherford Road. – Gram St. (South Side)	○	●	◑	n/a
5,6	Keele Street – Railway	○	●	◑	n/a
5,6 CC	Civic Centre	○	◑	◑	●
7	GO Train Station – McNaughton Road (North Side)	○	◑	◑	●
8	McNaughton Road East – Laramie Cresent	○	◑	◑	●
9	Railway – Prince Rupert Avenue	○	◑	◑	●
9A	Prince Rupert Avenue – Dufferin Street (South Side)	○	◑		●
10	Laramie Crescent – Dufferin Street	○	●	◑	n/a
11	Dufferin Street – Bathurst Street (North Side)	○	◑	◑	●
11A	Dufferin Street – Bathurst Street (South Side)	○	◑	◑	●
12	Sir Benson Drive – Bathurst Street	○	◑	◑	●
Rutherford Road					
13	Weston Road. – Highway 400 (Northwest Corner)	○	◑	◑	●
13A	Weston Road. – Highway 400 (North Side)	○	◑	◑	●
14	Highway 400 – Jane Street	○	◑	◑	●
14A	Juliard Drive – Jane Street (North Side)	○	●	◑	n/a
15	Jane Street – Railway (North Side)	○	◑	◑	●
16	Jane Street – Railway (South Side)	○	◑	◑	●
17	Rotational Drive – Keele Street	○	●	◑	n/a
18	Keele Street – GO Railway (North Side)	○	◑	◑	●
19	Keele Street – Westburne Drive (South Side)	○	●	◑	n/a

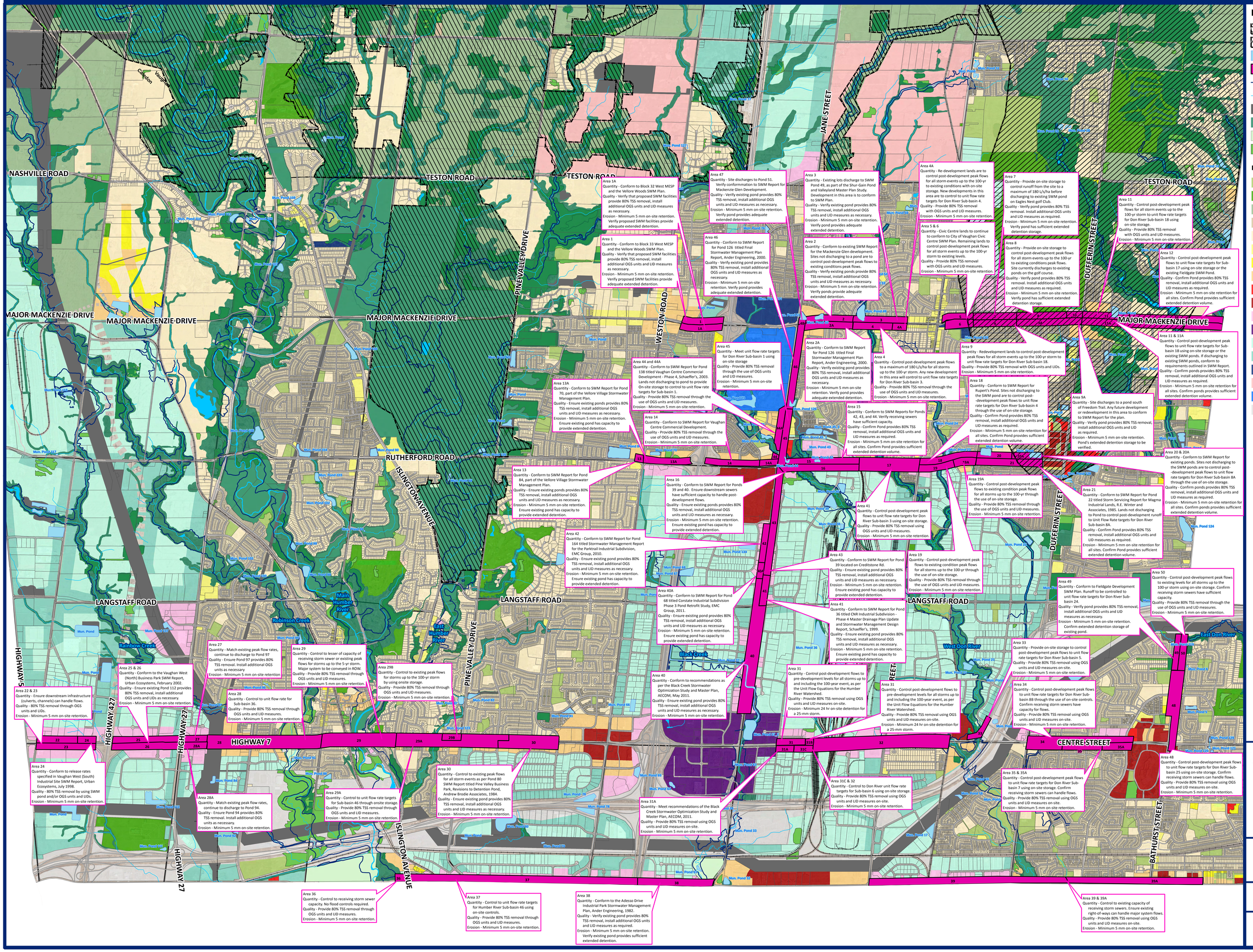
	Intensification Corridor	Do Nothing	Lot Level Controls	End-of-Pipe Controls	Lot Level with Existing SWM Infrastructure
19A	Westburne Drive – GO Railway (South Side)	○	●	◑	n/a
20	GO Railway – Peter Rupert Avenue (North Side)	○	◑	◑	●
20A	Peter Rupert Avenue – Grand Trunk Avenue (North Side)	○	◑	◑	●
21	GO Railway – Forest Run Boulevard. (South Side)	○	◑	◑	●
Highway 7					
22	Highway 50 – Highway 427 (North Side)	○	●	◑	n/a
23	Highway 50 – Highway 427 (South Side)	○	●	◑	n/a
24	251 New Enterprise Way and Northwest Corner of Highway 7 & 427	○	◑	◑	●
25	Highway 427 – Highway 27 (North Side)	○	◑	◑	●
26	Highway 427 – Highway 27 (South Side)	○	◑	◑	●
27	Highway 27 – Hydro Corridor	○	◑	◑	●
28	Hydro Corridor – Kipling Avenue (North Side)	○	●	◑	n/a
28A	Hydro Corridor – Kipling Avenue(South Side)	○	◑	◑	●
29	Kipling Avenue– Bruce Street	○	●	◑	n/a
29A	Bruce Street – Aberdeen Avenue/Marycroft Avenue	○	●	◑	n/a
29B	Sylvan Brook Avenue – Pine Valley Drive. (North Side)	○	◑	◑	●
30	Aberdeen Avenue – Ansley Grove Road. (North), Marycroft Avenue – Whitmore Road. (South)	○	◑	◑	●
31	Creditstone Road. – Costa Road. (North Side)	○	◑	◑	●
31A	Creditstone Road. – Costa Road. (South Side)	○	●	◑	n/a
31B	McCleary Court Community Environmental Centre	○	◑	◑	●
31C 32	Costa Road. – Concord Centre and Concord Centre Overpass – GO Railway	○	●	◑	n/a
33	150 m west of West Don River – Centre Street	○	●	◑	n/a

	Intensification Corridor	Do Nothing	Lot Level Controls	End-of-Pipe Controls	Lot Level with Existing SWM Infrastructure
34	Dufferin Street – Concord Road. (North Side)	○	●	◑	n/a
35	Dufferin Street – Concord Road. (South Side)	○	●	◑	n/a
Steeles Avenue West					
36	Humber River – Islington Avenue	○	●	◑	n/a
37	Islington Avenue – Highway 400	○	●	◑	n/a
38	Highway 400 – Jane Street	○	◑	◑	●
39 39A	North Side between Keele Street and Palm Gate Boulevard	○	●	◑	n/a
Jane Street					
40	Portage Parkway – north of Langstaff Road	○	◑	◑	●
40A	75 m north of Courtland Road to 350 m north of Courtland Road (West Side)	○	◑	◑	●
41	Langstaff Road – Edilcan Drive	○	◑	◑	●
42	350 m north of Courtland Road. – Locke Street	○	◑	◑	●
43	150 m north of Edilcan Drive – Rutherford Road.(East Side)	○	◑	◑	●
44, 44A	Rutherford Road – Springside Road (West)	○	◑	◑	●
45	Rutherford Road – Springside Road (East)	○	●	◑	n/a
46	Springside Road – Major Mackenzie Drive and areas north of Major Mackenzie Drive	○	◑	◑	●
47	Intersection of Jane Street and Major Mackenzie Drive	○	◑	◑	●
Bathurst Street					
48	Centre Street – Westmount Boulevard	○	●	◑	n/a
49	Westmount Boulevard – Hydro Corridor (West Side)	○	◑	◑	●
50	Westmount Boulevard – Hydro Corridor (East Side)	○	●	◑	n/a

○ ●

Least Preferred Most Preferred

Preferred SWM Strategy | Intensification Corridors



9.0 Previously Approved Secondary Plan Areas

Areas which have approved Secondary Plans and have moved forward in the development process were not evaluated in detail as part of the Master Plan. These areas are included in this report in order to provide a complete set of recommendations for anticipated development within the City. For each of the six (6) previously approved Secondary Plan Areas we have included a brief summary of the planned development and SWM criteria, as outlined in their respective OPA or Master Plan Reports

9.1. Carrville District Center Plan

The Carrville District Center Plan has been approved as OPA No. 651 February 10, 2006. This plan envisions the development of the lands at the intersection of Rutherford Road and Dufferin Street as an Urban Center, with the modification of these roads into multi-purpose urban streets. This vision includes the development or redevelopment of 57.0 ha of land surrounding this intersection into medium to high-density residential and mixed-use land uses with parks and natural areas throughout the development.

The SWM strategy for the Carrville District Center should be designed to meet requirements set out be the City and the TRCA as well as requirements from other governing agencies such as the MTO, MOE, and MNR which may have jurisdiction over the site. The current SWM criteria for this site are as follows:

- **Quantity Control**:
  - Control post-development peak flows to pre-development levels for all storms up to and including the 100-year storm (i.e. 2, 5, 10, 25, 50, and 100-year storms); and,
  - Unit flow rates for Don River Catchments 18 and 8A should be used for sites greater than 5 ha and the analysis should be completed using the 12-hour SCS storm distribution.
- **Quality Control**: All watercourses and waterbodies within the TRCA's jurisdiction are classified as requiring an Enhanced Level of Protection, which equates to 80% TSS removal;
- **Erosion Control**: As a minimum requirement the TRCA requires 5 mm on-site retention for areas which do not warrant a detailed analysis. For sites with SWM pond, extended detention of the 25 mm event for a period of 48-hours may also be required; and,
- **Water Balance**: Water balance requirements are site specific and should be determined in consultation with the TRCA.

As the Secondary Plan for this site has been approved and more detailed work may be underway it is important that any new development remain consistent with the current approved SWM plans for the Development Block.

9.2. Employment Lands, Highway 400 North (Blocks 34 and 35)

Development of the Highway 400 North Employment Lands (Blocks 34 and 35) has been approved as OPA 637, the gross developable area for these lands is approximately 771 ha. As per the requirements of the OPA No. 637 a Master Servicing / Transportation Strategy Study was prepared for these lands.

At the request of staff from the City the Study Area for this report was expanded to include lands surrounded the Highway 400 Employment Lands, which have been designated as Growth Areas. The total Study Area was thus increased to approximately 2300 ha.

The SWM strategy for these lands can be found in the Storm Drainage and SWM Section of the Highway 400 North Employment Lands Master Servicing / Transportation Strategy Study, prepared by Cole Engineering for the City, (February 2008). The site is located in both the Don River and East Humber River Watersheds, which are regulated by the TRCA. The SWM criteria specified in this report are listed bellow:

For lands within the Don River Watershed

- Hydrologic modeling should be performed using Visual OTTHYMO;
- Runoff events should be modeled using the 12-hour SCS storm distribution up to and including the 100-year storm event;
- Water quality requirement is an Enhanced Level of Protection, which equates to 80% TSS removal;
- Erosion control based on the detention of the 25 mm storm event for a minimum of 24 hours;
- Quantity control of post-development peak flow attenuation to pre-development levels is required for storms up to and including the 100-year event; and,
- Site water balance following new development shall resemble pre-development conditions to the extent possible, pre-development rate of infiltration should be maintained through one (1) or a combination of on-site measures to the extent possible.

For lands within the Humber River Watershed

- Hydrologic modeling should be performed using Visual OTTHYMO;
- Runoff events should be modeled using the 6-hour and 12-hour AES storm distribution up to and including the 100-year storm event;
- Quantity control to unit flow rates as per the West Humber River Subwatershed Study, Aquafor Beach, 1997;
- Water quality requirement is an Enhanced Level of Protection, which equates to 80% TSS removal;
- Erosion control based on the detention of the 25 mm storm event for a minimum of 24 hours;
- Quantity control of post-development peak flow attenuation to pre-development levels is required for storms up to and including the 100-year event; and,
- Manage water balance, new or improved SWM controls focusing on infiltration where feasible, green roof technologies and rainwater harvesting in areas with clay soils at surface and thick and thick aquitard layers underneath (e.g. in portions of the West Humber, Rainbow Creek, Purpleville Creek and Upper East Humber).

As the Secondary Plan for this site has been approved and more detailed work may be underway it is important that any new development remain consistent with the current approved SWM plans for the Development Block.

9.3. Steeles Corridor: Jane to Keele (OPA 620)

The Steeles Corridor Secondary Plan OPA 620 was adopted by City Council on June 26, 2006. The area encompassing OPA 620 is bounded by Steeles Avenue to the south, the CN Rail York Subdivision to the north, Jane Street to the west and Keele Street to the east. This area is anticipated to be developed with 5,000 to 5,500 residential units, and approximately 100,000-120,000m^2 of office / commercial use.

The Draft Municipal Servicing Master Plan Class EA Study OPA 620 Steeles Corridor: Jane to Keele, Vaughan, by SRM Associates, dated October, 2011 lists the SWM criteria for this site as follows:

- **Quantity Control**:
  - On-site quantity control to 180 L/s/ha for all of the OPA 620 area; and,
  - Control post-development peak flows to unit flow rates for the Humber River unit flow rates for all storms up to and including the 100-year storm (i.e. 2, 5, 10, 25, 50, and 100-year storms). The analysis should be completed using the 6-hour and 12-hour AES storm distribution.
- **Quality Control**:
  - All watercourses and waterbodies within the TRCA's jurisdiction are classified as requiring an Enhanced Level of Protection, which equates to 80% TSS removal; and,
  - Provision of an OGS (if required) for runoff directed into the BCPV lands south of Steeles Avenue.
- **Erosion control**: Extended detention of the 25 mm event for a period of 48-hours may also be required;
- **Water Balance**:
  - Provision of groundwater recharge, to the best extent possible, with the intent of matching pre-development infiltration levels;
  - On-site capture / re-use / infiltration of 15 mm of rainfall from 50% of the total developments roof areas; and,
  - On-site capture / infiltration of 7.5 mm of rainfall for the remaining roof and site area; and,
  - Provision of a roof runoff leader to provide "clean" runoff for the BCPV land south of Steeles Avenue.

As the Secondary Plan for this site has been approved and more detailed work may be underway it is important that any new development remain consistent with the current approved Servicing Strategy Master Plan and any other SWM reports for this area.

9.4. Block 40 / 47

The development of Blocks 40 and 47 must be in accordance with the City's OPA No. 400. Subsequently the lands in the northern portion have been separately designated under OPA 600. The planning objective for this area consists predominantly of executive homes interspersed with parks, pond blocks and commercial developments.

The Master Environmental / Servicing Plan Blocks 40 / 47 - Pine Valley Drive / Teston Road, City, by EMC Group Ltd., dated December, 2010, includes a SWM plan designed to meet the following criteria:

- **Quantity Control**: Control post-development peak flows to unit flow rates for the Humber River unit flow rates for all storms up to and including the 100-year storm (i.e. 2, 5, 10, 25, 50, and 100-year storms). The analysis should be completed using the 6-hour and 12-hour AES storm distribution;
- **Quality Control**: All watercourses and waterbodies within the TRCA's jurisdiction are classified as requiring an Enhanced Level of Protection, which equates to 80% TSS removal:
  - As the receiving watercourse is classified as a cold water fish habitat temperature mitigation will be required.
- **Erosion control**: On-site capture / re-use / infiltration of 5 mm of rainfall and extended detention of the 25 mm event for a period of 48-hours may also be required; and,
- **Water Balance**: Provision of groundwater recharge, through the use of LID practices, with the intent of matching pre-development infiltration levels to the best extent possible.

As the Secondary Plan for this site has been approved and more detailed work may be underway it is important that any new development remain consistent with the current approved Servicing Strategy Master Plan and any other SWM reports for this area.

9.5. Kipling Avenue

Properties fronting Kipling Avenue between Ellerby Square and Langstaff Road, as well as the Woodbridge Agricultural Fairgrounds (est of Kipling Avenue), and industrial lands (on the west side of Kipling Avenue). The proposed land used is primarily residential, with some commercial, institutional, parks, and the fair grounds. Development in this area is regulated by OPA 695, the SWM criteria can be summarised as follows:

- **General**: Meet the requirements for the TRCA guidelines on erosion and sediment control, 2006;
- **Quantity Control**: No quantity control is required as the site is tributary to the Main Humber River. Proponent must verify the capacity of the downstream pipes and overland flow routes from the site to the River;
- **Quality Control**: All watercourses and waterbodies within the TRCA's jurisdiction are classified as requiring an Enhanced Level of Protection, which equates to 80% TSS removal;
- **Erosion Control**: Proponents should contact the TRCA for erosion control criteria for this site; and,
- **Water Balance**: Proponents should contact the TRCA for water balance requirements for this site.

As the Secondary Plan for this site has been approved and more detailed work may be underway it is important that any new development remain consistent with the current approved Servicing Strategy Master Plan and any other SWM reports for this area.

9.6. Block 61 West

Block 61 West is located in the southwest corner of the Kleinburg-Nashville Community Plan (OPA 601) and is bounded by the Kleinburg-Nashville Heritage District to the north, a CP Rail Line to the east, Major Mackenzie Drive to the south and, Huntington Road to the west. The site is to be developed as primarily residential lands with parks, schools, community centers, commercial sites, SWM ponds, valley lands and woodlots.

The Nashville Heights Master Environmental and Servicing Plan, by Schaeffers Consulting Engineers, December 2009, describes the planned development and servicing strategy for this site. SWM for this site must meet the following criteria:

- **Quantity Control:**
  - Control post-development peak flows to unit flow rates for the Humber River unit flow rates for all storms up to and including the 100-year storm (i.e. 2, 5, 10, 25, 50, and 100-year storms). The analysis should be completed using the 6-hour and 12-hour AES storm distribution; and,
  - It has been agreed upon with the TRCA that additional storage will be provided for events larger than the 100-year storm, this storage will be provided as dry ponds adjacent to the proposed wet ponds.
- **Quality Control**: All watercourses and waterbodies within the TRCA's jurisdiction are classified as requiring an Enhanced Level of Protection, which equates to 80% TSS removal;
- **Erosion Mitigation**: An erosion detention volume will be based on the 25 mm rainfall event released over a 48-hour period, or a recommendation from a geomorphic / erosion threshold study; and,
- **Water Balance**: The volume and aerial distribution of recharge over the site should be maintained to closely match existing conditions.

10.0 Public Consultation

In order to fulfill the requirements of a Municipal Class EA, several opportunities were given to general public, residents, agencies, and interested stakeholders for learning, sharing and responding to the project. The Municipal Class EA requires the Proponent to undertake two (2) mandatory points of public contact during Phase 2 (Alternative Solutions). The Project Team has exceeded the mandatory number of public contacts, with the following opportunities for comment provided:

- Notice of Commencement;
- Notice of Public Information Centre #1;
- Public Information Centre;
- Notice of Public Information Centre #2;
- Public Information Centre #2;
- Notice of Completion; and,
- Materials relating to the EA process are provided in Appendix C.

10.1.1. Notice of Commencement

The Notice of Commencement was prepared and distributed to stakeholders and review agencies on September 15, 2011. The notice was also posted on the project website (www.vaughaninfrastructure.ca) as well as the local newspapers, "The Liberal" and "The Citizen". The notice informs stakeholders of the SWMMP being initiated in the City and the Study Area that may be affected. The notice provides background information including the purpose, objectives and process. It also notifies the public about the consultation process and gives locations of where further information can be found. Furthermore, the contact information for the City's Project Manager was made available to the public to engage any initial feedback on the project.

A copy of the Notice of Commencement is provided in **Appendix C-1**.

10.1.2. Notice of Public Information Centre #1

The Notice of Public Information Centre (PIC) #1 and a Project Information Sheet was prepared and distributed to stakeholders and review agencies on September 29, 2011. The notice was also posted on the project website (www.vaughaninfrastructure.ca) as well as the local newspapers, "The Liberal" and "The Citizen". A copy of the Notice of PIC #1 and Project Information sheet are available in **Appendix C-2**. The notice provided a description of the MPEA process, details of the PIC, and included a request for comments and input. The Project Information Sheet provided a brief description of the project, the Study Area and timing of the project, study objectives, and described the public and agency participation process. Contact information was provided for the City's Project Manager to encourage the submission of comments.

10.1.3. Public Information Centre #1

The first of two (2) PICs was held on October 13, 2011. It was attended by 16 people consisting of City staff, developers, planners, consultants, and the general public. The Project Team, including representatives from the Study Team and the City, attended to answer any questions that participants had.

The major elements presented at the first PIC included:

- Overview of the Class Environmental Assessment Process;
- Background Information;
- Study Objectives; and,
- Problem / Opportunity Statements.

The display panels presented at the PIC can be found in **Appendix C-3**. The PIC sign-in sheet and comment form can also be found in **Appendix C-3**. It is noted that no comments were received as a result of PIC #1.

10.1.4. Notice of Public Information Centre #2

The Notice for PIC #2 was prepared and distributed to stakeholders and review agencies on June 7, 2012. The notice was also posted on the project website (www.vaughaninfrastructure.ca) as well as the local newspapers, "The Liberal" and "The Citizen".

A copy of the Notice of PIC #2 is available in **Appendix C-4**. The notice provided a description of the MPEA process, details of the PIC, and included a request for comments and input. The Project Information Sheet provided a brief description of the project, the Study Area and timing of the project, study objectives and described the public and agency participation process. Contact information was provided for the City's Project Manager to encourage the submission of comments.

10.1.5. Public Information Centre #2

The second of two (2) PICs was held on June 27, 2012. It was attended by 15 people consisting of City staff, developers, planners, consultants, and the general public.

The Project Team, including representatives from the Study Team and the City, attended to answer any questions that participants had.

The major elements presented at the second PIC included:

- Overview of the Class Environmental Assessment Process;
- Background Information;
- Water and Wastewater;
- Population Growth Summary;
- Alternative Solutions;
- Evaluation Criteria;
- Design Criteria;
- Preferred Alternative;
- Timing and Costs;
- Storm Drainage / SWM;
- Existing Conditions and Constraints;
- Alternative Solutions;
- Evaluation Criteria;
- Design Criteria;
- Preferred Alternative;
- Future Growth Considerations; and,
- Rainbow Creek Subwatershed Update.

The display panels presented at the PIC can be found in **Appendix C-5**. The PIC sign-in sheet and comment form are also located in **Appendix C-5**. It is noted that no comments were received as a result of the PIC.

10.1.6. Notice of Completion

The Notice of Completion can be found under **Appendix C-7**.

10.2. Technical Advisory Committee

A Technical Advisory Committee (TAC) was assembled for the project which included members from various City departments, Regional Staff and representatives from the TRCA. The purpose of the TAC is to engage all interested public stakeholders in the project and consider any items that should be considered in the project prior to presenting the information to the public.

The first of two (2) TAC meetings was held on September 27, 2011 at the City's Offices. The meeting was scheduled just prior to PIC #1 so that any comments, suggestions or recommendations raised by the TAC could be implemented prior to presenting the project information to the public.

The presentation and the meeting minutes which provide preliminary comments on the Master Plan EA, which can be found in **Appendix D** with key points as they related to the SWM MP, are summarized below:

- The TRCA has a number of on-going initiatives within their jurisdiction which may have an impact on the study and a meeting to discuss these initiatives will be scheduled. The TRCA wants to be seen as a facilitator of (rather than a barrier to) approvals ; and,
- Representatives from York Region's planning department should be included in the TAC.

The second of two (2) TAC meetings was held on September 6, 2012 at the City's Offices. The meeting was scheduled just prior to PIC #2 so that any comments, suggestions or recommendations raised by the TAC could be implemented prior to presenting the project information to the public.

The presentation of the Master Plan EA can be found in **Appendix D**. The key point, as related to the SWM MP, is that the TRCA has a number of on-going initiatives within their jurisdiction which may have an impact on the study and a meeting to discuss these initiatives will be scheduled. The TRCA wants to be seen as a facilitator of (rather than a barrier to) approvals.

10.3. Consultation with TRCA

An initial meeting was held with staff of the TRCA on November 7, 2011. The purpose of this meeting was to determine if any of the current initiatives that are being undertaken by the TRCA will potentially have an impact on the SWM MP.

The main item raised at this meeting was a study being undertaken by the TRCA entitled "Hydrologic Study of Impacts on Flood Flows and Mitigation of Future Development in the Humber River Watershed". The original project description suggested that the MPEA should be closely co-ordinated with this study.

10.4. Consultation with the Ministry of the Environment

The Ministry of Environment was included on the stakeholder list as part of the Master Plan studies and received notification of commencement and PIC #1, PIC #2 and notice of completion.

In response to the notice of commencement for the study, an email date October 19 was received by the study team which requested that the MOE be contacted to discuss the Master Plan projects.

Through discussions held on October 20th 2011, it was requested by the MOE that they be included on the TAC in order to determine the relationship / interaction between the current municipal urban water Master Plan studies and other environmental assessments occurring across York Region.

The MOE wished to have representation on the TAC to determine the relationship between all the environmental assessments occurring in various municipalities throughout York Region.

11.0 Design Criteria Considerations

A review of the City's current SWM criteria was performed to determine where potential improvements could be made to help the City better manage stormwater in order to support future growth and development. The goal is to provide and maintain acceptable levels of service and flood protection throughout the City.

11.1. Existing Stormwater Management Criteria

A review of the TRCA's existing storm drainage and SWM criteria / standards were undertaken as part of the scope of this study. The TRCA's current SWM criteria for watercourses within the City is as follows:

- **Water Quantity Control:** Post-development peak flow rates will be controlled to pre-development peak flow rates for all storms up to and including 100-year storm event, as per Unit Flow Equations prescribed for the Humber River and Don River Watershed;
- **Water Quality Control:** Enhanced Level Protection (80% TSS removal);
- Erosion: A minimum of 5 mm of rainfall must be retained onsite for all areas. Additionally, for areas serviced by a SWM pond, at a minimum, runoff from a 25 mm storm must be detained for at least 24-hours for site area less than 5 ha and 48-hours for sites greater than 5 ha;
- **Water Balance:** Efforts should be made to maintain the pre-development water balance. Detailed water budget analysis are required at the block plan stage. The TRCA should be consulted to confirm water balance requirements specific to each site; and,
- **Storm Distributions:** The 6-hour and 12-hour AES storm distributions were used for the analysis within the Humber Watershed and the 12-hour SCS storm distribution was used for the analysis within the Don Watershed.

11.2. Proposed Stormwater Management Criteria

The existing SWM criteria were applied to the proposed development areas to determine the impacts. Considerations for improvement to the existing criteria included the potential to limit flooding, lower capital and maintenance costs, availability of land and environmental protection.

Quantity

Considerations for quantity control criteria for the proposed developments within the City were based on the City, TRCA and the MOE design criteria for SWM facilities. The quantity control requirements that were considered as part of this study included:

- Post-development peak flows for all events from the site should be controlled to the peak flow resulting from the pre-development (Greenfield) conditions;
- Post-development peak flows for all events from the site should be controlled to the peak flow resulting from the existing conditions;
- Post-development peak flows for all storm events must not exceed the existing peak flow rate for the 5-year frequency storm event based on the receiving capacity of the downstream storm sewer infrastructure as well as reported flooding;
- Post-development peak flows for all storm events from the site should be controlled to the pre-development peak flow rates as per Unit Flow Equations prescribed for the Humber and Don River Watersheds; and,
- Post-development peak flows for all events from the site do not require quantity control measures as prescribed for certain sub-basins in the Humber River Watershed.

Quality:

- Stormwater should be treated to Enhanced Protection (Level 1) as defined in the MOE SWM Planning & Design Manual (2003).

Erosion:

- Runoff volume from the 25 mm, 4-hour Chicago Design Storm is to be detained on site for a minimum of 24, 48 and 72-hours;
- Retention of the first 5 mm of each rainfall event on site for reuse and/or infiltration;
- Retention of the first 10 mm of each rainfall event on site for reuse and/or infiltration; and,
- Runoff volume from the 25 mm, 4-hour Chicago Design Storm is to be detained on site for a minimum of 24-hours and runoff from a small design event (5 mm) should be retained on site for reuse and/or infiltration.

Water Balance:

- Stormwater is to be retained on-site, to the extent practical, in order to achieve the same level of annual volume of overland runoff from the site as under existing conditions; and,
- Stormwater is to be infiltrated to the extent practical, in order to achieve the same annual volume of infiltration on the site as under existing conditions.

The impacts to the proposed development areas based on the evaluation criteria as previously described were considered when determining the preferred design criteria. The justification for the design criteria selected for the servicing strategy for each individual area is further explained in the evaluation of each alternative.

A summary of the criteria used to provide SWM for each specific Study Area is presented in **Table 11.1**.

Table 11.1 – Summary of Design Criteria for Secondary Plan Areas

Study Area	Quantity Control	Quality Control	Water Balance / Erosion
Yonge-Steeles	Post to existing	Enhanced protection (Level 1)	Post – Pre
Woodbridge Core	Post to 5 year existing		Post – Pre
West Vaughan Employment Area	Post to unit flow rate		5 mm on-site retention
Kleinburg-Nashville	No controls required for sites discharging directly to the East or Main branch of the Humber River. Post to unit flow rates for other sites.		5 mm on-site retention for all sites. Sites discharging to SWM Ponds may require extended detention for the 25 mm event over a period of 24 – 48 hours.

The preferred design criteria as outlined above in **Table 11.1**, has considered both traditional SWM in the form of end-of-pipe SWMF as well as LID practices where feasible. The existing criteria through the City, TRCA, and MOE have been considered for all future development and are considered appropriate. As such, it was determined that no changes need to be made to the City's Design Criteria.

Throughout the Greater Toronto Area there is an increasing recognition that LID practices, many of which are outlined in **Section 5.2.2**, can in fact help alleviate the impacts of increased stormwater runoff, stormwater pollution and can help improve the hydrological cycle by promoting infiltration and on-site retention through water reuse systems and a number of other techniques.

The TRCAs LID Planning and Design Guide (LID Guide) outlines a number of different techniques to help mitigate the increase in storm water runoff.

TRCA will recognize the water quality benefits of LID measures only if they are located on public property or if there are protocols in place which ensure the long term maintenance and operations on private property (i.e. legal agreements, bylaws).

The LID manual recommends a landscape-based approach to planning. This involves a high level understanding of Regional / Watershed based studies, management objectives and targets relevant to the specific Study Area. If a specific watershed plan is not available, a subwatershed assessment may be warranted to establish a regional environmental context. Specific LID measures which have been prescribed on a subwatershed level, or in this case, a City-Wide Master Plan context, should be refined at later stages in the planning and design process. Environmental impact assessments, geotechnical assessments, hydro-geological studies, fluvial geomorphology studies etc., will be used as a framework for SWM system planning.

12.0 Recommendations for Long Term Infrastructure Operation and Maintenance

Existing City standards require a submission of a SWM Operations and Maintenance Report for all proposed SWMF. The report is required to address:

- Procedure for draining forebay during maintenance;
- Sediment removal technique from facility;
- Forebay diversion plan during maintenance;
- Annual loading rate and sediment accumulation;
- Frequency of sediment cleanout;
- Inspection procedures and frequency of inspection; and,
- Description of pond features and how the pond operates under various storm events.

There is an opportunity to add to the scope of the required Operations and Maintenance Report. Recommended additions include:

- Management of safety hazards – drowning, contamination, noxious weed growth, West Nile Virus, odour management, etc;
- Landscape maintenance – specify required landscaping and maintenance activities required, either seasonally or regularly (e.g. grass mowing, snow ploughing);
- Inspection frequency – specify minimum frequency of a complete facility inspection, including the inspection of all hydraulic structures, as annual;
- Inspection records management – specify that every inspection be continuously updated in the centralized SWMSoft database to prioritize repairs;
- Scheduled maintenance needs – identify the need for the use of specialized maintenance equipments;
- Seasonal preparation – identify any special precautionary measures necessary to protect the facility prior to each season; and,
- As the TRCA's requirements have evolved to require more at source protection through the use of LIDs the City may become responsible for the maintenance and operation of LIDs located in public spaces. The operation and maintenance requirements currently in place should be expanded to include care for LIDs that are to be acquired by the City. As the characteristics and requirements of various creeks can greatly vary, it is recommended that specific monitoring guidelines for each pond be developed in cooperation with the TRCA. Monitoring requirements are further addressed in **Section 13.0**.

13.0 Monitoring Requirements

It is recommended that the City undertake a City-wide monitoring program in conjunction with the TRCA's existing monitoring program. This program would allow the City to gage the performance of its SWM infrastructure and the TRCA to assess the health of its watercourses using the shared network of monitoring stations.

At a minimum, the shared monitoring program would have to ability to confirm that SWM facilities along specific watercourses are performing as designed. As such, monitoring stations are recommended to be placed at strategic locations along watercourses within the City. These stations would measure stream flows and sediment levels in the watercourses. Additional monitoring could include water temperature and phosphorus loads where required. As TRCA's policies continue to evolve, having a shared monitoring network will also benefit both parties by providing up to date information on the state of the City's watercourses. Implementation of this type of monitoring program will alert the City of any potential problems and can be used in the future to adjust both the City's and the TRCA's SWM criteria.

14.0 Rainbow Creek Subwatershed Update

As part of the SWM / Drainage Master Plan, an update to the Rainbow Creek Subwatershed Study was undertaken to determine and help mitigate potential flooding and erosion impacts within the sub-watershed as a result of the proposed development. The subwatershed Update study has investigated the impacts of future proposed (2031 development horizon) and potential development (2051 development horizon) within the watershed and proposes SWM criteria in an effort to mitigate potential flooding and erosion impacts associated with future development. The detailed study is included as **Volume III** of this Master Plan study.

15.0 2051 Ultimate Build-out

The 2051 planning horizon will see the growth of the urban boundary mainly into Blocks 28, 42, 49, 56, 66, 67, 68, and 69. It is expected that the Blocks on the west side of the City (Blocks 66-69) will be developed to employment lands to complement the proposed employment lands in WVEA. Remaining new developments are expected to be a mix of employment, residential, and commercial lands.

Watershed and subwatershed updates by the TRCA may cause SWM requirements from the TRCA, MOE, and the City to change and evolve over time. As such, proposed future developments in these areas must continue to meet all of the most up-to-date SWM requirements regarding quantity control, quality control, erosion control, and water balance. Developments must also respect existing drainage patterns and provide best efforts during the block plan stages to maintain them.

16.0 Outreach Programs

It should be noted that SWM could be more effective with the addition of a public education program. A program should focus on informing residents and businesses about the use of BMPsand low-impact development measures.

The TRCA is committed to continuing community and public outreach to engage communities and encourage their participation in developing the future implementation plans. The TRCA currently runs a number of workshops and other outreach programs that the City could use as a foundation for a public education program.

The City can also model programs after those of The Region of York, such as their Water for Tomorrow Website or their Rain Barrel program to assist homeowners in reusing stormwater in their gardens.

17.0 Climate Change Adaptations

With rising global temperatures, weather patterns are expected to become more unpredictable and extreme weather events could take place at a higher frequency. As such, SWM criteria must evolve and adapt to the changing climate in order to provide adequate protection to public and private properties in large storm events.

The most disruptive storm event in recent history took place on August 19, 2005. The storm was very destructive as it had continuous downpour for several hours, followed by a very high intensity storm over approximately a one-hour period. Many parts of the City received over 100 mm of rainfall during this 1-hour period. A smaller storm follows shortly after.

The event caused flooding in many places around City and caused significant amount of damage to public infrastructure and private properties. The storm demonstrates the need to analyse the current design criteria in place, as large storms like the August 19, 2005 storm could become more commonplace due to climate change. If deemed necessary, modifications to the design criteria would be recommended to ensure that damage to private properties will be minimized for any future events.

The City has determined the August 19, 2005 storm as the baseline storm event for which impacts of climate change will be analysed for. The peak flows from the August 19, 2005 storm will be compared with the 100-year return frequency storm to determine if modifications to the design criteria are necessary.

The storm was used as input into the same post-development hydrologic model for Woodbridge. Catchments 4418 and 4422 were analyzed to determine the impact of the storm on a typical low-density residential neighbourhood, while Catchments 4407 and 4414 were analyzed to determine the impact on a mixed-commercial neighbourhood. The results are outlined below in **Table 17.1**.

Table 17.1 – August 19, 2005 Storm and 100-Year City IDF Peak Flows

Storm Event	Rain Gauge	Catchment Peak Flows (m^3/s)			
		4407a +4407b	4414a +4414b	4418	4422
100-year City IDF		2.65*	1.86*	0.95*	2.97*
August 19, 2005 Storm	Boyd Field Centre	2.04	1.50	0.98	2.95
	Claireville Dam	1.99	1.40	0.77	2.36
	Dufferin Reservoir	2.80**	2.13**	1.28	3.85
	Emery Yard	0.76	0.57	0.22	0.42
	Humber	2.43	1.76	1.12	3.43
	Maple	1.56	1.12	0.77	2.37
	Richvale	2.12	1.57	1.07	3.22
	Vellore Woods	2.12	1.57	1.07	3.22
	York Pumping Station	0.41	0.29	0.14	0.35
	York University	2.57	1.99	1.65**	4.62**

* denotes baseline condition (current major system conveyance design storm)
** denotes highest peak flow

The hyetograph obtained at Dufferin Reservoir and York University consistently produced higher peak flows than the current 100-year City IDF design storm. The storm observed at Dufferin Reservoir produced higher peak flows for commercial areas, whereas the York University storm produced significantly higher peak flows for residential areas. Most other hyetographs do not exceed the City's 100-year IDF storm.

It can be seen that the August 19, 2005 storm can produce higher peak flows than the 100-year City IDF storm. Typical cross sections of public right-of-ways were analysed to determine if they have additional capacity to accommodate for the higher peak flows. The City's SWM Design Criteria defines maximum ponding depths for major system flow conveyance on road right-of-ways for the 100-year storm. The maximum ponding depth allowed is 0.20 m above the crown of road for local roads, 0.10 m above the crown for collector and industrial roads, and crown of the road for arterial roads.

Flow areas from standard right-of-way cross sections were calculated and analysed to see how much more additional flows can be accommodated without affecting private properties. **Table 17.2** below summarizes the findings.

Table 17.2 – Additional Available Flow Areas in Public Right-of-Ways

Existing Standards				Additional Capacity Without Impacting Private Properties		
Standard City Cross Section	Description	Allowable Ponding Depth Above Crown of Road (m)	Available Flow Area (m^2)	Maximum Ponding Depth Above Crown of Road (m)	Additional Depth of Ponding Available (m)	Additional Available Flow Area Without Impacting Private Properties (m^2)
B8	**Major Collector Road** (26 m ROW, 14m Pavement)	0.10	**2.79**	0.13	0.03	**0.74**
B9	**Minor Collector Road** with 3 m Greenway (26m ROW, 11.5 m Pavement)	0.10	**2.02**	0.15	0.05	**1.03**
B10	**Minor Collector Road** (23 m ROW, 11.5 m Pavement)	0.10	**2.02**	0.15	0.05	**1.03**
B11	**Major Local Road** (20 m ROW, 9 m Pavement)	0.20	**2.54**	**No additional capacity available.**		
B12	**Local Road** (17.5 m ROW, 8 m Pavement)	0.20	**1.84**			

Results of the analysis show that collector roads designed to the City's current standards can accommodate additional ponding within the right-of-ways without affecting private property. However, there is no additional capacity available in right-of-ways for local roads.

17.1. Recommendations

As weather patterns become more unpredictable due to climate change, it is recommended that the City undertake a more detailed analysis of its existing SWM standards. The study should look into existing right-of-way geometry standards and pipe sizing requirements, and provide recommendations based on their ability to convey flows from the August 19, 2005 storm. As shown above, some existing right of ways that are designed based on the 100-year ponding depths may not be able to convey any additional flows. It is recommended that the City conduct this review of its existing SWM standards in order to mitigate damage to private properties as a result of climate change in the future.

18.0 Development Charges Implications and Recommended Future Studies

A previous Development Charges (DC) Report was prepared in 2008 by Hemson Consulting Limited entitled *Development Charges Background Study – City*. The study identified various services which were subject to development charges, including: General Government, Library, Fire and Rescue, Indoor Recreation, Park Development and Facilities, Public Works Buildings and Fleet, City-Wide Engineering (including roads and associated structures, sidewalks, streetlights, streetscaping and intersections), Water, and Wastewater and Storm Drainage.

As part of this study, preliminary cost estimates for new or improvements to existing infrastructure to support the City's Development Charges (DC) Update and Background Study have been developed.

18.1. Studies Subject to Development Charges

Although, it is anticipated that all capital costs associated with SWM infrastructure for the preferred SWM strategy for all future developments considered in this study will be borne by the development community and not the City, it is recommended that the City undertake additional studies to determine other potential short term and long term impacts of proposed development on the City's existing drainage infrastructure projects. It is recommended that these studies are included in the City's DC update.

Studies which may be subject to development charges are described below:

18.1.1. Black Creek Optimization Study

Over the years, much of the development within the Black Creek Watershed has occurred prior to the implementation of SWM practices. The lack of at source, conveyance, and end-of-pipe SWM controls has led to an increase in flooding within the watershed, poor water quality, and accelerated channel erosion. The City had undertaken the Black Creek Optimization Study to address SWM related issues within the watershed. The study recommended the following preferred alternatives for SWM:

- **Flood Improvements**: The recommended works include the construction of a new naturalized channel in order to convey the runoff generated from the Regional Storm without flooding adjacent properties. The new channel replaces the existing segment of Black Creek between Peelar Road and Edgeley Pond, with bridges at all road crossings;

- **Water Quality Improvements**: Retrofit of existing ponds and construction of at least two (2) new SWM ponds; and,
- **Erosion Improvements**: A combination of in-stream restoration measures to address localized erosion.

The total costs of preferred recommendation solution which incorporates Flood Improvement Alternatives, Water Quality Improvement Alternatives and Channel Erosion Improvement Alternatives is approximately $24,750,000.

18.1.2. Steeles Corridor Servicing Strategy Master Plan

The Steeles Corridor Secondary Plan OPA 620 was adopted by City Council on June 26, 2006. It is expected that the Study Area will house approximately 10,000 – 11,000 people and employ approximately 4,000 – 5,000 people.

The preferred SWM strategy for the proposed development area consists of a new quality / quantity control facility, a retrofit quality / quantity control facility, and a new quantity (dry pond) facility. The facility which is subject to a retrofit should be subject to a DC as it will be used to service future development. The ultimate required size of the pond to be retrofitted is approximately 13,000 m^3.

It is anticipated that the cost associated with pond retrofit will be in the order of $1,500,000 – $2,000,000.

18.2. Future Studies Subject to Development Charges

It is recommended that the City undertake additional studies to determine other potential DC eligible drainage infrastructure projects. These studies may include but are not limited to the following studies:

18.2.1. City-Wide Erosion Assessment Studies

As development has the potential to increase erosion on a given watercourse or tributary over time, it is recommended that a City-Wide Erosion Study be conducted to identify existing erosion sites and determine the potential long term effects of development on downstream erosion. Anticipated costs associated with a City-Wide Erosion Assessment Study is approximately $600,000.

18.2.2. City-Wide Flooding Studies

A total of 20 drainage concern site were identified from reported flooding during the August 19, 2005 event. The City-Wide Drainage and SWM Criteria Study conducted in 2009 identified potential causes of flooding at each of these locations.

The City is currently undertaking the second phase of this drainage study and focusing on seven (7) of the 20 previously identified flood vulnerable areas. A detailed hydraulic assessment of the flood vulnerable areas is being used to determine the current level of service for a given location. From the analysis, flood mitigation measures through implementation of lot level, conveyance, and storage alternatives will be recommended. Of the remaining 13 flood vulnerable areas, six (6) are located within or downstream of Secondary Plan Areas and intensification corridors.

It is recommended that similar drainage studies to the one that is currently being undertaken be conducted to determine the level of service of these areas and provide mitigation recommendations. Furthermore, it should be determined if flooding in these areas will in fact become worse as a result of development upstream. The hydraulic analysis required for the areas mentioned above could be subject to a DC as development upstream may have an effect on existing infrastructure downstream.

Anticipated costs associated with a City-wide flooding studies is approximately $600,000.

18.2.3. City-Wide Storm Sewer Network Hydraulic Study

A hydraulic assessment of the existing stormwater network should be conducted in order to determine the system's existing capacity and identify areas that are currently not meeting City's criteria. Although it is likely that proposed development within the City will manage stormwater through on-site controls, there may be long term impacts downstream of a proposed development, for which it is important that accurate storm sewer network data is representative of existing field conditions.

Anticipated costs associated with a City-wide storm sewer network hydraulic study is approximately $500,000.

18.2.4. Flood Remediation Environmental Assessment (Rainbow Creek)

Through the updated Master Drainage Plan for Rainbow Creek, **Volume III** of this report, additional areas flood vulnerable areas have been identified beyond the existing areas that have previously been identified as vulnerable to flooding. Within the areas identified as flood vulnerable, the study has made specific recommendations for sites where more study is need to assess the extent and potential risk from flooding. Through the process of a Flood Remediation Environmental Assessment, specific recommendations could be made as to the preferred flood remediation plan, and preliminary design to remediate flooding concerns and risk.