Table 6.1 100-Year Flows along Cooksville Creek at Selected Locations (EWRG, 2002)

Location	Flow (m3/s)
Matheson Ave. West	80
Bristol Road West	95
Eglinton Ave. West	95
Highway 403	115
Mississauga Valley Road	180
Central Parkway East	195
CPR	210
Dundas Street East	210
Queensway Ave. East	210
QEW	210
Lakeshore Ave.	210
East Branch	
Eglinton Ave. East	40
Highway 403	60

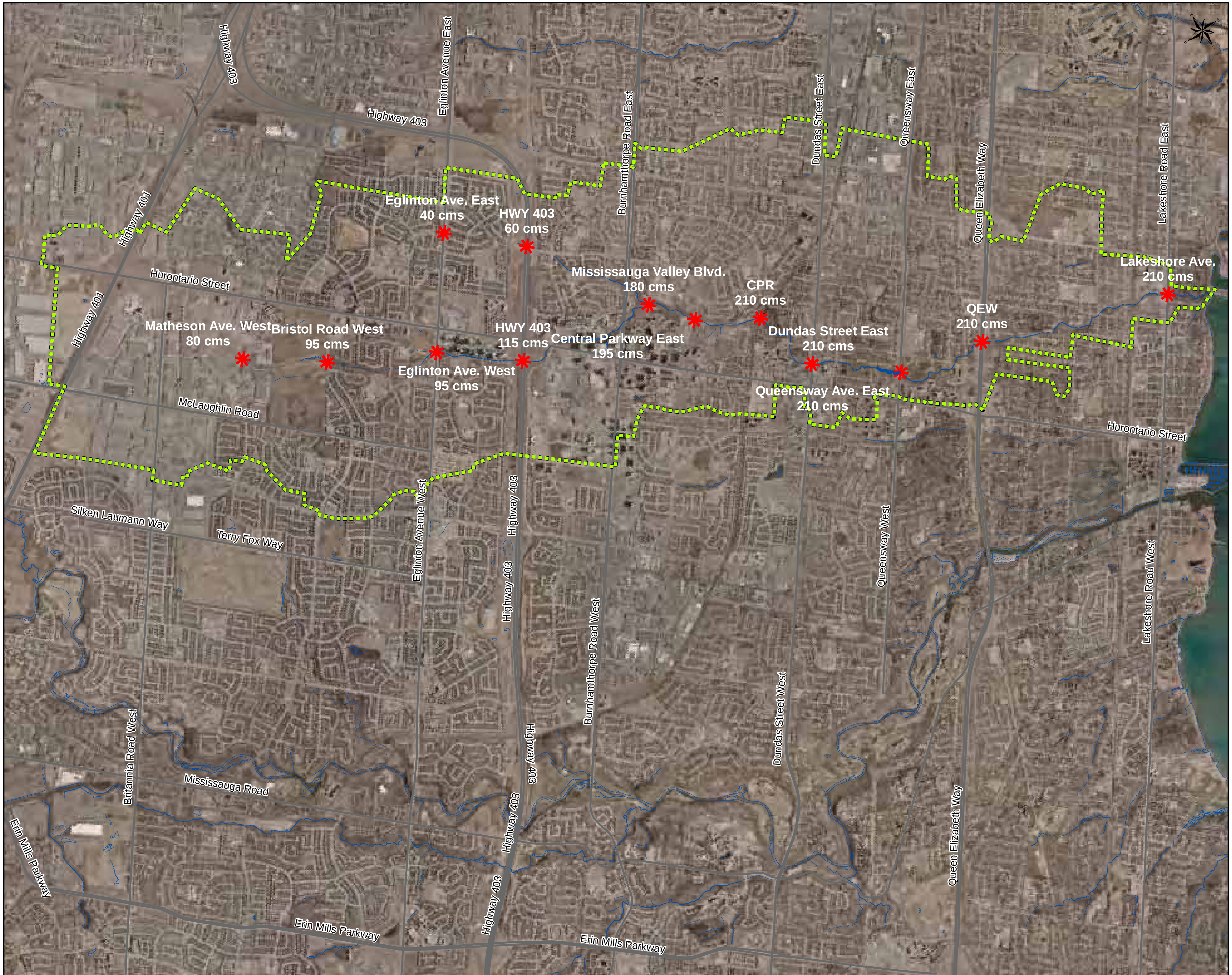
In order to mitigate actual and potential flood damages for the Regulatory storm along Cooksville Creek, EWRG (2002) identified and proposed a long list of alternatives that included:

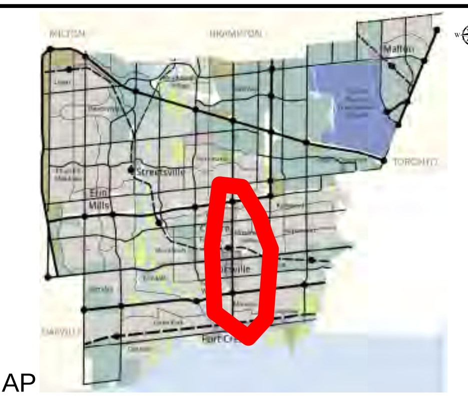
- Crossing capacity upgrade
- Watercourse capacity upgrade
- Dykes/Berms
- Reservoirs
- Building flood proofing
- Diversions

Responding to potential and actual flood damages along Cooksville Creek and to the recommendations of previous flood studies, the City of Mississauga and the CVC have constructed flood control measures to increase the level of flood protection. Historical records show that various remedial works have taken place to reduce flooding since the mid eighties.

Records also show that works to reduce flooding south of Hwy 403 have included upgrading of watercourse crossings at Lakeshore Road, Atwater Avenue, Kirwin Drive, and Camilla Road.

Recent experiences with flooding along Cooksville Creek, especially following the flooding that took place following the August 4th 2009 event (approximately 100-year storm) has led the City of Mississauga and CVC to look for new flood mitigation options that include traditional measures such as previously proposed measures (EWRG, 2002) in addition to innovative solutions that address flooding issues and other environmental concerns at the watershed scale. In the following sections, a recommended plan to address flooding issues along Cooksville Creek is illustrated.





KEY MAP

LEGEND:

Subwatershed Boundary

Streams

100Yr Flow Node Location

NOTES:

Base Mapping was provided by City of Mississauga

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100-Year Flows Along Cooksville Creek - Existing Conditions

FIGURE No. 6.1

DATE: May 2012

Table 6.2 Road / Rail Crossing Potential Flooding Summary (EWRG, 2002)

Location	Regional	100	50	25	10	5	2	Crossing capacity without overtopping (m^3/s)	Crossing capacity without building flooding (m^3/s)	Regulatory overtopping depth (m)
Lakeshore Road East	Overtops	Overtops	Overtops	-	-	-	-	200	160	0.7
Private access	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	< 75	210	2.2
CNR	Bypass	-	-	-	-	-	-	270	130	0.8
Atwater Avenue	Overtops	Bypass	Bypass	Bypass	Bypass	-	-	120	210	1.9
Queen Elizabeth Way	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	-	110	100	1.0
Camilla Road	Overtops	Overtops	Overtops	Overtops	Overtops	-	-	135	135	1.2
Queensway East	-	-	-	-	-	-	-	> 290	140	-
Paisley Boulevard East	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	75	75	1.2
King Street East	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	< 70	120	2.1
Dundas Street East	Overtops	Overtops	Overtops	Bypass	-	-	-	160	< 70	1.6
Kirwin Avenue	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	< 70	< 70	1.6
CPR	-	-	-	-	-	-	-	160	125	-
Mississauga Valley	Overtops	Overtops	Overtops	Overtops				< 70	100	1.1
Central Parkway East	-	-	-	-	-	-	-	> 250	> 240	-
Mississauga Valley	-	-	-	-	-	-	-	125	> 220	-
Burnhamthorpe Road	-	-	-	-	-	-	-	195	> 145	-
Robert Speck Parkway	-	-	-	-	-	-	-	> 220	> 145	-
Hurontario Street –Ramp	-	-	-	-	-	-	-	> 145	> 145	-
Hurontario Street	Bypass	-	-	-	-	-	-	115	115	0.3
Highway 403	Overtops	-	-	-	-	-	-	115	> 140	0.5
Private access	Overtops	Overtops	Overtops	Overtops	Overtops	Overtops	-	45	> 120	2.3
East Branch										
Burnhamthorpe Road	Overtops	Overtops	Overtops	Overtops	-	-	-	40	> 65	1.2
Meadows Boulevard	Overtops	Overtops	Overtops	Overtops	-	-	-	40	40	0.8
Rathburn Road East	Bypass	Bypass	Bypass	-	-	-	-	45	> 60	0.7
Central Parkway East	-	-	-	-	-	-	-	> 50	> 50	-
Bud Gregory Boulevard	-	-	-	-	-	-	-	> 40	> 40	-

6.2 Technical Assessment of the Recommended Plan

Based on an assessment which included Natural Environment, Social/Cultural, Economic and Implementation Criteria (**Section 5.3**), the following group of measures were selected to be part of the Recommended Plan (**Figure 6.2**):

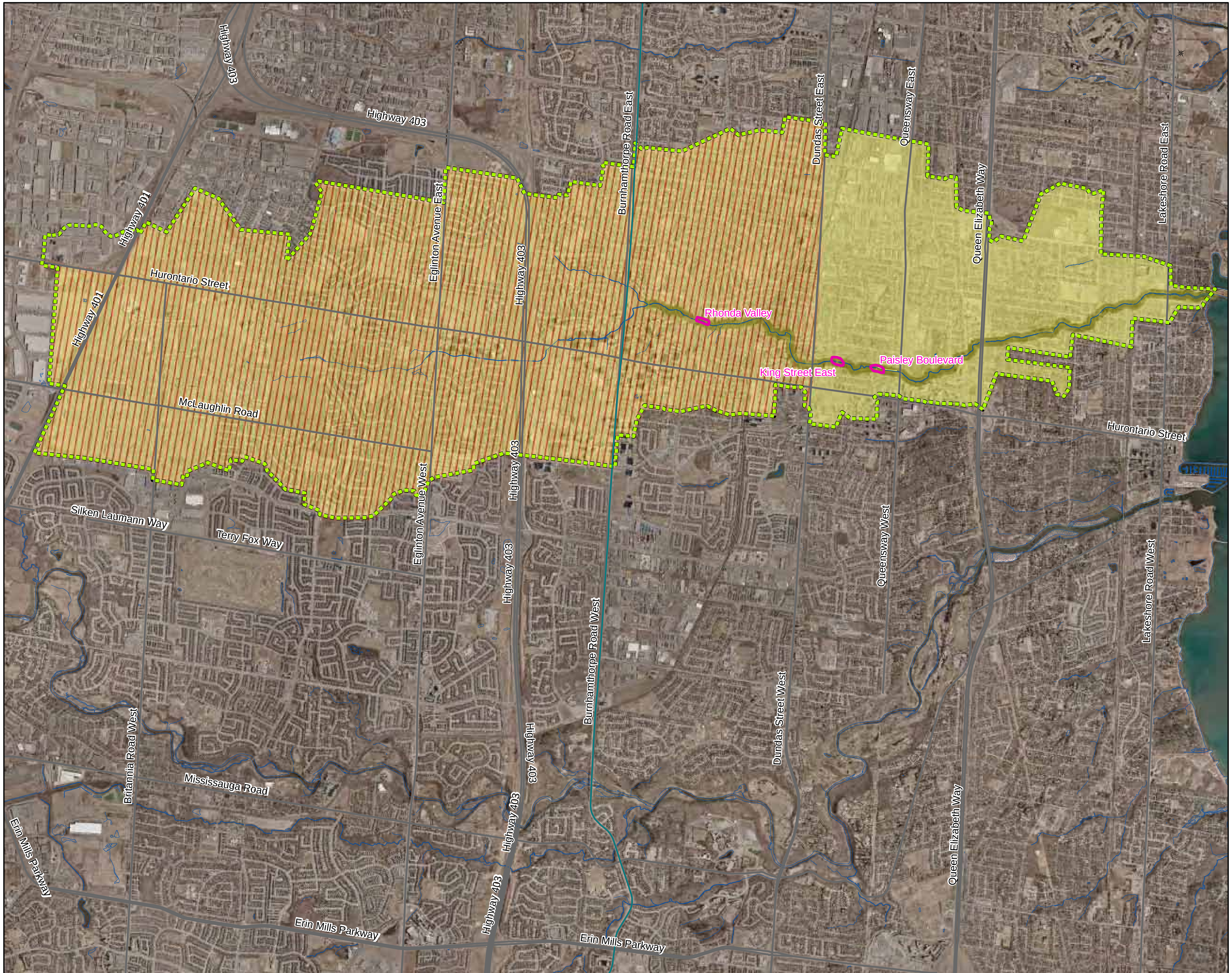
- Storage in the upstream locations to reduce flows within Cooksville Creek to acceptable levels.
- Watercourse and channel capacity upgrades together with creation of a berm in the King Street and Paisley Blvd areas where homes are more susceptible.
- Construction of a berm adjacent to Cooksville Creek to protect homes along Rhonda Valley Blvd.
- Implementation of source and conveyance control measures.

In summary, the preferred alternative focuses on flooding issues. Associated with the benefits from controlling flooding along Cooksville Creek are: restoration of aquatic and terrestrial habitat, improvement in water quality and protection of existing infrastructure including sanitary and storm sewers and adjacent walkways. Collectively, the implementation of the recommended measures will provide flood protection for all properties for the 100-year storm. Issues related to ongoing erosion, degraded water quality and poor aquatic habitat conditions will also be improved.

6.2.1 Storage in the upstream locations

Flood storage is a common stormwater management approach in controlling the quantity or quality of stormwater runoff. It works on the principle of storing a portion of the surface runoff coming from the upstream and allowing a limited flow to the downstream of the catchment. Accordingly, the flow rate is restricted to stay within the capacity of the downstream drainage system.

As illustrated in **Table 6.2**, the capacity of the downstream watercourse of Cooksville Creek (South of Hwy 403) is incapable to meet the increased peak flow rate arising from development. Therefore, the flood storage in the upstream portion of the watershed is deemed a suitable solution for flood management along Cooksville Creek.



KEY MAP

LEGEND:

Subwatershed Boundary

Controls

- Channel and Watercourse Crossing Upgrade
- Storage
- Conveyance and Source Controls
- Specific Crossing Upgrades and Berms

NOTES:

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Recommended Plan

FIGURE No. 6.2

DATE: May 2012

A methodology was implemented in order to identify and define hydrologic characteristics for sites within the Cooksville Creek watershed that accommodate flood storage. The methodology is based on the following components:

- **Field reconnaissance**: visits to potential flood storage sites based on background documents and consultation with the City of Mississauga. Key considerations when identifying storage sites were available space, proximity to Cooksville Creek and possibility for underground or above ground storage (**Figure 6.3**).
- **GIS analysis**: search for potential storage sites (**Figure 6.4**) across the Cooksville Creek watershed by:
    - GIS mapping for open space designated areas adjacent to Cooksville Creek
    - Identifying storm sewers that are 1200 mm and larger
- **Hydrologic analysis:**
    - Delineation of drainage areas for each candidate site (**Appendix A**)
    - Estimation of available storage for each site (assuming 300 m^3/ha and 1.5 m depth of storage)
    - Analysis using the current hydrologic model (SWMHYMO) for the 100 year storm under flood storage scenario (i.e. 13 candidate storage sites)

Figure 6.4 illustrates the output of field reconnaissance and GIS analysis. Fifteen (15) sites are shown and categorized based on drainage to open space adjacent to Cooksville Creek. **Figure 6.4** illustrates that open space was defined as existing parks, vacant land/private property and Hydro corridors. Two of the sites shown in **Figure 6.4** were dropped during the site selection process. These sites are 14 and 15, and they are located in the headwaters of Cooksville Creek south of Hwy 401. **Table 6.2** presents the output of the final analysis which proposed 13 sites for potential flood storage (**Figure 6.5**, excluding sites 14 and 15).

Table 6.2 Types of Sites Selected for Potential Flood Storage along Cooksville Creek

Site Types with Potential Flood Storage	Number
Existing parks	9
Vacant land	2
Hydro corridor	2

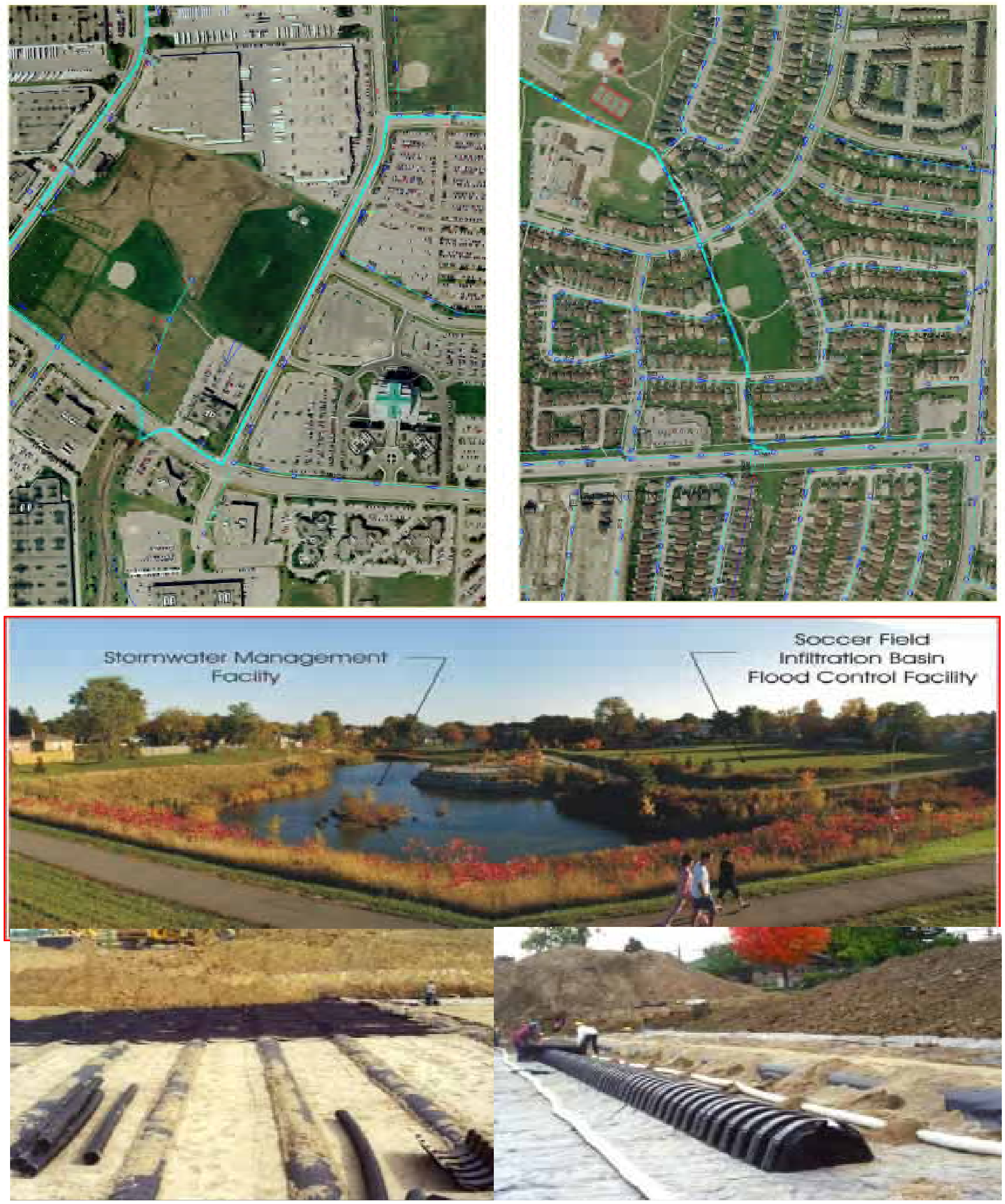
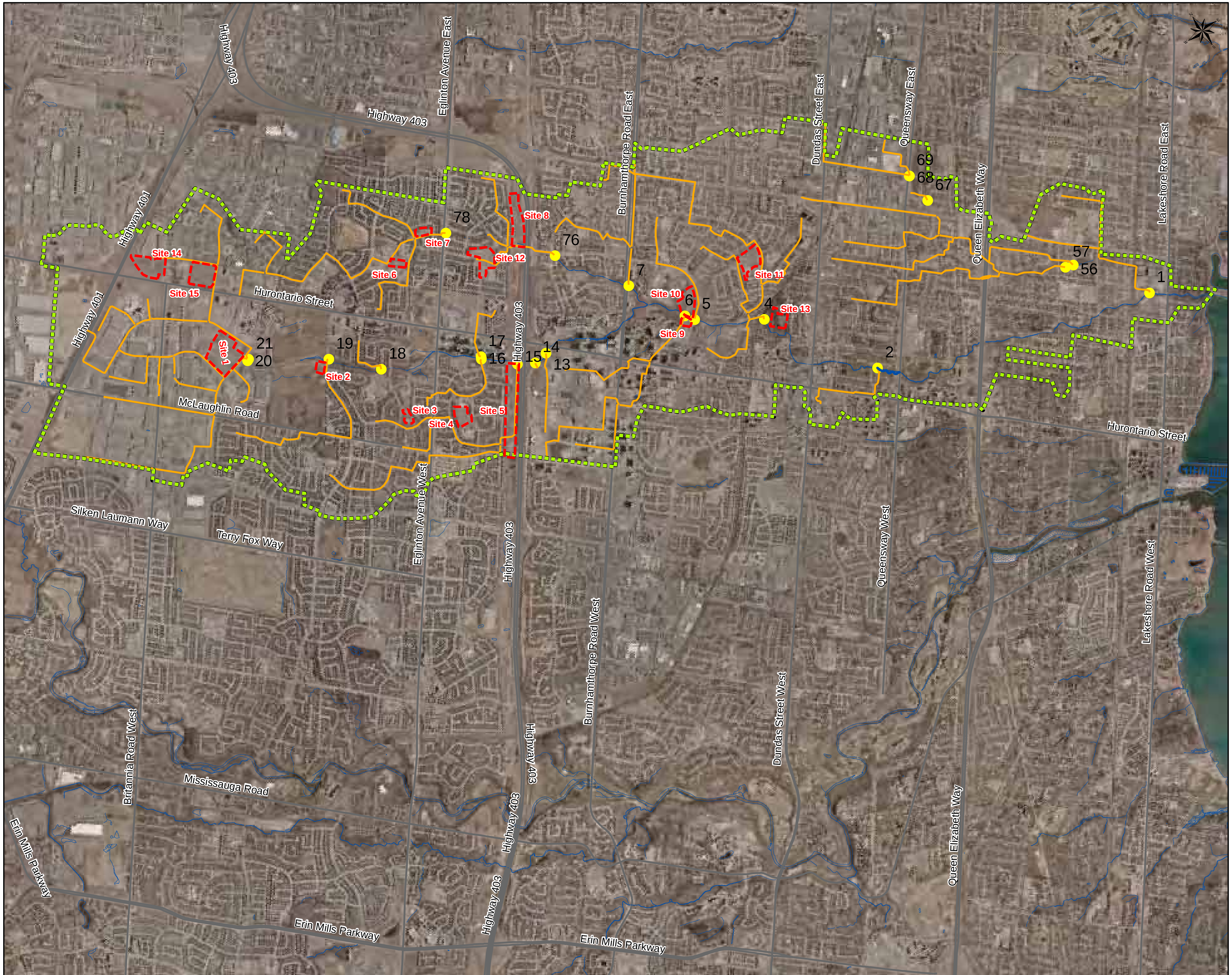
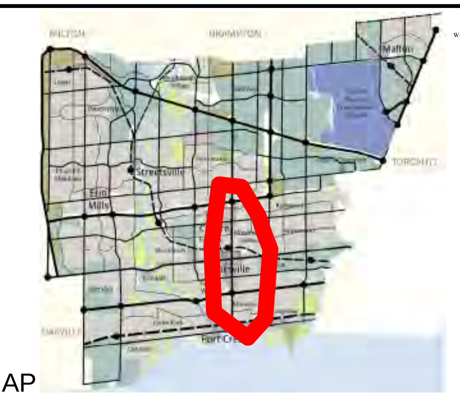


Figure 6.3 Examples of Potential flood storage sites identified during site visits (top left: Avebury Road (undeveloped property), top right: Eastgate Park (Public park). Underneath: an example of constructed storage facility (i.e. Terraview Park)



KEY MAP



LEGEND:

- Subwatershed Boundary
- Site Location
- Streams
- Storm Sewer > 1200 mm
- Outfall

NOTES:

Base Mapping was provided by City of Mississauga

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Identifying Potential Storage Sites Using GIS Analysis

FIGURE No. 6.4

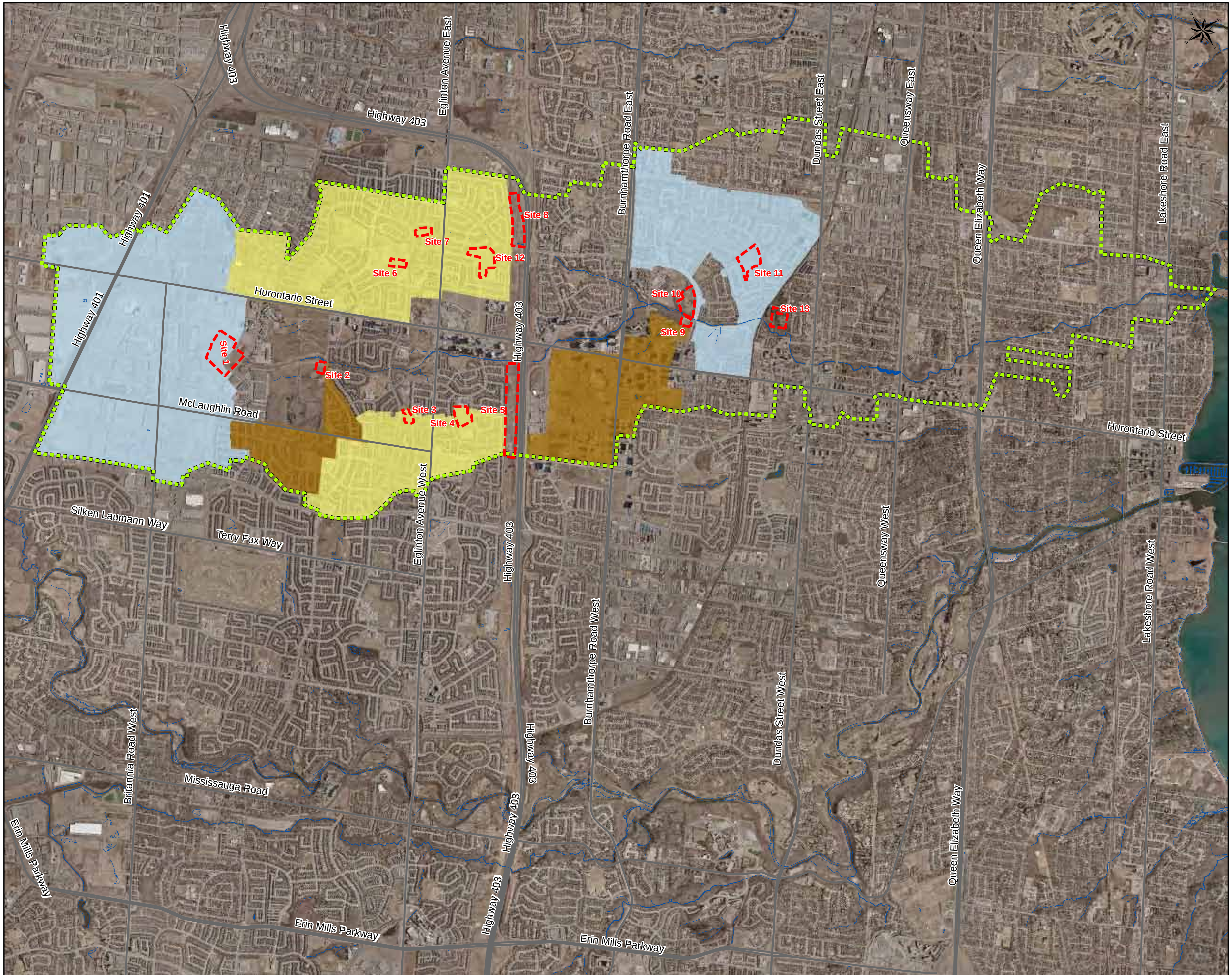
DATE: May 2012

Table 6.3 shows the complete list of sites selected for flood storage along Cooksville Creek. 13 potential sites have been identified. According to the estimates provided in **Table 6.3**, existing parks will provide 74% of the required flood storage, vacant lands will provide 7%, and Hydro corridors will provide 13% of storage. The relationship between area and volume is based on a depth of 1.5m. As noticed in **Table 6.3**, several sites (e.g. #1, #5, #7) have available areas that are smaller than the required areas for storage. However, for several sites (e.g. #6, #7, #8) redundancy has been built into the analysis in that each of the three sites service common drainage areas.

Following the delineation of the drainage areas for each candidate site, storage volumes for each site was estimated based on surface runoff generated from a 100-year storm (approximately the August 4th 2009 storm) and a runoff coefficient of 0.61.

Table 6.3 Characteristics of Sites for Potential Flood Storage along Cooksville Creek

Site #	Location	Drainage area (ha)	Ideal Storage Volume (m3)	Required Area (m^2)	Available Area (m^2)	Available Storage Volume (m3)
1	Park 317	555.5	166,650	111,100	86,030	129,045
2	Offline Britannia Farm	80.1	24,030	16,020	16,848	25,272
3	Greyshale Park	21.8	6,540	4,360	5,178	7,767
4	Heritage Hills Park	33.9	10,170	6,780	8,363	12,545
5	Hydro corridor west	165.6	49,680	33,120	25,849	38,774
6	Frank McKechnie Park	118.0	35,400	23,600	13,994	20,991
7	Eastgate Park	207.5	62,250	41,500	12,888	19,332
8	Hydro corridor east	352.8	105,840	70,560	17,132	25,698
9	Adjacent to Metro	165.0	49,500	33,000	17,716	26,574
10	Central Parkway east	45.4	13,620	9,080	11,397	17,096
11	McKenzie Park	165.0	49,500	33,000	35,058	52,587
12	Huron Heights	14.8	4,440	2,960	3,748	5,622
13	Given Road	211.3	63,390	42,260	39,310	58,965



KEY MAP

LEGEND:

- Subwatershed Boundary
- Site Location
- Streams
- Area Draining to Park
- Area Draining to Hydro R.O.W
- Area Draining to Private Lands

NOTES:

Base Mapping was provided by City of Mississauga

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Proposed Flood Storage Within the Cooksville Creek Watershed

FIGURE No. 6.5

DATE: May 2012

The hydrologic model SWHHYMO used in the hydrologic analysis component of EWRG (2002) was updated and modified in order to test the benefit of using upper watershed offline storage to reduce peak flows for large storms, especially the 100-year storm which is close in magnitude to the large storm event occurring in August 4th 2009 (**Appendix B**). **Figure 6.6** shows the hyetographs of the two storms. It is noticed that although the magnitude of the August 2009 storm peak rainfall intensity was less than that of the 100 year storm, the rainfall intensities in the time intervals leading up to the peak were greater for the August 2009 storm. As a result, the simulated peak flows resulting from the August 4th 2009 storm were higher than those resulting from the 100-year flow (235 m^3/s compared to 207 m^3/s).

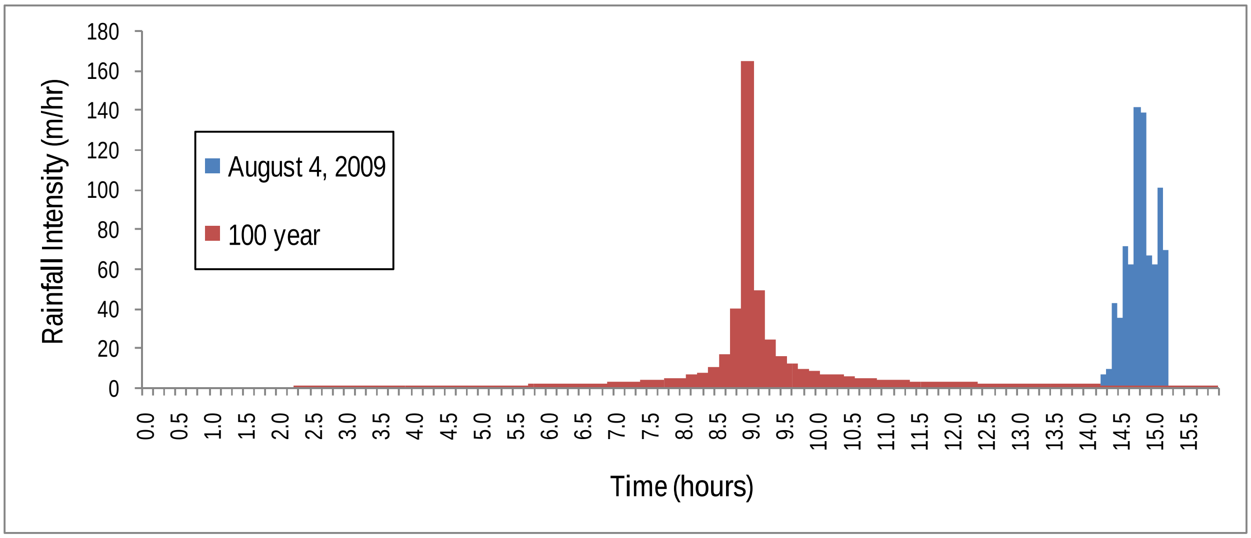

Figure 6.6 The Hyetographs of the 100-Year Storm and the August 4th 2009 Storm

Modifications to the original SWMHYMO model included:

- Developing a new rainfall input based on the August 4th 2009 storm event;
- Inserting flood storage sites in the hydrologic model with associated characteristics as illustrated in **Table 6.3**;
- Developing outflow-storage relationships for each storage site to optimize peak flow reduction. The overflow curves from storage sites were developed to balance the need to reserve capacity to capture the peak of the storm while minimizing the peak flow rate delivered to the creek;
- Quantifying peak flow reductions throughout the Cooksville Creek watershed.

Table 6.4 shows the 100-year peak flows without flood storage (EWRG, 2002) and with flood storage. The results show large reductions that range from 15.1% to 70.3% of the original flow (peak flow without flood storage). Following the hydrologic analysis, the current HEC-2 model of the Cooksville Creek watershed (EWRG, 2002) was run in order to quantify the benefits of flood storage sites and consequent flow reductions in lowering Cooksville Creek water surface elevations under the 100-year storm conditions.

Table 6.4 Cooksville Creek SWMHYMO Results for the 100-year storm before and after flood storage

Location	100 year storm		
	Original (EWRG, 2002)	Route Reservoirs for Basins 1-16	
	m^3/sec	m^3/sec	% of original
Site 1	62.0	9.4	15.1%
Site 2	30.9	6.3	20.3%
Site 3+4+5	29.8	6.1	20.3%
Site 6	29.6	13.4	45.3%
Site 7	42.0	16.9	40.2%
Site 12	9.4	4.3	45.8%
Site 8	57.6	23.1	40.1%
Site 9	33.2	16.7	50.3%
Site 10+11+13	43.3	8.8	20.2%
After Route CC5 (Dundas St)	207.3	126.6	61.1%
After Route CC4 (QW West)	210.1	131.8	62.7%
After Route CC3 (QEW)	203.4	131.1	64.5%
After Route CC2 (CNR)	196.9	130.1	66.1%
After Route CC1 (Lakeshore Rd)	220.2	154.5	70.2%
Lake Ontario	220.9	155.2	70.3%

In order to evaluate the effectiveness of flood storage sites on reducing peak flows in the downstream areas, the 100-year hydrograph with upstream storage was compared to the 100-year hydrograph without storage (**Figure 6.7**). The final peak flows due to flood storage sites (i.e. the 100-year hydrograph with upstream storage) were compared to road crossing conveyance capacities at Queensway, King Street, and Paisley Boulevard (**Table 6.2).** The results show that providing flood storage upstream of Dundas Street using thirteen (13) storage sites would reduce the 100-year surface runoff from 207 m^3/s to 127 m^3/s. This corresponds to a 39% reduction of peak flow. For the August 4^{th} 2009 storm (which is close to the 100-year storm), the hydrologic model predicted a peak flow reduction from 235 m^3/s to 129 m^3/s at Dundas Street. In regard to hydraulic considerations, the HEC-2 model predicted an average decrease of 0.84 meters for the 100-year storm following the use of the 13 storage sites upstream Dundas Street. Taking into consideration that the main road crossings within the study area have conveyance capacities that are above 127 m^3/s (e.g. Queensway), the allocation of flood storage sites according to **Figure 6.5** would mitigate flooding in most of the areas along Cooksville Creek.

Based on the hydrologic and hydraulic analysis conducted earlier and shown in detail in **Appendix B**, implementing flood storage sites as proposed in **Table 6.3** and **Figure 6.5** results in a majority of the areas along Cooksville Creek being out of the 100-year floodplain thus flood damages would be minimized. In that regard, it should be noted that while flood reduction for the 100-year would remove many areas from the 100-year floodplain and reduce flood damages, reducing the regional flows to prevent flooding is not entirely achievable under the flood storage plan. However, and as shown in **Figure 6.8,** compared to the extent of regional floodplain, the flood storage sites will decrease the extent of the existing regional floodplain and assist in reducing the impact of the regional storm.

In areas where conveyance capacity for the 100-year flood is smaller than the reduced peak flow with storage (127 m^3/s) such as King Street and Paisley Boulevard additional measures that are site-specific would be undertaken such as crossing upgrades and berm construction as discussed in the following sections.

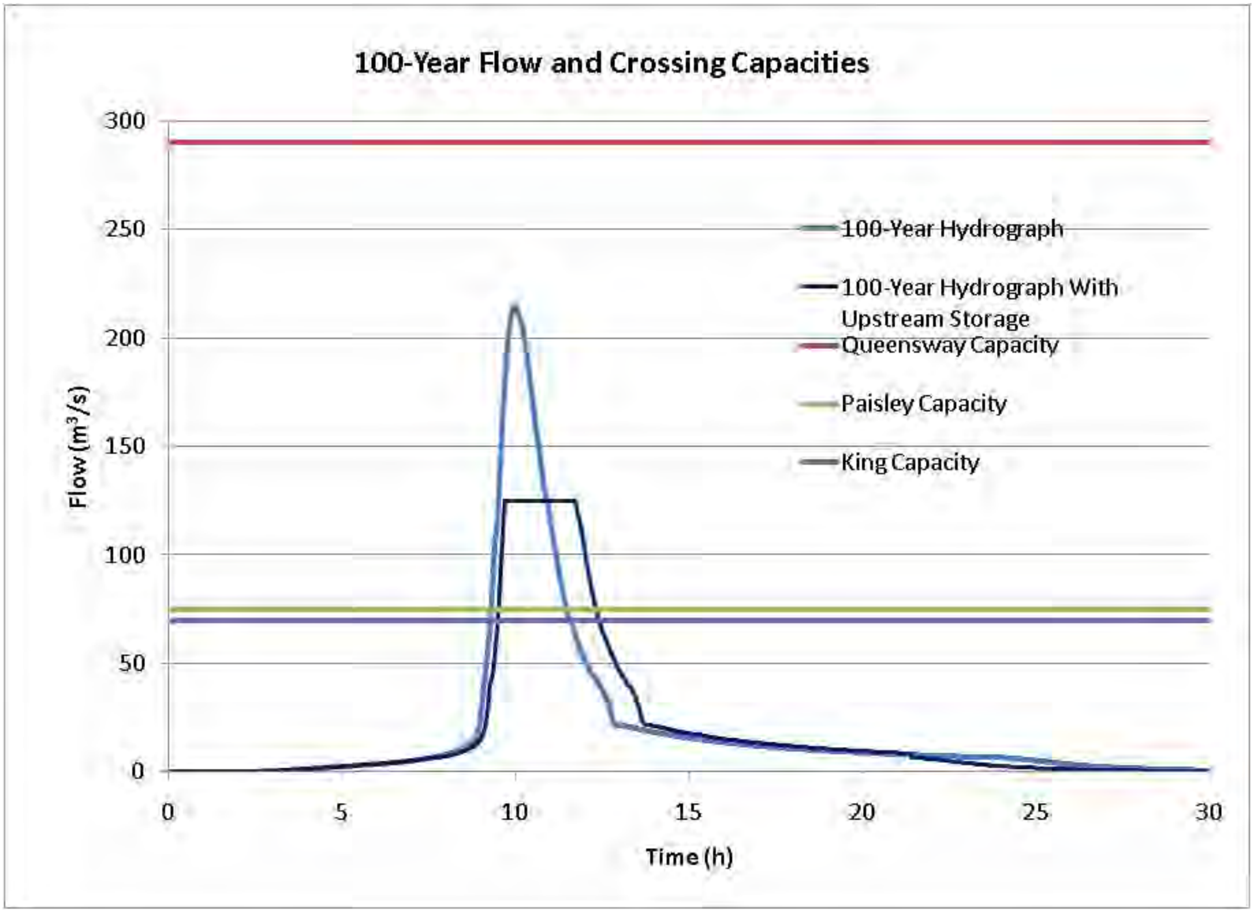

Figure 6.7 The 100-Year Hydrograph with Upstream Storage

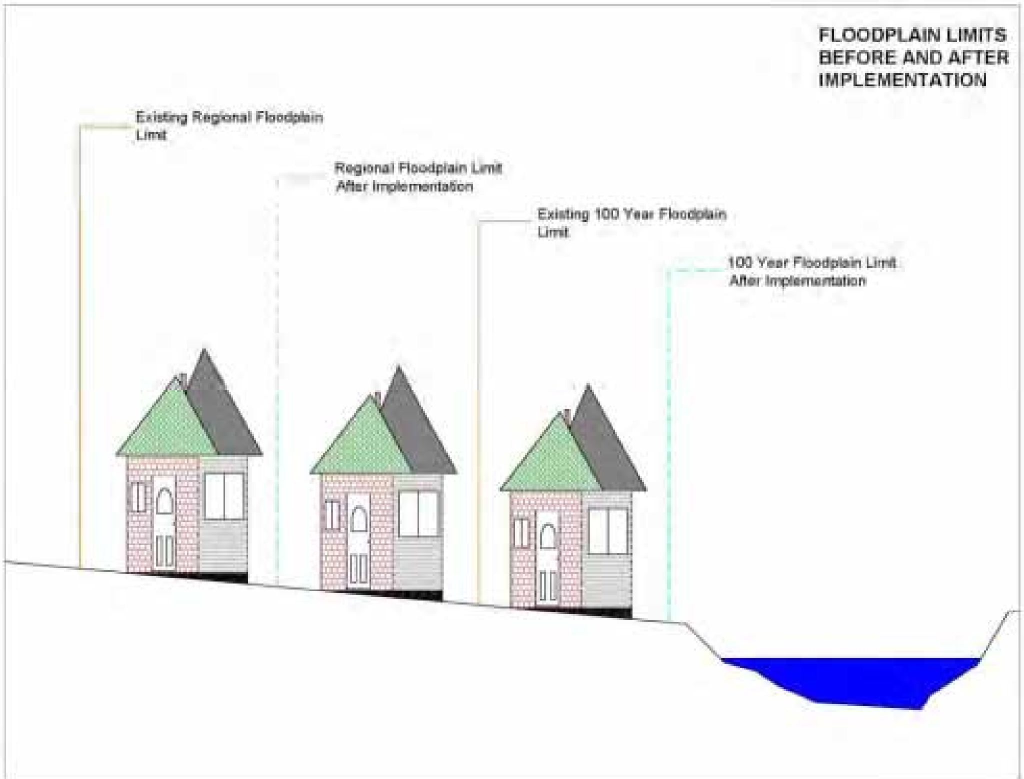

Figure 6.8 Conceptual Floodplain limits before and after the implementation of flood storage

It was observed during field reconnaissance that vacant land is limited within the Cooksville Creek watershed, which renders the implementation of traditional SWM facilities such as wet ponds and wetlands problematic. In such scenarios, subsurface storage facilities may provide an effective and much more accommodating SWM solution within urban areas such as the City of Mississauga. Compared to wet ponds or wetlands, subsurface storage facilities can be constructed underneath existing infrastructure such as roadways, parking lots and even public lands such as parks or recreational facilities. This alternative allows land parcels to provide stormwater management control while maintaining existing land use functions.

Example of subsurface flood storage (under construction)

The benefits associated with subsurface stormwater storage faculties may include, but are not limited to:

- Maximization of land area;
- Ability to infiltrate stormwater thereby providing recharge of groundwater ;
- Mechanism to replicate pre-development hydrology (water balance requirements);
- Helps to maintain stream baseflow;
- Eliminates thermal discharge loadings to receiving water bodies;
- Replenished groundwater supplies;
- Subsurface installation, minimize open water liabilities; and,
- Can be installed near the stormwater source thereby eliminating contaminant entrainment during conveyance.

All but one of the flood storage sites are expected to involve the construction of underground facilities to reduce peak flows and erosion, improve water quality and increase flows during dry periods. Site no.1 is the exception where construction could be aboveground or underground if necessary. Subsurface storage facilities may be constructed within open areas or private lands such as hydro corridors (i.e. Sites #5 and #8) or other suitable utility/municipal easements. **Figure 6.9** shows conceptual representations of some of the proposed storage sites. The sites shown are Site #1 (Park 317; Avebury Road) and Site #7 (Eastgate Park). Storm sewers that represent inlets and outlets to and from each storage site are illustrated beside conceptual images that show the possibilities for underground storage (subsurface storage) or above ground storage (wet pond). Eastgate Park (Site #7) was identified as an area with retrofit potential for underground storage. The existing area serves as a recreational facility and as such, the utilization of subsurface storage units as a viable stormwater management alternative was pursued. The conceptual design for Eastgate Park utilized the “Hybrid Milk Crate” alternative as its subsurface storage facility type.

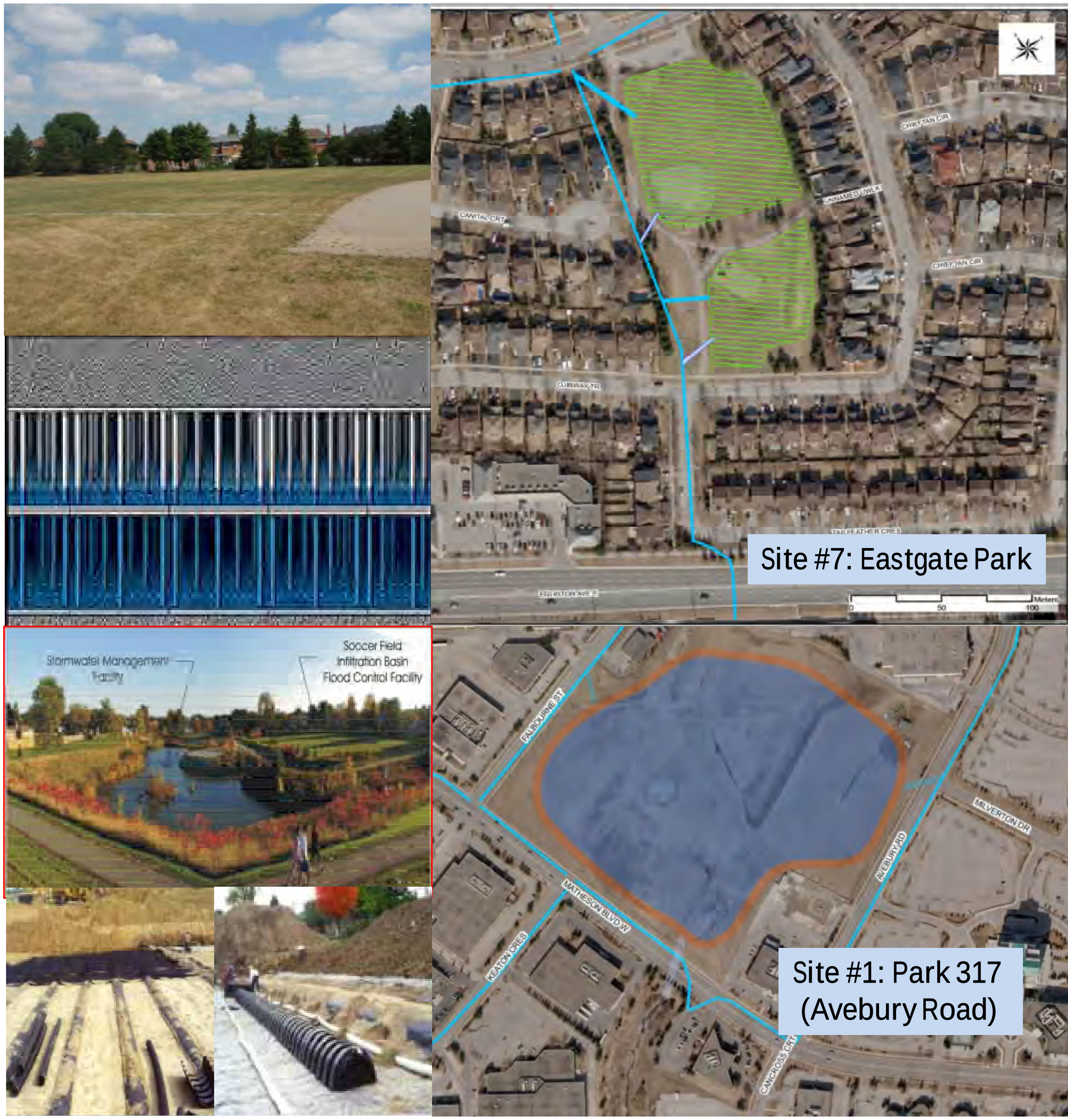

Figure 6.9 Proposed flood storage sites

6.2.2 Watercourse and channel capacity improvement

It is evident from historic flood records and previous hydrologic and hydraulic analyses (**Table 6.2**) that the capacity of King Street and Paisley Boulevard is not sufficient (less than 75 m^3/s) for the conveyance of flows ranging from the 2-year return flow to the 100-year and the Regional Flow. According to EWRG (2002), the overtopping depth of the Regional flow is 2.1 meters. In addition, the number of potential buildings flooded under the 100-year flow conditions is 16 buildings compared to 17 buildings under the Regional Flow conditions.

The flood storage assessment discussed in Section 6.2.1 showed that the implementation of flood storage sites will not be able to provide a solution for flooding problems at both crossings. Therefore, specific site solutions are proposed in this section for conveyance capacity at King Street and Paisley Boulevard. Generally speaking, the upgrades are as follows:

Paisley Boulevard upgrades

In the past, the CVC had widened and deepened the existing culvert cell at Paisley Boulevard, and completed over 380 m of channel improvement works (EWRG, 2002). The following proposed works are to complement constructed measures in order to achieve the overarching goal of mitigating flood damages in the area:

- Proposed creek expansion to improve channel capacity
- Proposed bridge extension to increase the conveyance
- Proposed berm

The proposed works noted above and shown in **Figure 6.10** illustrate the preferred alternative for Paisley Boulevard East. **Table 6.5** which summarizes a preliminary hydraulic analysis shows that adding an extra cell (12.5 x 2.94 m; Span x Rise) to the Paisley Boulevard crossing will increase the crossing capacity by 67% of its original capacity (from 75 m^3/s to 125 m^3/s). The proposed changes would include raising the road elevation from 103.4 m to 103.7 m. Increasing the crossing capacity to 125 m^3/s will allow the conveyance of the 100-year peak flows released from the flood storage sites proposed in Section 6.2.1.

Table 6.5 Paisley Boulevard East Upgrades and Capacity Improvement

Watercourse crossing	Description	Dimensions (Length,Span,Height) (m)	Crossing capacity without overtopping (m^3/s)
Existing Paisley Boulevard East	Twin trapezoidal box	(15,7.3,2.4)	75
Proposed Paisley Boulevard East	Twin trapezoidal box + 1 rectangular cell	(15,7.3,2.4) + (15,12.5,2.94)	125

The implementation of the berm proposed in **Figure 6.10** involves the purchase of a vacant lot adjacent to the Creek on the west side. The berm extends from Shepard Avenue easterly and could be constructed at the back part of lots # 37 and 38, or on the vacant land immediately to the north of Paisley Boulevard East. A preliminary hydraulic analysis shows that the top elevation of the proposed berm would be approximately 104 m.

King Street upgrades

The City of Mississauga has done some flood remediation works at King Street crossing which included a new culvert cell. Proposed measures to complement previous undertakings to mitigate flood damages in the area include:

- Proposed channel realignment
- Proposed channel extension
- Proposed trail realignment

The proposed works noted above and shown in **Figure 6.11** illustrate the preferred alternative for King Street East. **Table 6.6** which summarizes a preliminary hydraulic analysis shows that adding an extra cell (25 x 2.7 m, Span x Rise) to King Street East crossing will increase the crossing capacity by around 80% of its original capacity (from 70 m^3/s to 125 m^3/s). The proposed changes would include raising the road elevation from 105.9 m to 106.3 m. Increasing the crossing capacity to 125 m^3/s will allow the conveyance of the 100-year peak flows released from the flood storage sites proposed in Section 6.2.1

Table 6.6 King Street East Upgrades and Capacity Improvement

Watercourse crossing	Description	Dimensions (Length,Span,Height) (m)	Crossing capacity without overtopping (m^3/s)
Existing King Street East	Twin rectangular concrete	(20,5.8,2.1)	< 70
Proposed King Street East	Twin rectangular concrete + 1 rectangular cell	(20,5.8,2.1) + (20,25,2.7)	125

LEGEND:

KEY MAP

- Proposed Berm
- Proposed Creek Expansion
- Proposed Bridge Extension

NOTES:

Base Mapping was provided by City of Mississauga

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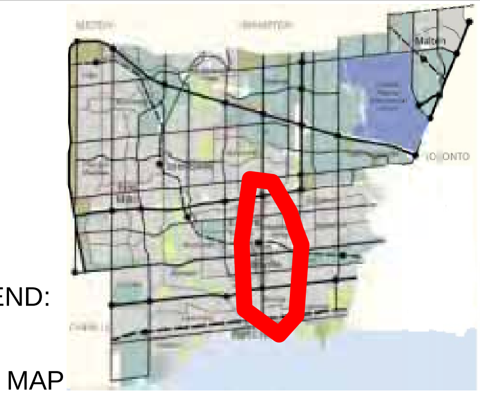
Paisley Boulevard East Proposed Upgrades

FIGURE No. 6.10

DATE: May 2012

LEGEND:

KEY MAP



- Proposed Channel Realignment
- Proposed Bridge Extension
- Proposed Trail Realignment

NOTES:

Base Mapping was provided by City of Mississauga

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Aquafor Beech Limited

MISSISSAUGA Leading today for tomorrow

COOKSVILLE CREEK FLOOD EVALUATION MASTER PLAN EA

King Street East Proposed Upgrade

FIGURE No. 6.11

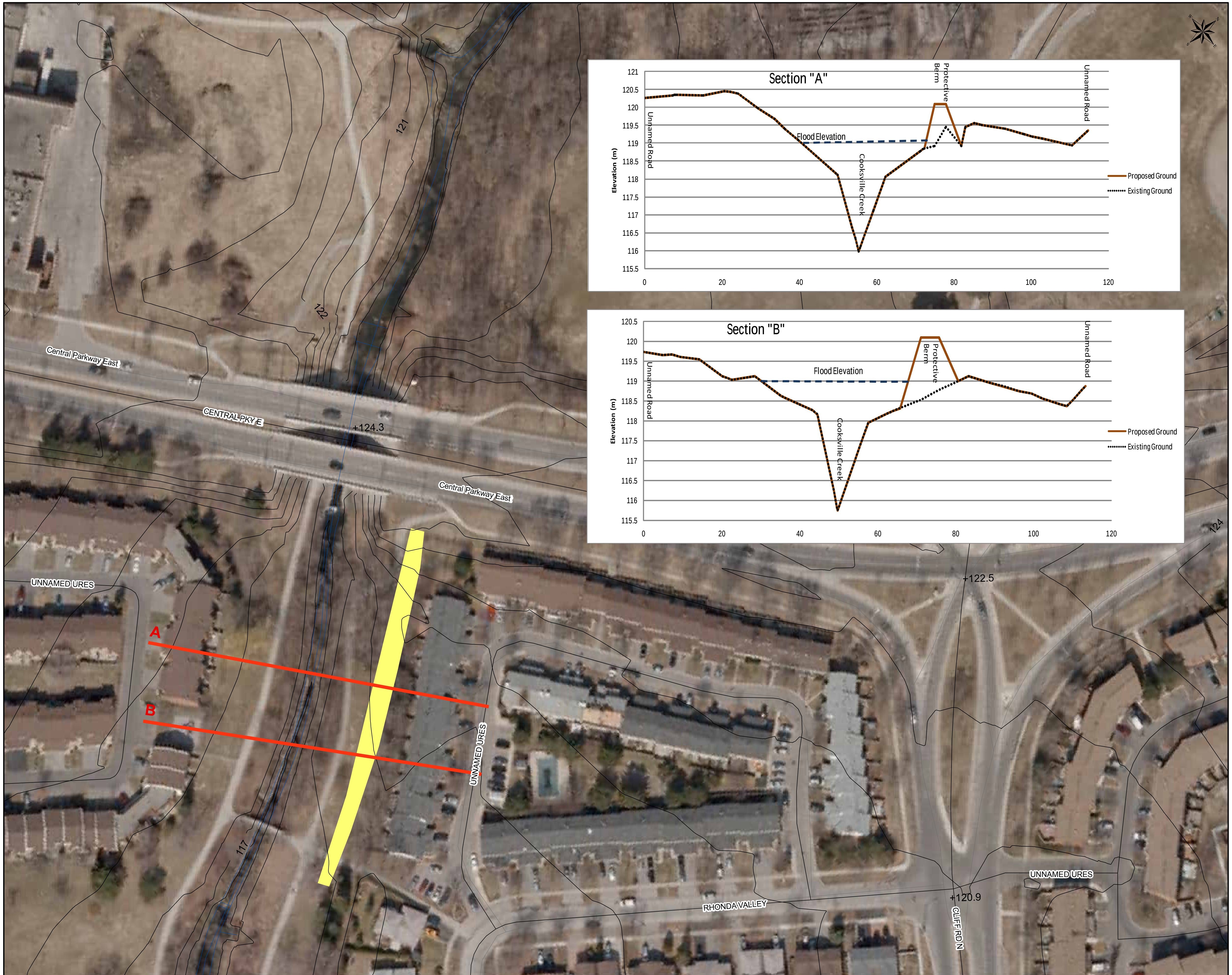
DATE: May 2012

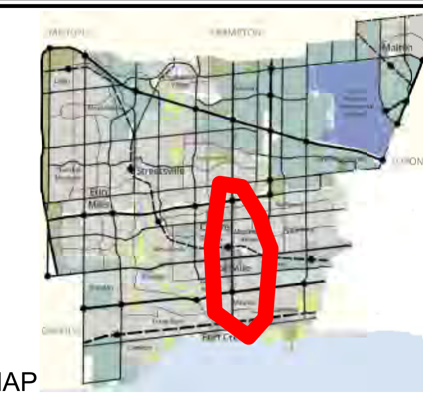
6.2.3 Construction of a berm to protect homes along Rhonda Valley

The Cooksville Creek Flood Remediation Plan (EWRG, 2002) has identified buildings along Rhonda Valley that have been floodproofed. **Table 6.7** lists the existing building floodproofing in the area. As part of the Recommended Plan for this study, a berm is proposed along Rhonda Valley extending to Central Parkway East as shown in **Figure 6.12**. The berm will help mitigate flood damages to the buildings adjacent to the valley.

Table 6.7 Existing Building Floodproofing at Rhonda Valley

Building Number	Address	Regional Flood Elevation (m)	Floodproofing Elevation (m)	Level of Protection
29001	3400 Rhonda Valley Unit 1	119.7	119.6	100 year
29002	3400 Rhonda Valley Unit 2	119.8	119.6	100 year
29003	3400 Rhonda Valley Unit 3	119.9	119.6	100 year
29004	3400 Rhonda Valley Unit 4	120.1	119.6	100 year
29005	3400 Rhonda Valley Unit 5	120.1	119.6	100 year
29006	3400 Rhonda Valley Unit 6	120.2	119.6	100 year
29007	3400 Rhonda Valley Unit 7	120.2	119.6	100 year
29008	3400 Rhonda Valley Unit 8	120.3	119.6	100 year
29009	3400 Rhonda Valley Unit 9	120.4	119.6	100 year
29010	3400 Rhonda Valley Unit 10	120.4	119.6	50 year
29011	3400 Rhonda Valley Unit 11	120.4	119.6	50 year
29012	3400 Rhonda Valley Unit 12	120.5	119.6	50 year
29013	3400 Rhonda Valley Unit 13	120.5	119.6	50 year





KEY MAP

LEGEND:

Cross-Section

Protective Berm

NOTES:

Base Mapping was provided by City of Mississauga

0 25 50 Meters

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Rhonda Valley Upgrades

FIGURE No. 6.12

DATE: May 2012

6.2.4 Implementation of source and conveyance control measures

Source and conveyance control measures are another component of the Recommended Plan. These measures help infiltrate, store, or increase evapotranspiration thereby reducing stormwater runoff. **Table 6.8** lists some of the source control and the conveyance control measures that can be implemented within the Cooksville Creek watershed in order to decrease stormwater runoff rate and volume and consequently mitigate flood damages along Cooksville Creek.

Source and conveyance measures are presented here as part of the solution to flooding issues along Cooksville Creek. However, these works will be implemented as part of the recently completed City of Mississauga Stormwater Quality Control Strategy Update (Aquafor, 2011). The City of Mississauga Stormwater Quality Control Strategy Update discusses the implementation of a series of conventional and innovative stormwater controls (including source control, conveyance control and end of pipe facilities) in the City of Mississauga in order to improve the quality of urban stormwater discharging to streams, rivers and lakes within the City. It should be noted that in addition to addressing water quality issues, the Strategy Update report includes major benefits to water quantity and other environmental considerations as part of the philosophy of Low Impact Development measures and the treatment train concept (Aquafor, 2011).

Table 6.8 Source and Conveyance control for flood management within Cooksville Creek

Source Control Measures
• Grass Swales or Vegetated Filter Strip • Bioretention • Stormwater Planters • Cisterns and Rainwater Harvesting • Soakaways • Rain Gardens and Bioretention • Rain Barrels • Permeable Driveways and Permeable Paving
Conveyance Control Measures
• Bioretention – Located either in the road or within the public easement • Exfiltration Trench / Pervious pipe systems • Roadside ditches and vegetated filter strips • Stream / valley buffer strips • Sewer replacement with pervious pipes • Pervious catch basins with goss trap • Public Easement Landscaping

Below is a brief description of proposed source and conveyance control measures in addition to schematics that show before and after situations.

Source control measures are small-scale stormwater management measures located at the beginning of a drainage system where stormwater is captured on-site or close to where the rainfall lands. Due to the relatively small area treated by an individual measure, source controls must be well distributed to reduce surface runoff and infiltrate or filtrate stormwater effectively. Source control measures are generally installed on private property within residential, commercial, industrial and institutional land uses. **Figure 6.13** shows a conceptual example for a source control measure (i.e. bioretention unit) within the Cooksville Creek watershed.

Figure 6.13 From Left to Right: before source control and after source control at a representative site within the Cooksville Creek watershed

Conveyance control measures are measures that are designed to manage stormwater as it travels overland or through pipes en route to the downstream outlet. Like source controls, conveyance control measures remove a portion of the total stormwater volume from entering the storm sewer network, slow the erosive velocity of stormwater entering watercourses, and filter out pollutants from stormwater. **Figure 6.14** shows a conceptual example for a conveyance control measure, which is a bioswale concept for the Lakeview neighborhood ROW retrofit project (under construction) within the Cooksville Creek watershed.

Figure 6.14 From Left to Right: before conveyance control and after conveyance control (concept) at Lakeview neighborhood within the Cooksville Creek watershed

7.0 IMPLEMENTATION STRATEGY

7.1 General

Based on considerations of study objectives, existing environmental conditions, and the requirements of the Environmental Assessment Act as stipulated in the Municipal Class Environmental Assessment document (Municipal Engineers Association, 2007), a long list of traditional and non-traditional flood control measures were proposed for evaluation. Following evaluation criteria based on Natural Environment, Social/Cultural, Economic, and Implementation considerations, the most effective alternatives in addressing criteria requirements were brought forward (Chapter 5). Flood control alternatives brought forward (also known as the Recommended Plan) were technically assessed and detailed in terms of their hydrologic, hydraulic and urban setting in Chapter 6.

This chapter intends to summarize the implementation considerations associated with the various elements of the Recommended Plan described in Chapter 6. The Recommended Plan is comprised of the following components of traditional and non-traditional flood control measures:

- Storage in the upstream areas of the Cooksville Creek watershed (north of Dundas Street) to reduce flows within Cooksville Creek to acceptable levels;
- Watercourse and channel capacity upgrades together with the creation of a berm in the King Street and Paisley Boulevard areas where homes are more susceptible;
- Construction of a berm adjacent to Cooksville Creek to protect homes along Rhonda Valley;
- Implementation of source and conveyance control measures.

In summary, successful implementation will:

- Alleviate flooding for all areas up to the 100 year storm and reduce flooding extent for the Regional flow;
- Improve water quality;
- Reduce ongoing erosion problems;
- Improve habitat for aquatic species.

In preparing the Implementation Strategy, the following points were considered:

- The Implementation Strategy must be flexible and realize that the techniques and approaches will change as the knowledge base advances;
- Implementation must be consistent with other municipal programs, policies and standards;
- The implementation should focus on areas which have historically been hardest hit by flooding.

In general, the activities that will need to be considered for each component, in order to successfully implement the Plan include:

- Cost (capital, operation and maintenance)
- Funding alternatives
- Policy or design standard implications
- Timeframe for implementation / Prioritization
- Expected environmental benefits
- Environmental Assessment requirements
- Prioritization
- Coordination with existing programs and projects
- Future study requirements
- Monitoring requirements

Table 7.1 provides a summary for each of the proposed elements of the Implementation Strategy.

7.2 Cost

The approximate cost to implement the flood control measures as stipulated in the Recommended Plan (Chapter 6) includes capital cost and operation and maintenance costs. Land cost is not included for areas such as Hydro corridors. According to **Table 7.2**, the approximate cost is assigned to each flood control measure of the Recommended Plan and is classified based on unit rate or lump sum. For example, different unit rates can be used to distinguish between the cost of constructing an above ground flood storage unit as opposed to an underground storage unit. For the case of underground flood storage sites, the unit rate is approximated as $\$250/m^3$. For the case of aboveground flood storage, the unit rate is approximated as $\$130/m^3$.

The implementation cost for site-specific flood control measures was estimated as a lump sum and ranges from $300,000 for Rhonda Valley to $7.5 million for King St. and Paisley Boulevard capacity upgrade projects. In regard to source and conveyance control measures, it should be noted that these measures while being integral to the implementation strategy they will be addressed on a city-wide basis as part of the City of Mississauga Stormwater Quality Strategy Update study.

Table 7.1 Implementation Strategy

Recommended Plan component	Capital cost ($)	Funding alternatives	Policy or Design Standard Implications	Timeframe for Implementation/Prioritization	Expected Environmental Benefit	Coordination with Existing Programs and Projects	Future Study Requirements
Storage in the Upstream Locations	93,600,000	Capital Funding	• Coordination with the Community Services Department re: parks programs and policies • Purchase of two properties	Park 317 (Site # 1) : 1 – 3 Years The remainder of sites (3 – 20 Years)	• Reduction of flood frequency along Cooksville Creek • Reduction in erosion problems • Improvement in water quality and aquatic habitat	Integration with the Community Services Department Parks programs and policies	Preliminary and detailed design
Watercourse and Channel Capacity Upgrades	7,5,000,000	Capital Funding	Purchase of vacant lot within floodplain at Paisley Boulevard	1 – 3 Years	Reduction of flood frequency at King St. and Paisley Boulevard	• Purchase of vacant lot at Paisley • Relocation of walkway in Cooksville Park	Preliminary and detailed design
Berm Construction at Rhonda Valley	300,000	Capital Funding	None	1 – 3 Years	Reduction of flood frequency at Rhonda Valley	Confirmation of existing trail/recreational requirements	Preliminary and detailed design
Implementation of Source and Conveyance Control Program	Priced as part of the Stormwater Quality Strategy Update (Aquafor, 2011)	As shown in the Stormwater Quality Strategy Update (Aquafor, 2011)	updating by-laws and policies to accommodate source and conveyance controls (Aquafor, 2011)	1 – 25 Years	Provide many environmental benefits due to their capacity to infiltrate, store, or increase evapotranspiration thereby reducing stormwater runoff volume and flow rate	Aquafor (2011) sets up a framework for the implementation of source and conveyance control measures	• Depends on specifics of site • Geotechnical assessment • Hydraulic conductivity test

Table 7.2 Approximate cost for the implementation of the Recommended Plan

Recommended measure	Site / Location	Unit	Quantity	Unit rate	Cost ($M)	Note
Flood storage in the upstream locations	**Site # 1**	**m³**	129,045	$130/ m³	16.8	Also called Park 317. Further upstream
	Site # 2	**m³**	25,272	$250/ m³	6.4	
	Site # 3	**m³**	7,767	$250/ m³	1.9	
	Site # 4	**m³**	12,545	$250/ m³	3.1	
	Site # 5	**m³**	38,774	$250/ m³	9.7	
	Site # 6	**m³**	20,991	$250/ m³	5.2	
	Site # 7	**m³**	19,332	$250/ m³	4.8	
	Site # 8	**m³**	25,698	$250/ m³	6.4	
	Site # 9	**m³**	26,574	$250/ m³	6.6	
	Site # 10	**m³**	17,096	$250/ m³	4.3	
	Site # 11	**m³**	52,587	$250/ m³	13.1	
	Site # 12	**m³**	5,622	$250/ m³	1.4	
	Site # 13	**m³**	58,965	$250/ m³	14.7	Further downstream.
	All sites	**m³**	**440,268**	**$250/ m³**	**93.6**	
Watercourse and channel capacity upgrade	**King St.**	Lump sum	-	-	2.5	
	Paisley Boulevard	Lump sum	-	-	5.0	
	All sites	**Lump sum**	**-**	**-**	**7.5**	
Construction of a berm along Rhonda Valley	**Rhonda Valley**	**Lump sum**	**-**	**-**	**0.3**	
Source and conveyance control measures	**Refer to the City of Mississauga Water Quality Strategy Update (Aquafor, 2011)**					

7.3 Funding Alternatives

There are a variety of funding alternatives for the implementation of the Recommended Plan. Based on past experience and discussions with the City of Mississauga, the following sources of funding will be pursued:

For the implementation of the flood storage sites and channel capacity upgrades at King St., Paisley Boulevard, and Rhonda Valley, capital funding is proposed.

The following funding sources were identified for <u>source control measures</u> (Aquafor, 2011):

- Grants – a variety of environmentally based grants and granting agencies (both private and public) are available and may be a potential source of funds for community based pilot projects, education programs and training expenses. Examples include RBC Blue-Water, TD Green Funds etc.
- Municipal General fund – tax based funds are reallocated from the general fund;
- Development Charges - a portion of charges paid by developers (generally used to pay the cost of new capital projects required as a result of growth) reallocated towards source control marketing in opportunity neighborhoods;
- Stormwater Utility – shift from funding stormwater using a tax based systems to a rate based system.

The following funding sources have been indentified for <u>conveyance control measures</u> (Aquafor, 2011):

- Municipal General fund – tax based funds are reallocated from the general fund;
- Development Charges - a portion of charges paid by developers (generally used to pay the cost of new capital projects required as a result of growth) reallocated towards source control marketing in opportunity neighborhoods;
- Stormwater Utility – shift from funding stormwater using a tax based systems to a rate based system.

7.4 Policy and design standards implications

<u>Flood storage sites</u>

In general, the flood storage sites recommended as part of the Recommended Plan shall be required to comply with policy requirements concerning parks within the City of Mississauga where many of the recommended storage sites are located. Coordination with the City of Mississauga Community Services Department is recommended to investigate park functions and usability. Purchase of two properties is also needed in order to proceed with the construction of sites 2 and 9. Furthermore, negotiations with Hydro One will be required for sites 5 and 8.

<u>Watercourse and Channel capacity upgrades</u>

The construction of a berm in order to mitigate flooding issues in the Paisley Boulevard area was recommended in Section 6.2.2 (**Figure 6.10**). To facilitate the construction of the berm, purchase of vacant lot within the floodplain of Cooksville Creek is necessary.

Source and Conveyance control

As mentioned in the City of Mississauga Stormwater Quality Strategy Update Study (Aquafor, 2011), the City of Mississauga has four (4) by-laws which potentially impact conveyance control implementation and general naturalization efforts:

- Nuisance Weeds and Tall Grass By-law;
- Property Standards By-law;
- Encroachment By-Law. And
- The Fence By-Law

According to Aquafor (2011), the City of Mississauga staff (Parks and Forestry) has held meetings with By-law Enforcement in consultation with Credit Valley Conservation to discuss amendments to the existing legislation which would alleviate these aforementioned conflicts. In addition, City staff is reviewing by-laws in other municipalities, especially those which have dealt with similar issues. It is recommended that the City, with the support of the City's Environmental Advisory Committee, develop an overall policy statement regarding naturalization and consider amendments to the aforementioned by-laws which would permit the implementation of the Recommended Stormwater Quality Strategy (Aquafor, 2011) for source controls efforts on private lands. Any such By-law amendments which result should then come before City Council.

In regard to conveyance control measures, the City of Mississauga Stormwater Quality Strategy Update study notes that updating by-laws and policies to accommodate source and conveyance controls would facilitate the use and occupation of its municipal right of ways and municipal parking lots where appropriate and consistent with City By-laws, procedures and other applicable legislation, through the issuance of permits for approved activities.

7.5 Timeframe for Implementation/Prioritization

Allocating a timeframe for the implementation of the Recommended Plan requires the understanding of the priority of each component of the Plan (**Table 7.1**). For example, the implementation of Site #1 (i.e. Park 317) is rendered a top priority (1-3 years) because of its large drainage area (555.5 ha) and for its location within the upper watershed where flood mitigation in addition to major environmental and ecological benefits can be achieved. On the other hand, the remainder of the recommended flood storage sites (12 sites) will be constructed on an as-required basis (3-20 years). By the same token, the implementation of conveyance capacity improvement at King St, Paisley Boulevard, and Rhonda Valley is a top priority (1-3 years) because of frequent flooding in these specific areas while the implementation of source and conveyance control could be carried out in the long term (1-25 years) since no major flood risk is associated with not implementing these measures in the short term.

7.6 Expected Environmental Benefits

Many environmental benefits will be achieved through the implementation of the components of the Recommended Plan. These benefits are illustrated in **Table 7.1**, and they can be classified according to the following spatial scale of impact:

- **Site-scale projects**: these are traditional flood control measures which intend to improve the conveyance capacity at King St. Paisley Boulevard and Rhonda Valley. The main objective of these projects is to reduce the flood frequency in the area of interest and avoid the overtopping of roads and the flooding of buildings along the Creek.
- **Watershed-scale projects:** these are non-traditional measures which intend to reduce flooding in all locations along Cooksville Creek, reduce erosion problems and improve water quality and aquatic habitat.
  - *Flood storage in upstream locations* provides flood mitigation by reducing peak flows to a level that can be conveyed downstream (**Figure 6.7**), minimizes erosion of stream bed and banks because of flow detention within storage facilities, and would prevent water quality issues such as thermal pollution of aquatic habitat by providing underground storage for surface water that is released under a storage-flow function.
  - *Source and conveyance control measures* provide a myriad of environmental benefits at the watershed scale due to their capacity to infiltrate, store, or increase evapotranspiration thereby reducing stormwater runoff volume and flow rate and recharging groundwater when infiltration can be facilitated.

7.7 Environmental Assessment Requirements

This study was undertaken using the Master Plan process and therefore meets the first two phases of the EA process according to **Figure 1.1**, and they are:

- **Phase 1**: Establish the Problem or Opportunity
- **Phase 2**: Identify and Assess Alternative Solutions to the Problem, and Select a Preferred Alternative

The City of Mississauga has selected **Approach 1** for undertaking the Master Plan. Approach 1 is the most common approach for Class EA studies, and it follows Phases 1 and 2 as defined above, then uses the Master Plan as a basis for future investigations of site specific Schedule ‘B’ and ‘C’ projects.

7.8 Coordination with other programs and projects

An important part of the Implementation Strategy is to coordinate the implementation of the Recommended Plan with existing programs and projects where physical changes are needed. Under the measures of the Recommended Plan, necessary coordination activities will include the following:

Flood storage sites

It was noted in Chapter 6 that open space areas along Cooksville Creek were investigated for proposing flood storage sites. The majority of proposed storage sites are located within parks (**Table 6.3**), accordingly measures should be taken to coordinate with the City of Mississauga Community Services Department in order to facilitate the integration of this component of the Recommended Plan into parks programs and policies.

Channel capacity upgrades at Paisley Boulevard and King St.

- Purchase of a vacant lot is required in order to construct a berm within the floodplain of Cooksville Creek at Paisley Boulevard. The berm will extend from Shepard Avenue easterly and could be constructed at the back part of lots # 37 and 38, or on the vacant land immediately to the north of Paisley Boulevard East;
- Relocation of a walkway in Cooksville Park is required in order to accommodate the proposed bridge extension and channel realignment.

Construction of a berm along Rhonda Valley

As noted earlier in Chapter 6, the construction of a berm along Rhonda Valley is necessary to help mitigate flood damages to the buildings adjacent to the valley. In order to proceed with the implementation of the berm along Rhonda Valley, the confirmation of existing trail and recreational requirements will be needed.

Source and Conveyance control measures

The City of Mississauga Stormwater Quality Control Strategy Update study (Aquafor, 2011) sets up a framework for the implementation of source and conveyance control measures. The implementation strategy for source control measure includes a social marketing strategy as an integral part of the overall strategy. The strategy for the implementation of conveyance control measures includes a process-based framework incorporating different alternative solutions for different roadway and ROW arrangements.

According to Aquafor (2011), the Recommended Stormwater Quality Strategy for source and conveyance control measures aligns with the recommendations of the Credit River Water Management Strategy Update (CRWMSU) which advocates the application of source and conveyance controls in new and existing areas (retrofits) to maintain or enhance the existing

Credit River watershed environmental resources and therefore meet various environmental targets.

In addition, source and conveyance control measures are an important component of the Cooksville Watershed Study process which includes characterization of existing conditions, impact assessment, and an implementation document.

7.9 Future study requirements

Future studies are required in order to complement the analyses, conclusions and recommendations of this study towards the implementation of each type of measure which constitutes the Recommended Plan.

The proposed construction of flood storage sites in the upstream locations and site-specific capacity upgrades and flood mitigation measures are subject to the Class Environmental Assessment Process. Projects undertaken by municipalities vary in their environmental impacts. Consequently, projects are classified according to Class EA Schedules ranging from A and A+ to B and C project schedules.

Since this study is considered a Master Plan under Schedule B and Approach 1, further steps will be needed to arrive to the implementation stage based on the Municipal Class Environmental Assessment process (Section 1.2). Accordingly, the Class EA process for this study follows Phases 1 and 2 as defined earlier, and then uses the Master Plan as a basis for future investigations of site specific Schedule 'B' and 'C' projects. Therefore, future studies will include preliminary and detailed design for confirming the feasibility and determine sizing requirements for each measure prior to construction.

Source and Conveyance control measures

According to the City of Mississauga Stormwater Quality Control Strategy Update study (Aquafor, 2011), future study requirements for source controls are minimal. Source control measures fall outside of the Municipal Class EA process, since they are to be constructed on private property, often by the individual land owner as a retrofit or during development/ redevelopment (i.e. the City if not the proponent). According to Aquafor (2011), the following studies can be initiated by land owners in order to implement source control measures on their properties:

- In-Situ Hydraulic Conductivity Testing; and/or
- Geotechnical investigations.

In general, Conveyance control measures fall within the Municipal Class EA process, specifically Part B- Municipal Road Projects. The specific Class EA Schedule of individual projects must be determined in relation to the specifics of the road reconstruction process Part B of the Municipal Engineers Association Class Environmental Assessment document (MEA 2000, as amended 2007), should be reviewed in conjunction with the project schedules in Appendix I.

Additional study requirements for the implementation of conveyance control measures include but are not limited to the following:

- Perform geotechnical investigation –Geotechnical investigations should be coordinated with those normally undertaken as part of road resurfacing and reconstruction projects (existing asphalt thickness, sub-grade thickness etc) and include boreholes within the ROW to determine soil stratigraphy, composition and grain-size.

- In-Situ Hydraulic Conductivity Testing - designs using LID infiltration techniques will require on-site soil testing using the Guelph Permeameter test (as specified in the Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0 (TRCA/CVC - 2010) or approved equivalent to confirm site specific design infiltration rates, design specification and costs.

7.10 Monitoring requirements

A monitoring program should be developed in order to ensure that the objectives of this study including primary and secondary objectives (Section 1.1) are met. The program will also comply with the recommendations of the technical assessment of the Recommended Plan. In that regard, the coordination with Credit Valley Conservation (CVC) is deemed necessary to take advantage of available data and logistics for monitoring purposes.

Suggested monitoring activities would include the following:

- <u>Flood storage sites</u>:
  - Flow monitoring upstream of storage sites for flood monitoring
  - Flow monitoring downstream of storage sites to validate peak flow reductions
  - Monitoring of key terrestrial and aquatic habitats influenced by high stormwater volumes (as recommended by Peel Climate Change Strategy Background Report, June 2011)
- <u>Site-specific capacity improvement and flood mitigation at King, Paisley and Rhonda Valley</u>:
  - Develop construction monitoring program to be followed during and following the construction to protect the natural environment
- <u>Source and conveyance control measures</u>:
  - Monitor pilot projects to assess technical performance. As part of the *Lakeview Neighborhood ROW Retrofit* and the *Elm Drive Road Retrofit Project,* the City of Mississauga in partnership with the CVC are undertaking the following monitoring activities:

- *Lakeview* - *D*esign of the monitoring program has been established and pre-construction monitoring is being undertaken (July 2010 to present) for flow, precipitation and water quality (Chloride, Conductivity, pH, *T*SS, TDS, and Total Phosphorous).

- *Elm Drive* - Flow monitoring began in the fall of 2011 to evaluate the peak and volume reductions and the design model and will continue through 2012. Available data includes groundwater level and temperature, precipitation and flow (Sept 2011 to present).

8.0 PUBLIC CONSULTATION PROCESS

Public Consultation included separate meetings with the Task Force Committee and the public. Meetings with the Task Force Committee have covered topics that included:

- Overview of the study;
- Relationship of this study to the other ongoing studies;
- General types of works that could be undertaken within the watershed;
- Information available from members of the Task Force;
- Presentation of stream restoration alternatives.

Task Force members were also encouraged to attend the Public Open House. The Public Open House was held on May 01, 2012 at City of Mississauga offices.

The Public Open House included:

- Welcoming from City of Mississauga staff
- A series of posters which defined
    - The study area
    - Objectives of the Open House
    - Problems and Opportunities
    - The Environmental Assessment Process
    - The flood Management Alternatives that were being considered
    - The Evaluation Process
    - Preliminary Preferred Solution
    - Next Steps

A summary of the information which was presented at the Open House is provided in **Appendix C.**

9.0 CONCLUSIONS / RECOMMENDATIONS

9.1 General

This study was carried out using the Master Plan process of the Class Environmental Assessment for Municipal Water and Wastewater Projects, and is subject to the requirements of the Environmental Assessment Act. This document, as presented, provides relevant information with respect to Phases 1 and 2 of the Environmental Assessment Process. Subsequent phases of the process will involve completion of contract drawings and documents for all proposed works together with appropriate monitoring requirements.

9.2 Conclusions

The following points are key conclusions drawn from this study:

- Flooding issues are dominant along Cooksville Creek, especially downstream of HWY 403 where development has taken place within the Regulatory floodplain;
- Flooding is exacerbated due to undersized crossings and lack of stormwater management facilities to mitigate actual and potential flood damages;
- There is significant opportunity to implement traditional and non-traditional flood management measures within the Cooksville Creek watershed that would mitigate flood damages and address environmental issues such as stream erosion and water quality;
- The evaluation of alternatives used four sets of criteria: Natural environment, Social/Cultural, Economic, and Implementation criteria. A technical assessment was applied to alternatives that were ranked highest in the evaluation;
- Proposing traditional and non-traditional alternatives to mitigate floods at the watershed scale (i.e. allocation of flood storage sites in upstream locations), and at the site scale (i.e. crossing expansion, watercourse realignment, and berm construction at King Street, Paisley Boulevard and Rhonda Valley) is necessary to mitigate flood damages along Cooksville Creek;
- The implementation of the Recommended Plan proposed in this study to mitigate flood damages would protect a majority of the areas for the 100-year storm and assist in reducing impact for the Regional storm. In addition, many environmental benefits such as sustaining stream health and stability and improving water quality.

9.3 Recommendations

It is recommended that the following actions are taken:

(1) That the proposed flood management measures as outlined in this document (i.e. Recommended Plan) be undertaken

(2) That the Implementation Strategy is visited in order to apply the suggestions of the Recommended Plan

(3) That future studies take into consideration the findings and proposals outlined in this study, especially Chapter 6 and Chapter 7.

10.0 REFERENCES

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