

Cooksville Creek Flood Evaluation Master Plan EA

Final Report

A report prepared for:

The City of Mississauga

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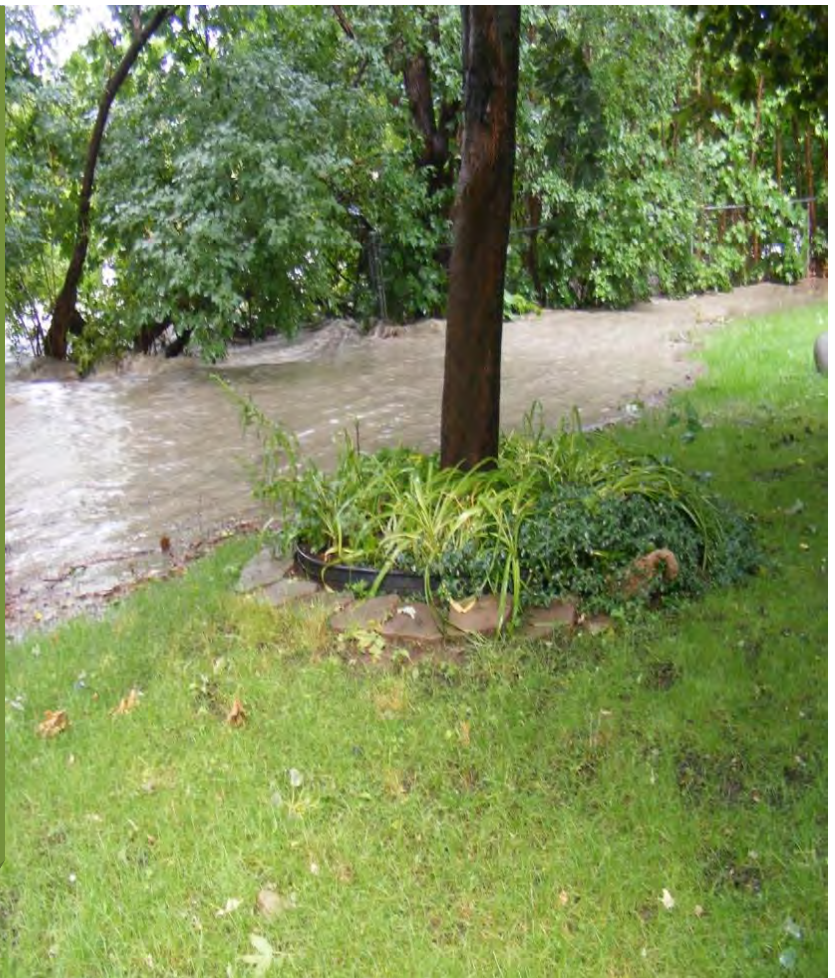


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EXECUTIVE SUMMARY

Introduction

The Cooksville Creek watershed is an urban watershed located entirely within the City of Mississauga. The watershed drains an area of approximately 33.9 Km² (3,390 ha) outletting to Lake Ontario. The watershed has been under increasing urban development pressure since the 1940's, moving from a predominant agricultural land use with woodlots and natural creek corridor in the forties to a combination of residential and industrial/commercial land use at present time (60% residential, 34% industrial/commercial, 6% open space).

Drainage infrastructure within the Cooksville Creek watershed has been designed to quickly and efficiently convey flows from the table lands to the receiving stream. More specifically, stormwater and flood management within the Cooksville Creek watershed has hinged upon a storm sewer system spanning across the watershed and three stormwater management facilities used as detention basins to store stormwater runoff and slowly release it to the receiving waterways.

Past experience with riverine issues across the Cooksville Creek watershed suggests that it is prudent to pursue a modern, implementable approach that attempts to mitigate riverine flooding. In order to address a progressive vision for looking at flood control for environmental and socio-economic purposes, this study proposes a combination of traditional measures that have been historically proposed to manage flood issues within the Cooksville Creek watershed (EWRG, 2002) and innovative flood control approaches that not only address flooding issues but also consider the management of other environmental features and functions in the watershed such as water quality and stream erosion. The study also presents an implementation strategy to assure that the solutions proposed are tangible and implementable.

This study is a Master Plan that is carried out under Approach 1 of the Municipal Class Environmental Assessment, and is subject to the requirements of the Environmental Assessment Act. Public meetings, together with a series of formal and informal meetings were held with stakeholders including the City of Mississauga, Credit Valley Conservation and local residents.

Study Objectives

The objectives of the study are as follows:

- Primary objective:
 - Reduce the occurrence of riverine flooding for dwellings and properties adjacent to Cooksville Creek
- Secondary objectives:
 - Reduce extent and frequency of erosion;
 - Improve water quality conditions within Cooksville Creek;

- Improve aquatic habitat conditions

Phase 1 – Problem and Opportunity Identification

Based on the requirements of the Environment Assessment process stipulated by the Municipal Class Environmental Assessment (MEA, 2007), there are identified problems and/or opportunities that need to be addressed in the study area. The problems identified in this study are divided into primary problems and secondary problems.

Primary problem

As a result of the urban character of the Cooksville Creek watershed, the watershed exhibits a flashy hydrologic response typical of highly urbanized watersheds developed without the benefits of updated stormwater management infrastructure. Flooding and drainage issues exist within the watershed in areas where development has reduced channel conveyance and restricted floodplain capacity, and as a result caused backwaters to flood upstream reaches. According to the Cooksville Creek Flood Remediation Plan (EWRG, 2002), approximately 304 buildings can be inundated in the middle and lower part of the watershed for the regulatory flood (i.e. Hazel Storm) and 119 buildings for the 100-year flood. Recent storms occurring in the watershed (August 4, 2009 storm) had caused flood damages that impacted buildings, municipal infrastructure, pedestrian bridges and channel protection measures along Cooksville Creek (EWRG, 2010). In terms of location within the watershed, the Cooksville Creek Flood Remediation Plan (EWRG, 2002) notes that the buildings impacted by flooding are classified as follows (**Figure ES.1**):

- From CNR to the QEW, approximately 108 buildings could potentially be flooded for the regulatory storm. The majority of the buildings could be flooded because of the CNR crossing low capacity ($130 \text{ m}^3/\text{s}$ compared to Regional Flow of $295 \text{ m}^3/\text{s}$).
- From QEW to King Street East, 108 buildings could potentially be flooded due to QEW crossing low capacity ($110 \text{ m}^3/\text{s}$ compared to Regional Flow of $295 \text{ m}^3/\text{s}$).
- From the CPR to Central Parkway East, where CPR crossing has a capacity of $125 \text{ m}^3/\text{s}$ compared to $250 \text{ m}^3/\text{s}$ for the Regional Flow.



KEY MAP

LEGEND:

- Streams
- Subwatershed Boundary

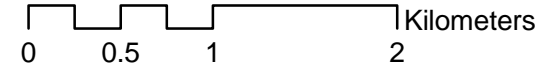
Properties Susceptible to Flooding During Regulatory Storm

Location

- Burnhamthorpe Road East to Eglinton Avenue East
- CNR to QEW
- CPR To Mississauga Valley Boulevard (North)
- Eglinton Avenue West to Matheson Boulevard West
- Highway 403 to Eglinton Avenue East
- King Street East to CPR
- Lake Ontario to CNR
- QEW to King Street East

NOTES:

Base Mapping was provided by City of Mississauga



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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

No. of Properties Susceptible
to Flooding During Regulatory Storm

FIGURE No. ES.1

DATE: May 2012

Secondary problems

Secondary problems within the Cooksville Creek watershed are: erosion and water quality degradation. Erosion along Cooksville Creek is manifested by the following:

- Downward erosion of the channel into the underlying shale bedrock
- Channelization of Cooksville Creek has resulted in a loss of the historical meander pattern and associated pools and riffles
- Extensive failure of bank and bed protection

Concerning the status of surface water quality in the watershed, previous reports (CVC, 2010) notes that surface water has high levels of E coli and chloride. Water temperatures do not comply with the Provincial standards for cold water habitat. Under dry weather conditions, concentrations for nutrients and metals meet guidelines. Wet weather concentrations/loadings are significantly high for nutrients and metals and exceed guidelines. Fish habitat issues include water temperatures exceeding 26°C and unsuitable substrate for spawning needs.

Opportunities

The opportunities identified for this study include the following:

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

Phase 2 – Evaluation of Alternative Solutions

The alternative solutions that were initially developed to address the study objectives and associated issues were broadly categorized as follows:

Traditional alternatives

- Watercourse capacity upgrade: increasing the capacity of the existing watercourse may reduce flood levels.
- Crossing capacity upgrade: increasing the capacity of existing culverts or bridges may reduce water levels.
- Dykes/Berms: dykes or berms are built adjacent to dwellings in order to contain flows within the floodplain
- Flood proofing: Landowners can floodproof buildings by sealing or filling in openings which are susceptible

- Land acquisition: Flood susceptible properties could be purchased by the City or Credit Valley Conservation and then removed.

Non-Traditional alternatives

- Storage in Upstream locations: storage in upstream lands within parks or vacant properties could be used to reduce flood levels in Cooksville Creek
- Source control measures: implemented on private property, include roof downspout disconnection, use of rain barrels, pervious driveways and rain gardens
- In-channel storage: storage within Cooksville Creek could be used to reduce flood levels
- Conveyance control measures: implemented within the municipal right-of-way include bioretention units, or perforated pipes. The measures encourage infiltration or evapotranspiration, thereby reducing runoff and flood levels.
- Tunnel: construction of a tunnel, which would divert flows above levels which cause flooding could be considered.

The evaluation of the two sets of alternative solutions used a two-fold approach:

- First evaluation level: provided a general description of each potential alternative and evaluated each alternative based on the following categories of criteria:
 - Natural environment
 - Economic
 - Social/Cultural
 - Implementation

The result of the first evaluation level was that a set of alternative solutions was brought forward based on their effectiveness in addressing the assessment criteria.

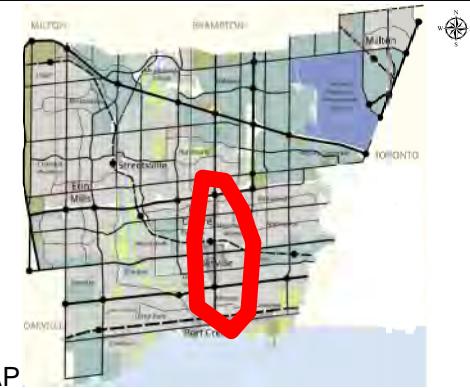
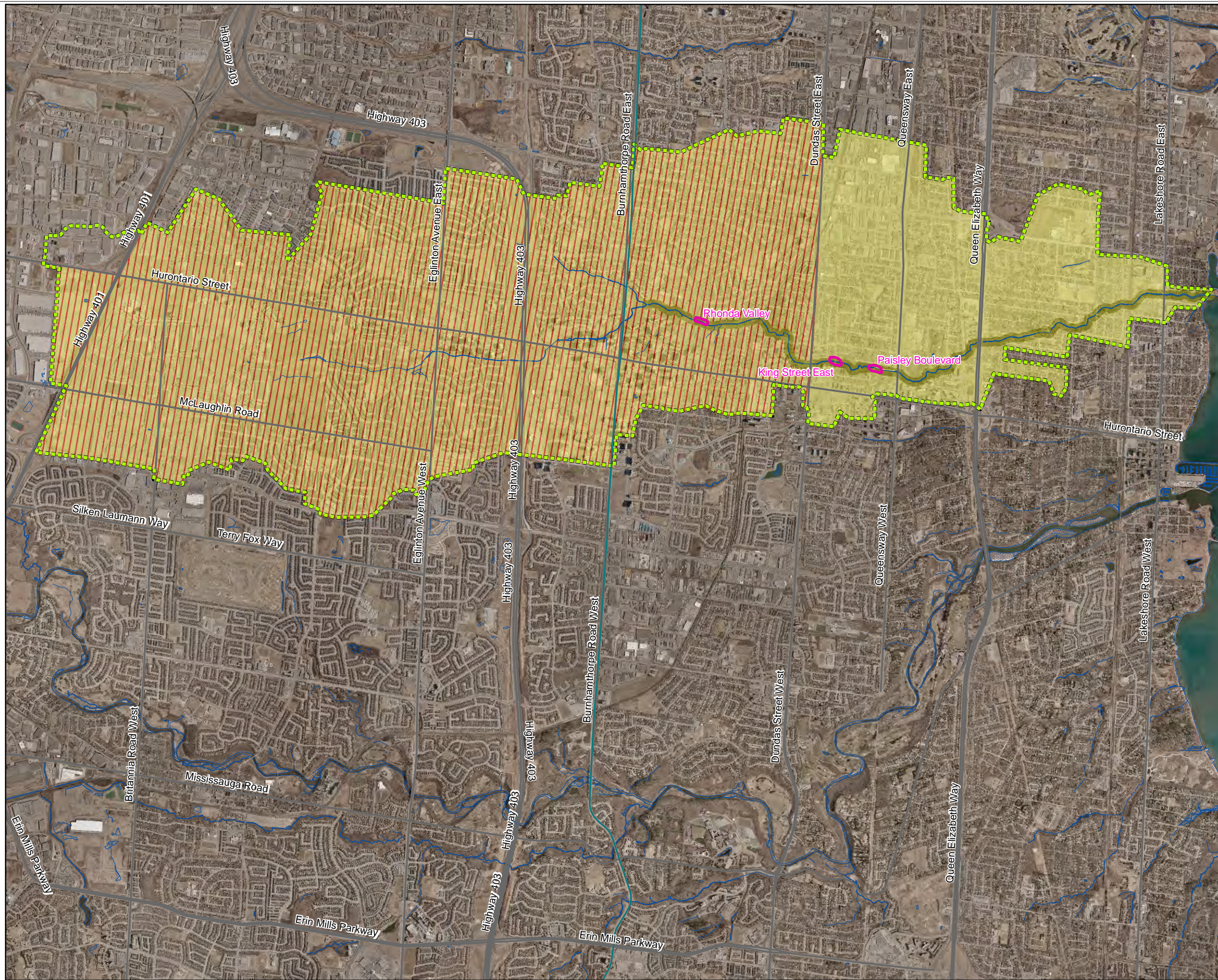
- Second evaluation level: carried out a technical assessment of the alternatives which have been brought forward in order to establish a practical plan.

Selection of the Preferred Alternative

The set of alternative solutions that scored highest in the first evaluation level is called: the Recommended Plan. The Recommended Plan is illustrated in **Figure ES.2**, and it includes the following solutions:

- Flood 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 Road 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



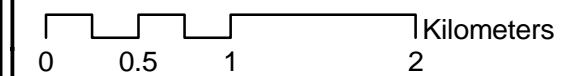
KEY MAP

LEGEND:

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

NOTES:

Base Mapping was provided by City of Mississauga



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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

Recommended Plan

FIGURE No. ES.2

DATE: May 2012

Implementation Strategy

The Implementation Strategy describes the activities which must be undertaken if the Recommended Plan is to be successfully implemented. 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;
- The Implementation Strategy must be consistent with other municipal programs, policies and standards;
- The implementation should focus on areas which have historically been hardest hit by flooding

The Implementation Strategy includes the following components, many of which are illustrated in **Table ES.1**:

- 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 ES.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	<ul style="list-style-type: none"> Coordination with the Community Services Department re: parks programs and policies Purchase of two properties 	<p>Park 317 (Site # 1) : 1 – 3 Years</p> <p>The remainder of sites (3 – 20 Years)</p>	<ul style="list-style-type: none"> 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	7,500,000	Capital Funding	Purchase of vacant lot within floodplain at Paisley Boulevard	1 – 3 Years	Reduction of flood frequency at King St. and Paisley Boulevard	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Depends on specifics of site Geotechnical assessment Hydraulic conductivity test

Public Consultation

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.

Conclusions and Recommendations

- (1) Flooding issues are dominant along Cooksville Creek, especially downstream of HWY 403 where development has taken place within the Regulatory floodplain;
- (2) Flooding is exacerbated due to undersized crossings and lack of stormwater management facilities to control flooding and mitigate actual and potential flood damages;
- (3) 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;
- (4) 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;
- (5) 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;
- (6) The implementation of the Recommended Plan proposed in this study to mitigate flood damages would protect 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, improving water quality and aquatic habitat would be realized;
- (7) The Implementation Strategy provides an approach to allocate necessary resources for realizing the Recommended Plan.

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 be followed 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.

1.0 INTRODUCTION

The Cooksville Creek watershed is a typical urban watershed with 94% of its area developed and only 6% constituting open space. The watershed area is 33.9 Km² with an approximate length of 15 Km and an approximate width of 2 Km. Intensive urban development along Cooksville Creek accompanied with undersized road crossings and lack of adequate stormwater management measures have led to flooding issues along Cooksville Creek including a large storm event (close to the 100-year storm) which occurred on August 4th, 2009 and caused flood damage along the Creek (EWRG, 2010).

The City of Mississauga has retained Aquafor Beech Limited to conduct a flood evaluation study for Cooksville Creek. Floodline mapping for Cooksville Creek was originally completed by Kilborn Limited in 1975. Dillon Limited completed the Cooksville Creek Watershed Study in 1979. Dillon's study carried out a hydrologic assessment, and identified flooding problem areas with alternative flood control measures for the 50 and the 100-year storm flows under various development conditions. The 1975 floodline mapping for Cooksville Creek was updated in 1996 by R.V. Anderson (R.V.A, 1996).

Environmental Water Resources Group completed a study entitled Cooksville Creek Flood Remediation Plan (EWRG, 2002) which reviewed the floodline mapping done by RV Anderson (R.V.A, 1996) and proposed flood mitigation measures. EWRG (2002) showed that 304 buildings (the majority of them located downstream of Highway 403) could potentially be flooded during the Regulatory Storm. Moreover, the EWRG study proposed traditional flood management measures (e.g. enlargement of road/railway crossings, channel enlargement, flood proofing) that focused on reducing flood damage during the Regulatory Storm.

Building on previous flood assessment and remediation studies covering Cooksville Creek, the City of Mississauga has shown interest in combining current knowledge concerning flood issues in the study area with new and innovative solutions in order to alleviate and/or manage flooding-related issues on public and private properties.

This study is a flood evaluation study which has the format of a Master Plan Class EA study. The study addresses relevant urban and environmental features and functions within the Cooksville Creek Watershed in order to propose innovative flood and stormwater management measures that are holistic in coping with various environmental concerns such as water quality, erosion, flooding, and fisheries, but with special focus on flooding issues.

The study consists of the following nine (9) sections:

- 1. Introduction**
- 2. Identification of Problems and Opportunities**
- 3. Review of Background Documents**

- 4. Review of Existing Conditions**
- 5. Evaluation of Alternatives**
- 6. Recommended Plan**
- 7. Implementation Strategy**
- 8. Public Consultation Process**
- 9. Conclusions and Recommendations**

The study also contains three appendices:

- **Appendix A:** Catchment Delineation for Flood Storage Sites
- **Appendix B:** Hydrologic and Hydraulic Modeling
- **Appendix C:** Public Consultation Material

1.1 Study Objectives

The objectives of the study are as follows:

- Primary objective:
 - Reduce the occurrence of riverine flooding for dwellings and properties adjacent to Cooksville Creek
- Secondary objectives:
 - Reduce extent and frequency of erosion;
 - Improve water quality conditions within Cooksville Creek;
 - Improve aquatic habitat conditions

1.2 Municipal Class Environmental Process

The study is being completed as a Municipal Class Environmental Assessment. The Environmental Assessment Act was legislated by the Province of Ontario in 1990 to ensure that an Environmental Assessment is conducted prior to the onset of development and development related (servicing) projects. Depending on the individual project or Master Plan to be completed, there are different processes that municipalities must follow in order to meet Ontario's Environmental Assessment requirements.

Class Environmental Assessments (Class EA) are prepared for approval by the Minister of the Environment. A Class EA is an approved planning document that defines groups of projects and activities and the environmental assessment (EA) process which the proponent commits to for each project undertaking. Provided the process is followed, projects and activities included under the Class EA do not require formal review and approval under the EA act. In this fashion, the Class EA process expedites the environmental assessment of smaller recurring projects.

The Municipal Class Environmental Assessment Master Planning process to be followed in this study is illustrated in **Figure 1.1**. The process as shown in **Figure 1.1** could involve up to five phases of assessment. These phases include:

- **Phase 1:** Establish the Problem or Opportunity
- **Phase 2:** Identify and Assess Alternative Solutions to the Problem, and Select a Preferred Alternative
- **Phase 3:** Identify and Assess Alternative Design Concepts for the Preferred Solution, and Select a Preferred Design Concept.
- **Phase 4:** Prepare an Environmental Study Report
- **Phase 5:** Process with Design and Implementation.

Public and agency consultation is also an important and necessary component of the five phases.

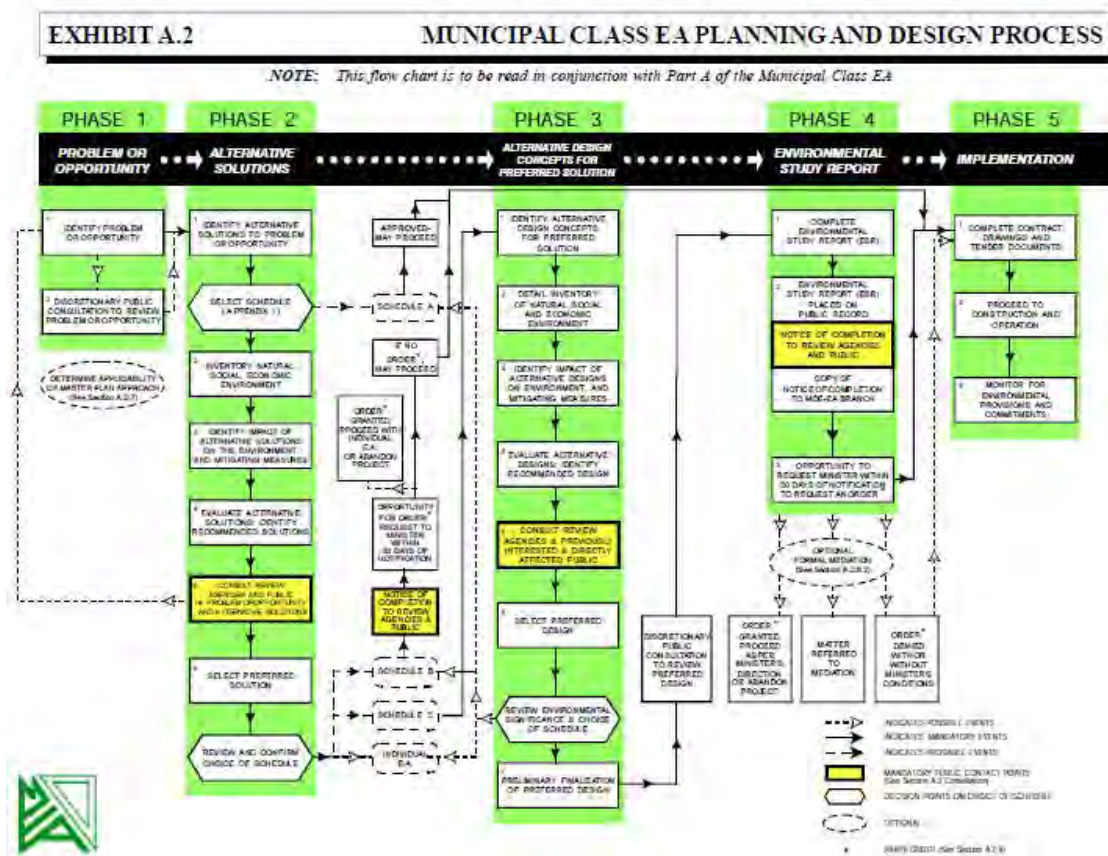


Figure 1.1 MEA Planning and Design Process (MEA, 2007)

In partial fulfillment of Ontario's Environmental Assessment requirements, a Master Plan must satisfy at least the first two phases of the Class Environmental Assessment process. Depending on the type of Master Plan to be completed, Phases 3 and 4 may also be required.

The Municipal Engineers Association's Class EA document also classifies projects as Schedules A, A+, B or C depending on their level of environmental impact and public concern. Any project identified in this Master Plan must be classified as to their level of complexity which will in turn decide which Schedule process needs to be followed.

- **Schedule 'A'** projects are generally routine maintenance and upgrade projects; they do not have the potential for significant environmental impacts or need public input. Schedule 'A' projects are pre-approved without any further public consultation.
- **Schedule 'A+'** Introduced in 2007 by the Municipal Engineers Association, these projects are pre-approved; however the public is to be advised prior to the project implementation. Per Appendix I –Project Schedules of the Municipal Class Environmental Assessment (2000, as amended in 2007), wastewater management projects that are intended to **“modify, retrofit, or improve a retention/detention facility including outfall or infiltration systems for the purposes of stormwater quality control” including “biological treatment through the establishment of constructed wetlands”** are pre-approved under Schedule A⁺ of the MEA.
- **Schedule 'B'** projects have more environmental impact and do have public implications. Examples would be stormwater ponds, river crossings, expansion of water or sewage plants beyond up to their rated capacity, new or expanded outfalls and intakes, and the like. Schedule 'B' projects require completion of Phases 1 and 2 of the Class EA process.
- **Schedule 'C'** projects have the most major public and environmental impacts. Examples would be storage tanks and tunnels with disinfection, anything involving chemical treatment or expansion beyond a water or sewage plants rated capacity. Schedule 'C' projects require completion of Phases 1 through 4 of the Class EA process, before proceeding to Phase 5 implementation.

The Municipal Engineers Association's Class EA document also identifies four different approaches to completing Master Plans corresponding to different levels of assessment. Regardless of the approach selected, all Master Plans must follow at least the first two phases of the Class Environmental Assessment process.

- **Approach 1**, the most common approach, is to follow Phases 1 and 2 as defined above, then use the Master Plan as a basis for future investigations of site specific Schedule 'B' and 'C' projects. Any Schedule 'B' and 'C' projects that need specific Phase 2 work and Phases 3 and 4 work, usually have this Phase 2, 3 and 4 deferred until the actual project is implemented.
- **Approach 2**, is to complete all of the work necessary for Schedule 'B' site specific projects at the time they are identified. Using this approach, a municipality would identify everything it needed in the first five years and would complete all the site specific work required, including public consultation to meet Class EA requirements. The Master Plan in such cases has to be completed with enough detail so that the public in site specific locations can be reasonably informed, and so that the approving government Agencies (Conservation Authorities, Natural Resources, Federal Department of Fisheries and Oceans, Transportation Canada etc.) can be satisfied that their concerns will be addressed before construction commences.
- **Approach 3**, is to complete the requirements of Schedule 'B' and Schedule 'C' at the Master Plan stage.
- **Approach 4**, is to integrate approvals under the EA and Planning Acts. For example, the preparation of new or amended Official Plans could be undertaken simultaneously with Master Plans for water, wastewater and transportation, and approval for both sought through the same process.

For the purpose of this study, the City of Mississauga has selected Schedule B and Approach 1 for undertaking the Master Plan. The Master Plan will therefore be completed such that the level of investigation, consultation and documentation is sufficient to fulfill the Municipal Class EA requirements for the Schedule B and C projects identified in the Master Plan.

Accordingly, this report provides a study which comprises the two phases of the Class EA process, namely:

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

Following the understanding of problem/opportunity component, alternative solutions will be assessed and a recommended plan (i.e. Preferred Alternative) to provide alternative solutions and a strategy for implementing a number of projects across the Cooksville Creek watershed will be proposed.

1.3 Background

The Cooksville Creek has a drainage area of 33.9 Km², with 94% of the total area developed. The land use distribution in the watershed is approximately 60% residential, 34% industrial/commercial and 6% open space. The climate of the Cooksville Watershed can be characterized as moderately cool with an average annual temperature of about 7.5°C and an

average annual precipitation of about 793mm. The total water equivalent of mean annual snow represents approximately 115mm. The watershed is under significant pressure from urban development. **Figure 1.2** shows land use changes in an urban area within the watershed (i.e. Hurontario St. and QEW) since the forties of the twentieth century. As opposed to a predominant agricultural land use with woodlots and natural creek corridor in the forties, residential land use dominates the landscape at present time.

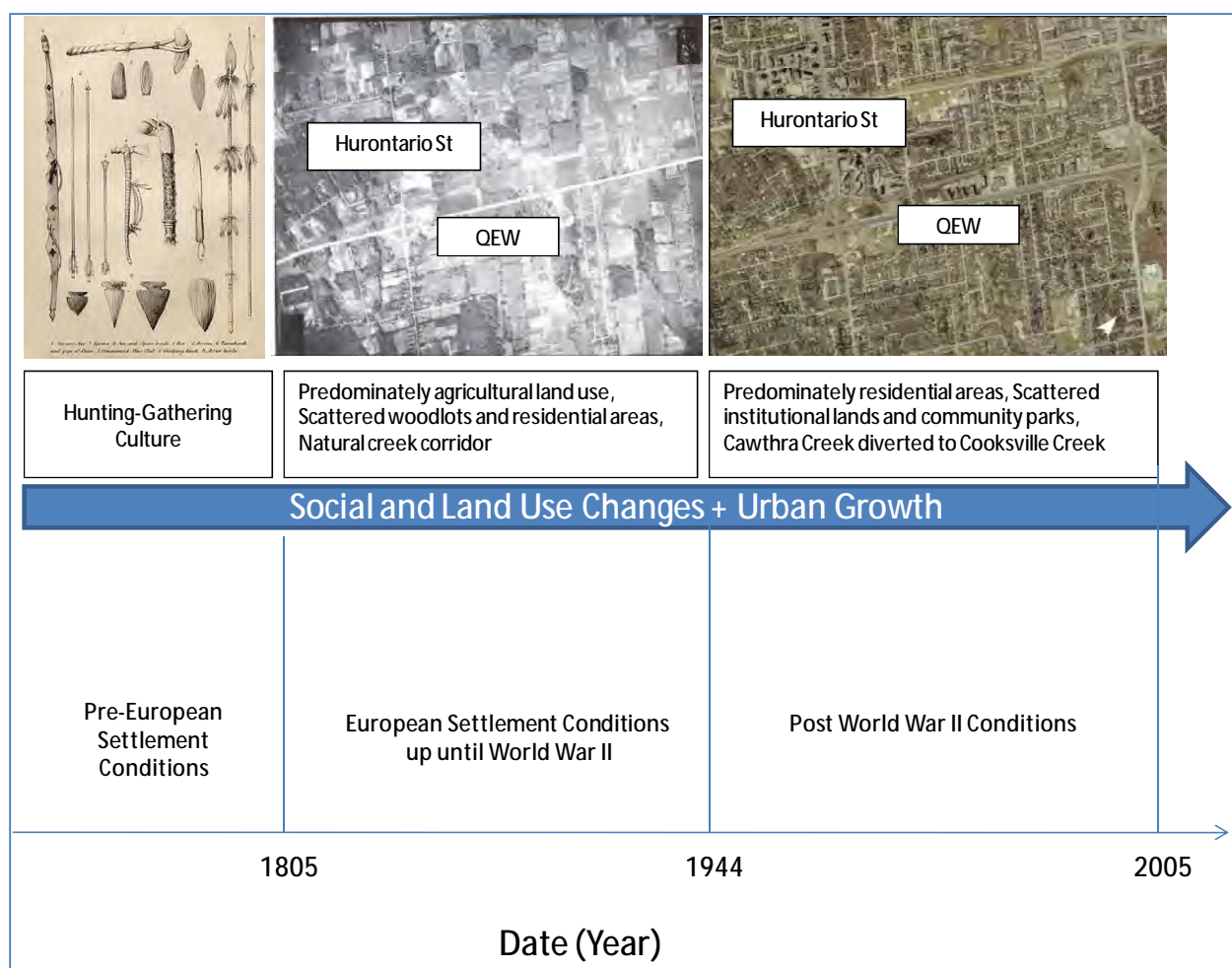


Figure 1.2 Age of Development Map for the Cooksville Creek Watershed (Hurontario St. and QEW Intersection as an example)

According to previous studies (EWRG, 2002), formal floodplain management within Cooksville Creek dates back to 1969. Flat floodplains in addition to highly erodible shale substrate along Cooksville Creek have resulted in increasing the susceptibility of areas along the Creek to flooding-related issues such as flooding, erosion, and water quality issues.

The urbanization of the Cooksville Creek watershed (about 94% of the watershed area is under residential and industrial/commercial land use) has altered the natural hydrological cycle within

the watershed and negatively affected the hydrology of Cooksville Creek. Although highly modified, the Cooksville Creek corridor is an important feature of the watershed. The Cooksville Creek watershed is dominated by urban land uses and has very little natural area remaining (9.6%). The percentages of forest (2.2%) and wetland habitat (0.2%) fall short of Environment Canada Habitat Guidelines which stress that a minimum of 30% forest coverage within a watershed is required in order to maintain forest interior species and area sensitive species, and that each watershed have greater than 10% of it's land in wetland habitat (or 6% of any subwatershed). Protection of the remaining natural sites is crucial to maintaining the ecological integrity and species diversity within the localized area and providing surrounding residents access to a significant green space.

Environmental changes that have occurred to the Cooksville Creek Watershed over years of increasing urban development include:

- The hydrology of the Cooksville Creek watershed is typical of an urban watershed. More specifically, the runoff coefficient is high, the hydrograph is flashy, and surface runoff volume is high due to high percentage of impervious areas;
- Water quality degradation resulting from urban-driven point and non-point source pollution such as increasing chloride levels;
- Stream erosion issues resulting from the alteration of the hydrology of the watershed due to urban development; and
- Natural heritage degradation including negative impacts to fish habitat (e.g. fish barriers and riparian cover) and the decrease of the percentage of terrestrial areas within the watershed.

1.4 Flood Management approach

1.4.1 General

Floods endanger lives, cause heavy economic losses and can have severe environmental consequences by eroding streams and transporting contaminants on their way. Although a natural phenomena, humans can reduce the likelihood of flooding and limit their impacts through sound and adequate measures that accommodate environmental and socio-economic concerns.

In general, the alteration of the natural hydrological cycle as a result of urbanization (i.e. increasing impervious cover) is manifested by significant changes in the proportion of precipitation that infiltrates into the ground, evaporates back into the atmosphere and enters drainage features as surface runoff. In particular, for a given storm event, the total volume of stormwater runoff reaching a stream increases 3 to 5 fold compared to rural or forested watersheds, accompanied with an increase in magnitude and duration of peak runoff (**Figure 1.3**). Implications of these impacts include flooding issues, property and infrastructure damage, and modifications in stream morphology due to excessive erosion and/or sedimentation.

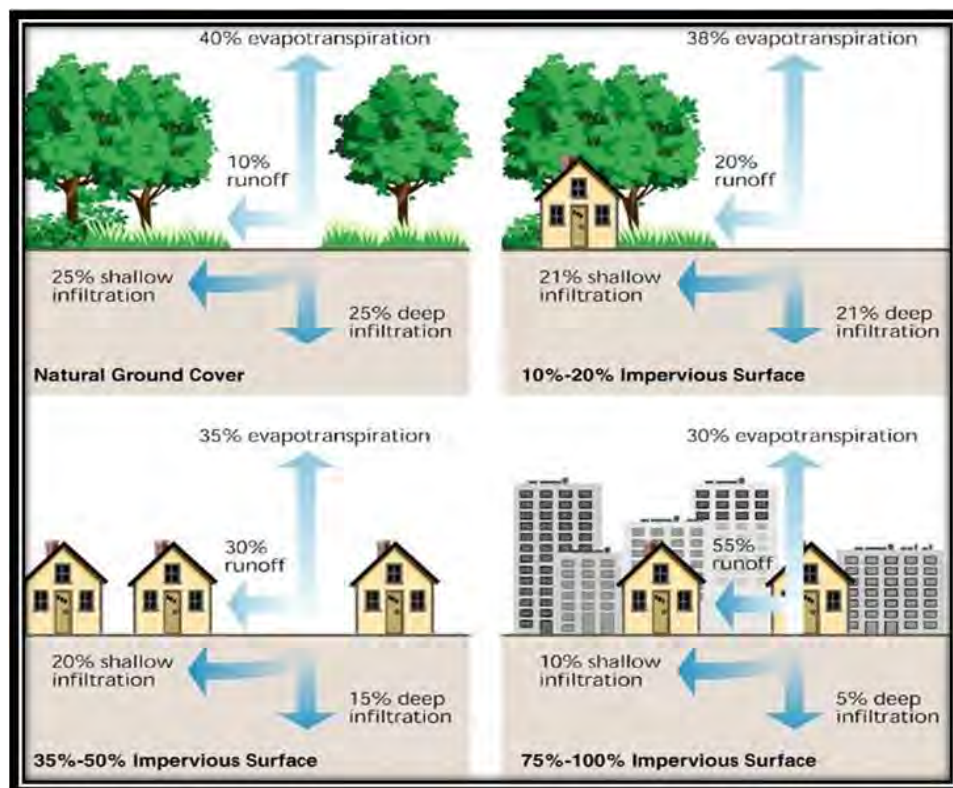


Figure 1.3 Impact of Urbanization on the Natural Hydrological Cycle

1.4.2 Traditional and Non-Traditional Flood Control Measures

This study adopts a progressive vision of looking at flood control for environmental and socio-economic purposes. The vision combines traditional measures that have been historically proposed to manage flood issues within the Cooksville Creek watershed (EWRG, 2002) with innovative approaches that not only address flooding issues but also consider the management of other environmental features and functions in the watershed such as water quality and erosion. Therefore, the study analyzes suites of flood management measures and proposes an implementation strategy to assure that the solutions proposed are tangible and implementable.

Traditional flood control measures include measures such as increasing road crossing capacity, floodproofing and/or enlarging watercourses. Non-traditional measures include measures such as flood storage above and underground in addition to Low Impact Development (i.e. source and conveyance control). Combining both measures at the watershed scale (e.g. flood storage within a portion of the watershed) and at the site scale such as increasing road crossing capacity to convey more water would lead to major socio-economic and environmental benefits.

2.0 IDENTIFICATION OF PROBLEMS AND OPPORTUNITIES

This chapter describes the key environmental issues at the Cooksville Creek watershed scale, and presents their relevance to the study objectives. The assessment of the environmental problems below is founded on the premise that hydrology is a key driver of environmental features and functions at the watershed scale. Therefore, examining flood management entails the study of impacts on other resources within Cooksville Creek Watershed, mainly water quality, fisheries and stream erosion. The chapter also presents general opportunities that are introduced to set-up a framework which could identify and propose specific solutions and implementation strategies for flood management within Cooksville Creek Watershed as per the primary and secondary objectives of the study (Section 1.1).

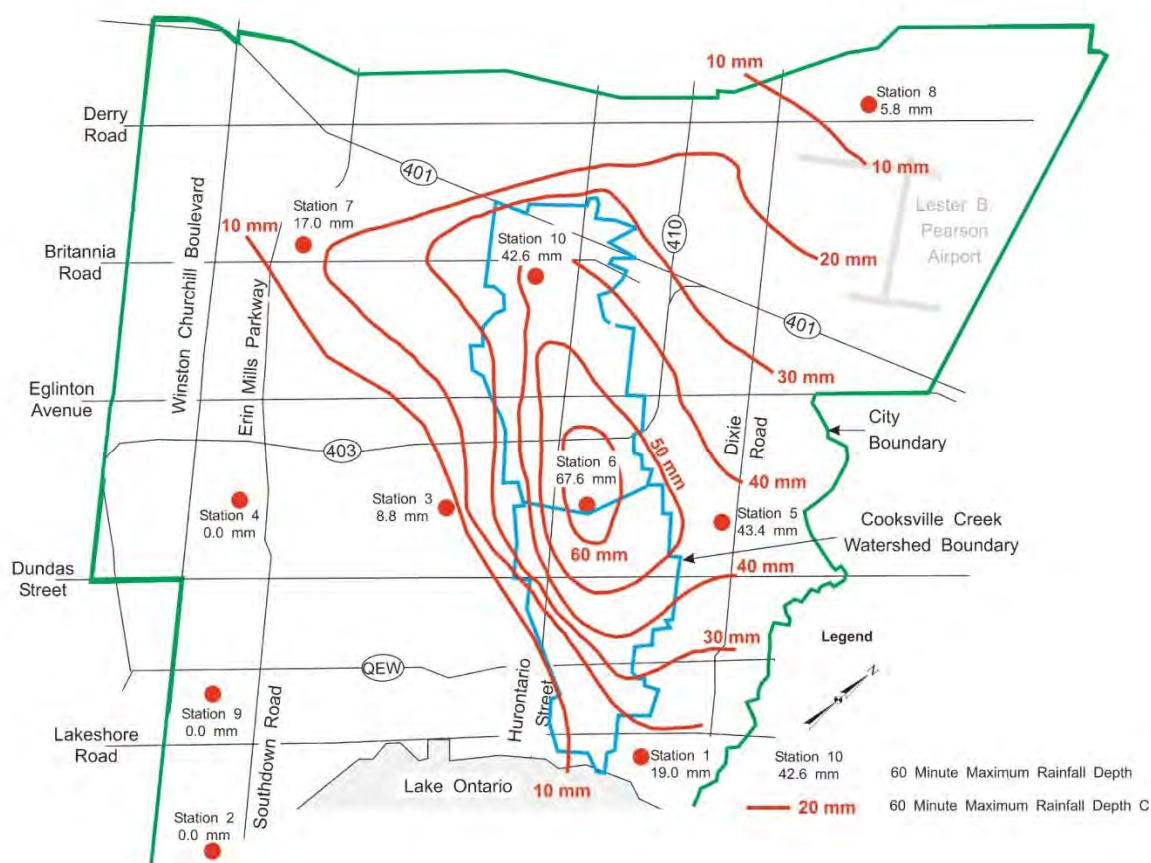
2.1 Problems

2.1.1 Flooding

The Cooksville Creek watershed exhibits a flashy hydrologic response typical of highly urbanized watersheds developed without the benefits of updated stormwater management infrastructure. Flooding and drainage issues exist within the watershed in areas where development has reduced channel conveyance and restricted floodplain capacity, and as a result caused backwaters to flood upstream reaches. Approximately 304 buildings can be inundated in the middle and lower part of the watershed for the regulatory flood (i.e. Hurricane Hazel) and 119 buildings for the 100-year storm (EWRG, 2002).

On August 4, 2009, significant flood damages occurred within Cooksville Creek watershed (**Figure 2.1**). The damages took place in different areas and covered many land uses including:

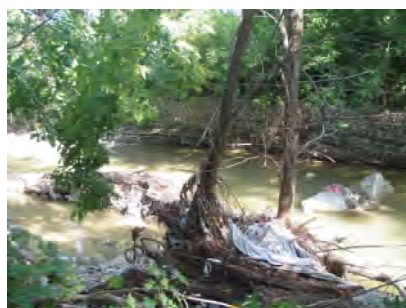
- Buildings (i.e. basements and yards);
- Municipal infrastructure;
- Fences and pedestrian bridges, and
- Trails and channel protection measures



Basement flooding



Degraded municipal infrastructure



Stream erosion

Figure 2.1 Above: An isohyetal map representing rainfall depth across the Cooksville Creek Watershed during the August 4, 2009 Storm Event (EWRG, 2010). Below: Impacts of the August 4, 2009 Storm Event within the Cooksville Creek Watershed

Approximately 68 mm of rainfall was recorded in one hour on August 4, 2009. **Figure 2.1** shows the rainfall depth distribution across the Cooksville Creek watershed, where it can be noticed that the highest rainfall depth was recorded at the centre of the watershed. This localized high intensity rainfall event generated the highest streamflow rate ever recorded by the Water Survey of Canada (WSC) Cooksville Creek near Cooksville gauge (02HB030, located roughly at the

centre of the watershed). The runoff volume generated was approximately 571,500 m³ from an upstream drainage area of 20.6 Km². Runoff estimates from the August 4, 2009 event showed a runoff coefficient of 0.61 which reveals the high runoff proportion of the watershed's water budget (**Figure 1.3**), which is typical of urban watersheds.

Generally speaking, most of the inundation occurs in the middle and lower areas of the watershed (**Figure 2.2**). Inundation affects approximately 304 buildings for the Regulatory Flood and approximately 119 for the 100 year flood (EWRG, 2002). In terms of location within the watershed, these buildings are classified as follows:

- From CNR to the QEW, approximately 108 buildings could potentially be flooded for the regulatory storm. The majority of the buildings could be flooded because of the CNR crossing low capacity (130 m³/s compared to Regional Flow of 295 m³/s).
- From QEW to King Street East, 108 buildings could potentially be flooded due to QEW crossing low capacity (110 m³/s compared to Regional Flow of 295 m³/s).
- From the CPR to Central Parkway East, where CPR crossing has a capacity of 125 m³/s compared to 250 m³/s for the Regional Flow.



KEY MAP

LEGEND:

- Streams
- Subwatershed Boundary

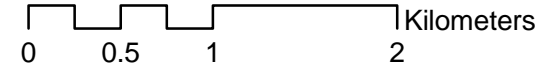
Properties Susceptible to Flooding During Regulatory Storm

Location

- Burnhamthorpe Road East to Eglinton Avenue East
- CNR to QEW
- CPR To Mississauga Valley Boulevard (North)
- Eglinton Avenue West to Matheson Boulevard West
- Highway 403 to Eglinton Avenue East
- King Street East to CPR
- Lake Ontario to CNR
- QEW to King Street East

NOTES:

Base Mapping was provided by City of Mississauga



2600 Skymark Avenue
Mississauga, ON L4W 5B2
Phone: 905-629-0099
Fax: 905-629-0089



COOKSVILLE CREEK FLOOD EVALUATION MASTER PLAN EA

No. of Properties Susceptible to Flooding During Regulatory Storm

FIGURE No. 2.2

DATE: May 2012

2.1.2 Erosion

CVC (2010) indicates that most of the Cooksville creek reaches are either in adjustment or in a transitional/stressed state. Accordingly, Cooksville Creek is a watercourse that is actively adjusting in the form of widening and degradation (incision). These two processes have combined to create an over-sized cross-section which was necessitated by the need to accommodate urbanized peak flow events but, for much of the year, supports minimal baseflows.



Existing and historic land use practices and channel modifications within the Cooksville Creek watershed have combined to create a watercourse that is not stable in the long term. Fluvial geomorphic issues observed along Cooksville Creek are manifested in the following:



- Downward erosion of the channel into the underlying shale bedrock;
- Channelization of Cooksville Creek has resulted in a loss of the historical meander pattern and associated pools and riffles ;
- Extensive failure of bank and bed protection.

Cooksville Creek has experienced significant erosion over the last 20 years. During this period, the City of Mississauga has undertaken restoration works at 12 sites, where \$8 million was spent to restore Cooksville Creek. In addition, the City of Mississauga has identified 10 priority stream erosion control projects for the period between 2011 and 2020 (**Figure 2.3**).

2.1.3 Water quality

Surface water within Cooksville Creek has high levels of E coli and Chloride. Water temperatures do not comply with the Provincial standards for cold water habitat. Under dry weather conditions, concentrations for nutrients and metals meet guidelines. However, wet weather concentrations/loadings are significantly high for nutrients and metals and exceed guidelines.

In regard to groundwater quality, groundwater is very hard along the Cooksville creek. The groundwater throughout the watershed has high concentration of sodium and chloride due to the intensive application of road salt. The concentration of sulfate is relatively high. In general, the groundwater in the watershed is not suitable for drinking purpose, but it can be used for irrigation and other commercial purposes. All parameters of concern are within permissible limits except for Un-Ionized Ammonia and Dissolved Oxygen, where some samples showed higher and lower concentrations, respectively.

In general, most of the watershed is not inhabited by fish. Instream barriers are a primary factor that exclude fish upstream of Atwater Boulevard (lower watershed). Other fish habitat issues include water temperatures exceeding 26°C and substrate for spawning needs.

WATERCOURSE EROSION CONTROL PROJECT INDEX

SHER-0700-01	2011 SHERIDAN CREEK EROSION CONTROL (DES 2010)	DS OF BENEDET DRIVE
COOK-1000-01 MULT-0200/0300-01 SAWM-0300-01 SHER-0200-01	2012 COOKVILLE CREEK EROSION CONTROL (DES 2010) MULLET CREEK EROSION CONTROL (DES 2008) SAWMILL CREEK EROSION CONTROL (DES 2010) SAWMILL CREEK EROSION CONTROL (DES 2011) SHERIDAN CREEK EROSION CONTROL (DES 2001)	N OF DUNDAS ST E BEHIND JAGUAR VALLEY DR BURNHAMTHORPE RD W TO BEHIND WOODCHUCK LANE (MCPS #2) BURNHAMTHORPE RD TO THE COLLEGEWAY ERIN MILLS PKWY TO BURNHAMTHORPE RD W CLARKSON RD TO MEADOW WOOD RD
COOK-0500-01 COOK-2100-01 CRED-0800-01 APPL-0400-01	2013 COOKVILLE CREEK EROSION CONTROL (DES 2010) COOKVILLE CREEK EROSION CONTROL (DES 2011) CREDIT RIVER EROSION CONTROL (DES 2010) APPLEWOOD CREEK EROSION CONTROL (DES 2011)	WILIA RD TO ORANO AVE BURNHAMTHORPE RD E TO MISSISSAUGA VALLEY BLVD, EAST BRANCH S OF DUNDAS ST W BEHIND JARVIS ST (GRAMS #21) BEHIND DIXIE OUTLET MALL
COOK-1800-01 COOK-1700-01	2014 COOKVILLE CREEK EROSION CONTROL (DES 2011) COOKVILLE CREEK EROSION CONTROL (DES 2010)	RATHBURN RD TO ABSOLUTE AVE HWY 403 TO HURONTARIO ST
COOK-0800-01 COOK-0200-01 CRED-0300-01	2015 COOKVILLE CREEK EROSION CONTROL (DES 2010) COOKVILLE CREEK EROSION CONTROL (DES 2014) CREDIT RIVER EROSION CONTROL (DES 2010)	KING ST TO NORTH OF PARSLEY BLVD CAWTHRA CREEK DIVERSION N OF LAKESHORE RD E S OF QEW, BEHIND PINETREE CRES (GRAMS #28)
COOK-1100-01 ETOB-0800-01 MIMI-1200-01 MULT-0900-01	2016 COOKVILLE CREEK EROSION CONTROL (DES 2014) ETOBICOKE CREEK EROSION CONTROL (DES 2014) MIMICO CREEK EROSION CONTROL (DES 2014) MULLET CREEK EROSION CONTROL (DES 2014)	CPR TO KIRWIN AVE EGLINTON AVE TO HYDRO CORRIDOR S OF ETUDE DR TO DERRY TANNERY ST TO THOMAS ST
MULT-2200-01 MULT-2200-02 WOLF-0300-01	2017 MULLET CREEK EROSION CONTROL (DES 2014) MULLET CREEK EROSION CONTROL (DES 2014) WOLFDALE CREEK EROSION CONTROL (DES 2010)	WABUKAYNE TRIB, US OF CPR WABUKAYNE TRIB, DS OF ERIN MILLS PKWY N AND S OF CENTRAL PARKWAY
COOK-0800-01 COOK-1300-02 CRED-0400-01 ETOB-0800-01 MULT-2000-01	2018 COOKVILLE CREEK EROSION CONTROL (DES 2010) COOKVILLE CREEK EROSION CONTROL (DES 2017) CREDIT RIVER EROSION CONTROL (DES 2010) ETOBICOKE CREEK EROSION CONTROL (DES 2010) MULLET CREEK EROSION CONTROL (DES 2010)	QEW TO ELAINE TRAIL RHONDA VALLEY BLVD TO MISSISSAUGA VALLEY BLVD N OF QEW, BEHIND MISSISSAUGA CRES (GRAMS #27) N OF EGLINTON AVE QUEN TRIB, US OF ERIN MILLS PKWY TO MIDDLEBURY DR
APPL-0200-01 CRED-0200-01 CRED-1700-01 MULT-0700/0800-01	2019 APPLEWOOD CREEK EROSION CONTROL (DES 2010) CREDIT RIVER EROSION CONTROL (DES 2010) CREDIT RIVER EROSION CONTROL (DES 2010) MULLET CREEK EROSION CONTROL (DES 2010)	CNR TO S. OF LAKESHORE N. OF CNR, BEHIND MISSISSAUGA RD & STAVEBANK RD (GRAMS #29/30) W OF CREDITVIEW RD BEHIND KENNINGHALL BLVD (GRAMS #4) GO TRANSIT TO DS OF ERIN CENTRE BLVD
ETOB-0800-01 ETOB-0100-01 ETOB-0100-02	2020 ETOBICOKE CREEK EROSION CONTROL (DES 2020) ETOBICOKE CREEK EROSION CONTROL (DES 2020) ETOBICOKE CREEK EROSION CONTROL (DES 2020)	US & DS OF CPR, S. OF DUNDAS ST DS OF QEW (ADJACENT TO TORONTO GOLF CLUB) US OF CNR (ADJACENT TO TORONTO GOLF CLUB)

CONVEYANCE AND STORM DRAINAGE IMPROVEMENTS PROJECT INDEX

APPL-0100-01 COOK-STM-01 COOK-STM-02 APPL-Lakeshore	2011 APPLEWOOD CREEK CHANNEL IMPROVEMENTS (DES 2011) MISSISSAUGA VALLEY COMMUNITY CTR (DES 2011) SQUARE ONE STM SEWER REPAIR (DES 2011) APPLEWOOD CREEK CROSSING IMPROVEMENT (DES 2011)	DS OF LAKESHORE RD E LID PILOT PROJECT HURONTARIO ST TO COOKVILLE CK CULVERT UNDER LAKESHORE RD E
COOK-1200-01 COOK-1300-01	2012 COOKVILLE CREEK CHANNELIZATION (DES 2011) COOKVILLE CREEK DYKING (DES 2011)	MISSISSAUGA VALLEY BLVD TO CPR DS OF CENTRAL PKWY E
COOK-CNR COOK-Queensway	2013 COOKVILLE CREEK CULVERT IMPROVEMENTS (DES 2011) COOKVILLE CREEK CULVERT IMPROVEMENTS (DES 2011)	CNR CULVERT QUEENWAY EAST CULVERT
COOK-CPR	2014 COOKVILLE CREEK CULVERT IMPROVEMENT (DES 2011)	CPR CULVERT
COOK-STM-01	2015 COOKVILLE CREEK - SQUARE ONE STORM SEWER REPAIR (DES 2011)	HURONTARIO ST TO COOKVILLE CREEK

STORMWATER MANAGEMENT FACILITY PROJECT INDEX

#5401 #3701	2012 RETROFIT MULLET CREEK ARCH SWM POND (DES 2011) RETROFIT COOKVILLE CREEK SWM POND (DES 2012)	W OF ARGENTIA RD & N OF DERRY RD W BRISTOL RD BETWEEN MCLAUGHLIN & HURONTARIO
#5805 #5402	2013 NEW FACILITY SAWMILL CREEK (GLEN ERIN BROOK) SWM POND (DES 2010) RETROFIT MULLET CREEK SWM POND (DES 2012)	N OF HWY 403, W OF WINSTON CHURCHILL N OF DERRY RD & W OF BENTLEY DR
#2801A #5802	2014 REHABILITATION EASTGATE BUSINESS PARK (2014) RETROFIT LITTLE ETOBICOKE CREEK TIMBERLEA SWM POND (DES 2014)	N OF HYDRO CORRIDOR, W OF ETOBICOKE CREEK S OF MATHESON BLVD, E OF DRIFTBOULEVARD DR
#5701 #4403 #4402A #0401 #4503	2015 REHABILITATION CHURCHILL MEADOWS (DES 2010) REHABILITATION FLETCHERS CREEK TFFS (DES 2010) REHABILITATION SHIPP-HIGGINS (DES 2010) CLEARVIEW CREEK SWM (QUALITY & QUANTITY) FACILITY (DES 2010) MEADOWVALE AREA SWM (QUALITY & QUANTITY) FACILITY (DES 2010)	W OF NINTH LINE, N OF THOMAS ST E OF MCLAUGHLIN RD, S OF GOLDEN HILLS WAY E OF MCLAUGHLIN RD, AT FLETCHERS CREEK S OF LAKESHORE RD W N OF HWY 401, E OF CREDIT RIVER
#5702 #0801 #2201 #5301 #0403 #0402	2016 REHABILITATION CHURCHILL MEADOWS (DES 2010) REHABILITATION MATTAMY LORNE PARK (DES 2010) REHABILITATION MARY FOX CREEK (DES 2010) REHABILITATION FIELD RUN SUBDIVISION (DES 2010) LAKESHORE RD WEST AT CLARKSON WWTP AVONHEAD CREEK SWM (QUALITY & QUANTITY) FACILITY (DES 2010)	W OF NINTH LINE, AT THOMAS ST W OF MISSISSAUGA RD, N OF CPR S OF HILLCREST AVE, W OF PARKERHILL S OF HWY 407, W OF SECOND LINE W LAKESHORE RD WEST AT CLARKSON WWTP N OF LAKESHORE RD, W OF HAZELHURST RD
#2101	2020 NEW FACILITY COOKVILLE CREEK SWM POND (DES 2020)	CITY CTR AT MISSISSAUGA VLLY BLVD & CENTRAL PKWY, E

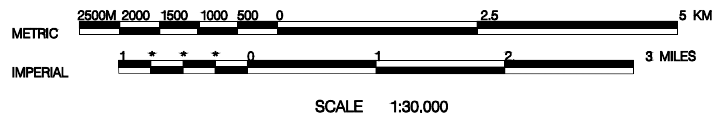
LEGEND

Budget Year for Construction	
2011	2016
2012	2017
2013	2018
2014	2019
2015	2020

- △ CULVERT IMPROVEMENTS
- NEW SWM FACILITY
- SWM FACILITY RETROFIT
- ◇ SWM FACILITY REHABILITATION
- EROSION CONTROL AND DRAINAGE WORKS
- MUNICIPAL WARD BOUNDARIES
- 2 MUNICIPAL WARD NUMBERS

The Capital Budget Program is reviewed
on an annual basis and is subject to change.

For information please call
Transportation and Infrastructure Planning
at 615-3200 ext. 3133



2.2 Opportunities

Previous flood records in the watershed in addition to the August 4, 2009 event emphasize the need to mitigate floods in the study area. Traditional mitigation measures such as the enlargement of road/railway crossings, channel enlargement, flood proofing and non-traditional stormwater management alternatives such as LID measures and treatment train approach should be implemented to reduce potential flood damages and provide water quality and stream restoration benefits.

The implementation of innovative flood management measures consistent with the objectives of this study will reduce flooding and erosion problems, improve water quality conditions, and improve aquatic habitat conditions. The proposed measures are consistent with the recommendations of previous studies and reports that set a foundation for water and environmental management at various scales, including:

- At the watershed scale (Credit River Water Management Strategy Update (CRWMSU, 2007) and Cooksville Creek watershed study (CVC, 2010))

The recommended approach in the CRWMSU is two-pronged, and involves:

1. A broad suite of stormwater management measures for future development must be applied and be more comprehensive if further degradation of the watershed is not to occur;
2. In existing urban areas (and rural areas), greater emphasis must be placed on incorporating sustainable stormwater management practices in order to improve environmental conditions and therefore meet various environmental

- Municipal-wide scale (the City of Mississauga Stormwater Quality Control Strategy Update Study)

The main objective of **the City of Mississauga Water Quality Strategy** is to develop a city-wide strategy to implement the storm water quality controls required to service developing sites. The strategy was developed to provide more efficient protection of the City's watercourse systems in accordance with all applicable regulations and guidelines and at reduced construction costs (to developers) and maintenance costs (for the City).

Flood management alternatives should be addressed within the Cooksville Creek watershed. These alternatives can have many objectives (e.g. CRWMSU objectives) such as flooding control (as a primary objective), water quality, water balance, stream processes, and terrestrial and aquatic habitat. The application of these alternatives can provide restoration opportunities across the watershed. The City of Mississauga Water Quality Strategy (Aquafor, 2011) addresses stormwater quality management using a comprehensive approach which incorporates providing a myriad of environmental benefits including water balance improvement. More specifically, the City of Mississauga Water Quality Strategy has emphasized that managing surface runoff volume has great potential of decreasing pollutant load by minimizing surface runoff (which is the key transporting agent of surface contaminants) and optimizing infiltration and evapotranspiration.

3.0 REVIEW OF BACKGROUND DOCUMENTS

Several documents have described the environmental conditions within the Cooksville Creek watershed and discussed the flooding issues within the context of identifying natural and urban features, defining floodlines and flooding issues, and proposing flood mitigation measures. These documents include the following:

Cooksville Creek Flood Remediation Plan (EWRG, 2002)

The Cooksville Creek Flood Remediation Plan complemented mitigation and remedial measures proposed in previous flood studies that covered the Cooksville Creek watershed such as the Cooksville Creek Watershed Study (Dillon, 1979) and Cooksville Creek Floodline Mapping Study (RVA, 1996). The study defines flood flows, spill zones, frequency and number of buildings which flood within the Cooksville Creek Watershed. The main objective of the Cooksville Creek Flood Remediation Plan was to propose measures to mitigate potential and actual flood damages within the Cooksville watershed for the Regulatory storm. The report proposes traditional measures such as crossing enlargement and flood proofing based on a comprehensive analysis of the capacity (or lack thereof) of existing crossings as well as channel capacity. The report provides insight with respect to the types of measures that were considered together with the evaluation approach.

The remedial measures considered by EWRG (2002) to mitigate flood damage during the Regulatory storm included the following:

- Measures that modify the extent of flooding
 - Structural measures including crossing enlargement, watercourse enlargement, dykes/berms, and reservoirs;
- Corrective measures that modify the susceptibility to flooding
 - Structural measures including flood proofing and relocation
 - Non-structural measures including evacuation, flood fighting and flood forecasting
- Preventive measures that modify the susceptibility to flooding
 - Regulations (floodplains)
 - Zoning by law
 - Special policy areas
- Modify the regulatory flood standard

The recommendations of the study include the following:

- The City continue to implement the current CVC one zone approach
- The City should undertake measures on their property or easements to raise the level of protection where feasible

- The City encourages external agencies to ensure that their crossings can convey the regulatory flood without building flooding
- The City advise property owners of the risk to life and property damage that could result from being in the Regulatory Floodplain
- The City ensure that any re-development within the Cooksville Creek watershed be accompanied by the appropriate stormwater management and flood protection measures

Special Policy Area Study for the Cooksville Creek Floodplain (Phillips, 2003)

The Special Policy Area Study for the Cooksville Creek Floodplain considers the Cooksville Creek Watershed but focuses on properties that were considered as Special Policy Areas (SPAs). The primary objective of the study was to evaluate technical and policy alternatives in order to consider development and redevelopment potential. A couple of potential sites for storage on table lands (Bristol Road and Mississauga Valley Boulevard) were noted. A tunneling option was also considered.

Cooksville Creek Watershed Study (CVC, 2010)

Cooksville Creek Watershed study involves three phases; Watershed Characterization, Evaluation of Alternatives and Implementation. To date, the first phase has been completed and the Evaluation of Alternatives has been initiated. The watershed study addresses a broad range of objectives and issues including flooding, erosion, water quality together with the protection and enhancement of aquatic and terrestrial resources. Of relevance to this study is the fact that several candidate sites located on table land, or upstream of flood susceptible areas within the creek have been identified. If implemented, these measures would reduce flooding.

City of Mississauga Water Quality Control Strategy Update Study (Aquafor, 2011)

The City of Mississauga Water Quality Control Strategy Update Study has noted that only 15 percent of the city has stormwater management facilities in place. The study has identified subsequent sites and proposed a program involving source and conveyance control measures which address a variety of objectives. Collectively, these measures would assist in reducing flooding for the more frequent events.

City of Mississauga Development Charges Study (Aquafor, 2009)

Development charges is a portion of charges paid by developers, and generally used to pay the cost of new capital projects required as a result of growth. **Table 3.1** shows the breakdown of identified storm drainage works and total cost for each category. These works are anticipated to take place within future development and re-development growth lands that has an area of 919 hectares, which represents approximately 3.2% of the total lands within the City of Mississauga.

According to the study, the resulting development charge for storm drainage is \$77,000 per net hectare.

Table 3.1 Storm Drainage Categories and Total Cost

Storm Drainage Component	Total Cost (\$)
Stream erosion control works	110,777,500
Conveyance improvements	21,001,000
Stormwater management	90,310,600
Storm sewer over sizing	4,701,000
Background studies and monitoring	4,560,000

4.0 EXISTING CONDITIONS

4.1 Study Area

The Cooksville Creek watershed is located within the City of Mississauga, east of the Credit River, that drains an area of approximately 33.9 Km² (3,390 ha) outletting to Lake Ontario. Understanding environmental and urban features and functions within the Cooksville Creek watershed is a necessary precursor for addressing flood management scenarios and implementation strategies. In the following sections, a characterization-based effort is undertaken to define the study area by describing the natural environment, existing municipal infrastructure, and socio-economic environment within the watershed.

4.2 Natural Environment

4.2.1 Geology , Physiography and Soils

Cooksville Creek watershed overburden is characterized by six stratigraphic units: Maple Formation, Halton Till, Iroquois Lake deposits, glaciolacustrine deposits, organic deposits and modern alluvium. The Cooksville Creek watershed study shows that the overburden is less than 10 m for most areas southwest of Eglinton Ave. However, northwest of Eglinton Ave. the overburden reaches as thick as 75m

The Cooksville Creek watershed is located in the southwest end of the South Slope enclosed by the Oak Ridges Moraine to the north, the Niagara Escarpment to the west, and the shoreline of Lake Ontario to the southeast. The southwest end of the South Slope comprises four sub-physiographical units: Iroquois Plain, Fluted Till Plain, Trafalgar Moraine and Peel Plain (Chapman 1984). Cooksville Creek watershed straddles the Iroquois Plain and the Fluted Till Plain.

The upper watershed corresponds to till plain underlain by continuous Halton Till. Middle watershed consists mainly of the till plain and shale plain. Lower watershed corresponds to the Iroquois Sand Plain with a few patches of outcropped bedrock and Halton Till.

4.2.2 Terrestrial Communities

The Mississauga Natural Areas Survey (NAS) includes a comprehensive survey of plants and animals in the Cooksville Creek watershed. Compared to other areas in the Credit River watershed, natural areas within Cooksville Creek watershed have had relatively good botanical coverage since the NAS began surveying in 1996. Records of flora and fauna are shown in **Table 4.1**.

Table 4.1 Flora and Fauna within the Cooksville Creek watershed (CVC, 2010)

Flora			Fauna		
Total	Native (Non-native)	Of Conservation Concern	Total	Native (Non-native)	Of Conservation Concern
594	408 (186)	175	118	111 (7)	80

Table 4.2 shows the ecological communities of the Cooksville Creek watershed, mapped primarily using the Ecological Land Classification (ELC) System for Southern Ontario. As shown in **Table 4.2**, Ecological communities were separated into distinct types: Forest, Wetland, Successional, Aquatic, and Urban.

Table 4.2 Ecological communities within the Cooksville Creek Watershed (CVC, 2010)

Ecological community	Coverage in hectares (% of watershed)
Natural Forest	79.1 (2.2)
Wetland	6.8 (0.2)
Successional	244.1 (7.2)
Aquatic	0.5 (0.02)

Natural land uses cover only 9.6% of the Cooksville Creek watershed (natural areas include woodlands and wetlands as compared to open space which includes parks and other vacant uses). Where natural habitat occurs today it is highly fragmented and only a small remnant of pre-settlement conditions. Urbanisation, intensification and increased human use continue to put pressure on these remaining natural habitats. Forest habitat exists is often small in size, fragmented and isolated from one another. Interior forest conditions do not appear to be frequent in the study area, and forest fragments across the watershed appear to be impacted by trails, human disturbance, and encroachment. Present mapping indicates that wetland ecosystems amount to less than 1% of the study area. Wetlands provide important ecological goods and services on many levels and support the health of the entire watershed.

Opportunities to enhance and improve the ecological features of this highly urbanised watershed should focus not only on existing natural habitats but also on the entire urban forest and the possibilities presented for ecological restoration in manicured open spaces.

4.2.3 Fisheries

In general, most of the watershed is not inhabited by fish. No reaches upstream of the QEW contained fish. Sampling at the mouth had the most species, including a mix of lake and river species. The presence of fish barriers seems to be the most limiting factor affecting fish distribution, however, fairly natural sections in some areas reporting crayfish may indicate good potential for restoring fish populations throughout most of Cooksville Creek.

Key fisheries issues include:

- Unstable flows (high storm flows and low baseflow) impact habitat, ultimately limiting fish survival.
- Poor water quality due to unmanaged stormwater, salt, water temperatures and nutrients.

4.2.4 Hydrology

The Impact Monitoring Program within the Cooksville Creek watershed has used a group of rain gauges and streamflow stations (CVC, 2010) which revealed that the alteration in the hydrology of the watershed is primarily manifested by a rapid response to rain events that is typical of an urbanized watershed.

Hydrological parameters that are relevant to flooding issues in the watershed and represent the increasing impact of urban development include:

- Time from the peak rain to the peak flow can be as little as 15 minutes.
- The difference between low flows and maximum flows is extremely high and can reach several orders of magnitude greater than low flows.

4.2.5 Hydrogeology

Groundwater regime in the Cooksville Creek watershed is divided into three parts: upper watershed, middle watershed, and lower watershed. The Eglinton Ave. W and Dundas St. act as two boundaries dividing the watershed into upper, middle and lower watershed. Total discharge of groundwater in the Cooksville Creek watershed is about 87 L/S, over 85% of which is contributed by middle and upper watershed. The large contribution by middle and upper watershed may be due to the upgradient movement of deep groundwater and the passive dewatering in headwater areas of the east tributary.

Recharge of groundwater has been affected dramatically by urbanization since urban development alters the natural hydrological cycle as a result of clearing of vegetation and paving of the ground surface (i.e. increasing impervious cover). Recharge rates across the watershed are presented in **Table 4.3**

Table 4.3 Physiography and Recharge in the Cooksville Creek Watershed (CVC, 2010)

Watershed component	Geological characteristics	Recharge rate
Upper watershed	Till plain underlain by continuous Halton Till	Moderate
Middle watershed	Till plain and shale plain	Low
Lower watershed	Iroquois Sand Plain with a few patches of outcropped bedrock and Halton Till	High

Comparing with recharge in un-urbanized areas, the recharge in the Cooksville Creek watershed has the following characteristics:

- The total amount of recharge is reduced greatly by pavement, buildings and anthropogenic consolidation of soils as a result of urbanization;
- The geographical distribution of recharge becomes more uneven since recharge is reduced almost to zero for most of paved and built-up areas;
- The recharge occurs mainly on public areas – parks and corridors (transportation, utilities, and creeks), natural areas and conservation areas.

4.2.6 Hydraulics

The Regulatory Storm for the Cooksville Creek watershed is the Regional (Hurricane Hazel) Storm except upstream of Highway 10 on the east branch where the 100 year storm governs. The Regulatory Floodplain along Cooksville Creek occupies a total area of approximately 150 ha and ranges in width from 20 to 300 m. The Regulatory floodplain above Burnamthorpe Road East is narrow in comparison to the floodplain below Dundas Street.

According to EWRG (2002), six (6) spill zones are located along Cooksville Creek. Spill zones are areas where flow may bypass a crossing and re-enter the watercourse further downstream or be diverted to another watershed. The spill zones are found at the following locations:

- CNR;
- Queen Elizabeth Way;
- Kirwin Avenue;
- Hurontario Street;
- Highway 403; and
- Rathburn Road East (East Branch)

4.2.7 Fluvial Geomorphology

Historical records of Cooksville Creek indicate that, prior to extensive urbanization and development, the creek exhibited a more meandering form associated with a channel in unconsolidated material and a more gradual slope. The drainage density (ratio of stream length to drainage area) of the basin in the 1950's was substantially higher than present, as the main channel benefited from numerous contributing tributaries; granted many of these tributaries has been modified due to agricultural practices.

Cooksville Creek in its present-day form is channelized over most of its length (92%) (**Table 4.4**) through a variety of methods and materials, including gabion baskets, concrete, rip-rap, armourstone and grass lining (**Figure 4.2**). The removal of low-order tributaries over time has resulted in a simplistic drainage network comprised essentially of two, first-order upstream branches and a second-order main channel.

Table 4.4 Summary of Channel Lining Materials (EWRG, 2002)

Channel Lining Material	Watercourse Length	% of Total Length
Gabion Baskets	3.5 km	24 %
Concrete	1.7 km	11 %
Natural (eroded)	1.2 km	8 %
Armourstone	2.4	16 %
Grass – Trapezoidal	6.4	41 %
Total	14.9 km	100 %



Figure 4.2 Channelized sections of Cooksville Creek (CVC, 2010)

The prevailing geomorphic condition of Cooksville Creek can be summarized as a watercourse that is actively adjusting in the form of widening and degradation (incision). These two processes have combined to create an over-sized cross-section which was necessitated by the need to accommodate urbanized peak flow events but, for most of the year, supports minimal baseflows. The two primary modes of channel adjustment have also resulted in the extensive failure of bank and bed protection throughout the creek due to undermining and outflanking.

4.2.8 Water quality

As surface runoff moves on impervious areas, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, and ground waters. Urban stormwater runoff can include elevated levels of suspended solids, bacteria and nutrients from livestock, pet wastes and faulty septic systems, excess fertilizers, herbicides and insecticides from agricultural lands and residential areas, oil, grease and toxic chemicals and sodium and chloride from road salt.

Figure 4.3 shows an example of water quality issues in the Cooksville Creek watershed. Parameters of Concern (POCs) were identified on a watershed scale as indicators of water quality for the Cooksville Creek watershed. These POCs were identified for both surface water (instream) and stream sediments.

Surface water within Cooksville Creek has high levels of E coli and chloride. Water temperatures do not comply with the Provincial standards for cold water habitat. Under dry weather conditions, concentrations for nutrients and metals meet guidelines. However, wet weather concentrations/loadings are significantly high for nutrients and metals and exceeded guidelines.



Figure 4.3 Water quality issues within the Cooksville Creek watershed (CVC, 2010)

The following trends of the groundwater quality can be found in the watershed (CVC, 2010)

- Groundwater is very hard and increases in hardness down gradient because of the long flow distance.
- The groundwater throughout the watershed has high concentration of sodium and chloride due to the intensive application of road salt and winter de-icers.
- The concentration of sulfate is relatively high. The high concentration of sulphate may be related to the pyrites in shale formation.
- In general, the groundwater in the watershed is not suitable for drinking purpose, but it can be used for irrigation and other commercial purposes.
- Groundwater contamination could include sources such as road salt, spills, landfill leakage, contaminated sites, leakage from sanitary sewers and other human activities.
- Groundwater quality should be investigated further. More sampling and experience are needed to get statistically real results from outfall sampling.
- All parameters of concern are within permissible limits except for Un-Ionized Ammonia and Dissolved Oxygen, where some samples showed higher and lower concentrations, respectively.

4.3 Municipal infrastructure

There are three types of drainage systems in the Cooksville Creek watershed (**Figure 4.4**). They are: Minor Drainage System such as storm sewers, ditches and swales (Figure 4.4a), Major Drainage System such as the Cooksville Creek and related overland flow paths (Figure 4.4b), and Stormwater Management (SWM) facilities such as wet ponds, dry ponds and wetlands (Figure 4.4c).

Traditionally, drainage infrastructure in the Cooksville Creek watershed was designed to quickly and efficiently remove flows to safely control and convey stormwater without flooding effects. As the impacts of improper management of stormwater runoff became more evident, stormwater management facilities such as detention basins were constructed to store the stormwater runoff and slowly release it to the receiving waterways.

There are three stormwater management facilities within the Cooksville Creek watershed. They are:

- **Water quantity on-line pond on Bristol Road:** Constructed in the eighties. Located north of Bristol Road West and west of Hurontario Street. The pond is intended to provide downstream protection up to the 100-year storm event for the 600ha upstream portion of the watershed (CVC, 2010);
- **Water quantity pond on Burnhamthorpe Road:** Constructed in 1999 to provide water quantity control for Square One. The volume provided within the pond is 77 m³;
- **MTO Pond on Highway 403.**

Figure 4.4c shows one of these facilities: MTO pond on Highway 403, which is located in the headwaters of Cooksville Creek East Tributary. The facility was constructed to provide water quantity and quality control to the flows from the median and northeast bound lanes of Highway 403 between Cawthra Road South and Central Parkway Boulevard. The facility controls and releases flows at pre-development levels for the 2 year through 100 year storm events. The active storage volume provided within the pond is 2,031 m³, which control flows from a tributary area of 24.0 ha.

Traditional stormwater management systems, including storm sewers and detention ponds fail to effectively address flooding and other environmental issues. During the last twenty years, it has been proven that innovative stormwater management alternatives including source control (measures on private property), conveyance control (measures within road right of ways) together with end of pipe measures (dry ponds, wet ponds, wetland and subsurface facilities) applied sequentially can replace traditional measures.



Figure 4.4 Examples of drainage systems in the Cooksville Creek watershed

4.4 Socio-Economic Environment

Written Archaeological evidence suggests that Native peoples had been attracted to the Cooksville Creek watershed and greater Credit River valley for thousands of years. Iroquoian and Algonquian and later Ojibiway inhabited the area as rivers, creeks, forested areas and Lake Ontario provided ample opportunities for fishing and hunting.

European settlement of the Cooksville Creek watershed and greater Credit River watershed began with the first and second purchases of the Mississauga tract by the British government (an area extending from Burlington to the Etobicoke River) in 1805. Several small villages and residential areas were established in the 19th century to support the surrounding farms with supplies, communication, trade and processing capabilities. Within the Cooksville Creek watershed were several villages, hamlets and residential districts (CVC, 2010). Lakeview, Mineola, Cooksville, and Dixie are only a few areas found within the Cooksville watershed.

After World War II, agricultural lands that had previously characterized the Cooksville Creek watershed, gave way gradually to residential, commercial and industrial development. The rise of the automobile, improvements of roads and creation of the highway system allowed people to live further away from city centers like Toronto where they worked. Soon the villages of Cooksville and Dixie gave way to the development of the City of Mississauga. The increased development of the Cooksville Creek watershed led to major modifications to the Cooksville creek watercourse.

4.4.1 Land use

The Cooksville Creek watershed is an urban watershed. The distribution of land use in the watershed is approximately 60% residential, 34% industrial/commercial and 6% open space (CVC, 2010). **Table 4.5** shows a breakdown of land uses.

Table 4.5 Land use summary (CVC, 2010)

Land Use	Percentage
Residential	
• Low Density	37%
• Medium Density	5%
• High Density	4.5%
Industrial/Commercial	23 %
Community Parks/Open Space	6.0 %
Institutional	5.0 %
Natural Areas	9.5%
Agriculture	4.0%
Roads	6.0%

4.4.2 Transportation / Utility Corridors

The Cooksville Creek watershed contains major transportation corridors that run throughout the watershed and provide major economic and social benefits. These transportation corridors include:

- Road corridors: including Highway 401 and Highway 403 and other major roads that constitute a large percentage of the imperviousness of the watershed. Hwy 401 is located in the headwaters of Cooksville Creek, and Hwy 403 is located in the centre part of the

watershed. Generally speaking, most of flood damages are located south of Hwy 403 where many buildings are located within the regulatory floodplain.

Many road crossings within the watershed constrain the flow of Cooksville Creek and negatively affect the conveyance of water, increase backwater and flooding potential, and change velocity and erosion thresholds along the Creek.

- Rail corridors: Canadian National Railway (CNR), and Canadian Pacific Railway (CPR)

Utility corridors cover a very small area in the Cooksville Creek watershed. They range from 30 to 100 meters wide with turf and meadow vegetative cover. Utilities include underground dry utilities (e.g., gas) and overhead wires. In some areas, tributaries to Cooksville Creek run along or through the corridors. Therefore, utility corridors represent a great opportunity for ecological restoration, and maintenance of the natural hydrologic regime within the watershed. Utility corridors within the watershed include the following:

- Utility Corridor 1 – North of the QEW
- Utility Corridor 2 – North of Queensway Boulevard
- Utility Corridor 3 – North of Highway 403



Figure 4.5 Utility corridors within the Cooksville Creek watershed, from Left to Right: Utility corridor 1, Utility corridor 2, and Utility corridor 3

5.0 EVALUATION OF ALTERNATIVES

5.1 General

This chapter provides a general description of alternatives evaluated in order to address solutions for key issues described in Section 2.1 and meet the study objectives as identified in Section 1.1. For the purpose of screening the alternative solutions, the evaluation criteria are presented. Finally, the rationale for selecting the preferred solution is discussed.

5.2 Long list of alternatives

For the purpose of addressing the study objectives as outlined in Section 1.1, a long list of alternative solutions are presented below. The alternatives listed are mainly concerned with flood mitigation within the Cooksville Creek watershed. Other environmental benefits would result from implementing the long list of alternatives including improving water quality and stream health and stability.

The long list of alternatives is divided into two categories: Traditional and non-traditional. Traditional alternatives can be defined as measures that are designed and implemented based on engineering-based flood mitigation measures that would increase the conveying capacity of watercourses and crossings. Non-traditional alternatives are mostly stormwater management measures that encourage the use of the resources of the watershed as a whole by promoting stormwater storage, infiltration and other innovative measures to decrease surface runoff at the watershed scale.

Traditional alternatives

- Watercourse capacity upgrade: increasing the capacity of the existing watercourse may reduce flood levels.
- Crossing capacity upgrade: increasing the capacity of existing culverts or bridges may reduce water levels.
- Dykes/Berms: dykes or berms are built adjacent to dwellings in order to contain flows within the floodplain.
- Flood proofing: Landowners can floodproof buildings by sealing or filling in openings which are susceptible.
- Land acquisition: Flood susceptible properties could be purchased by the City or Credit Valley Conservation.

Non-Traditional alternatives

- Storage in Upstream locations: storage in upstream lands within parks or vacant properties could be used to reduce flood levels in Cooksville Creek.

- Source control measures: implemented on private property, include roof downspout disconnection, use of rain barrels, pervious driveways and rain gardens.
- In-channel storage: storage within Cooksville Creek could be used to reduce flood levels.
- Conveyance control measures: implemented within the municipal right-of-way include bioretention units, or perforated pipes. The measures encourage infiltration or evapotranspiration, thereby reducing runoff and flood levels.
- Tunnel: construction of a tunnel, which would divert flows above levels which cause flooding could be considered.

The evaluation of the long list of alternatives including the traditional and the non-traditional alternatives mentioned above was carried out at two levels:

- First evaluation level: provides a general description of each potential alternative and evaluates each alternative based on the following categories of criteria:
 - Natural environment
 - Economic
 - Social/Cultural
 - Implementation
- Second evaluation level: carries out a technical assessment of the alternatives which have been brought forward in order to establish a practical plan.

5.3 Evaluation Criteria

The Environmental Assessment Act and the Municipal Class Environmental Assessment (Class EA) document require a systematic evaluation of alternatives in terms of their advantages and disadvantages. The evaluation of alternatives for this study involves assessing alternative solutions based on sets of criteria that are founded on the objectives and the rationale of the study, in addition to considerations of the Environmental Assessment process. The evaluation criteria considered in assessing each alternative are shown in **Tables 5.1 to 5.4**, and they include a series of evaluation criteria consisting of Natural Environment, Social/ Cultural, Economic and Implementation criteria. Each alternative from the long list (Section 5.2) was assessed based on these categories of criteria consistent with the Environmental Assessment process.

Table 5.1 Natural Environment Evaluation Criteria

Natural environment evaluation criteria	Description of criteria
Potential to reduce riverine flooding	Potential to reduce flooding of properties along Cooksville Creek floodplain
Potential to reduce erosion	Potential to reduce erosion within Cooksville Creek
Potential to improve water quality	Potential to improve water quality based on existing water quality conditions
Potential to improve aquatic habitat	Potential to improve aquatic habitat by improving baseflows or stream habitat

Table 5.2 Economic Evaluation Criteria

Economic evaluation criteria	Description of criteria
Construction costs	The relative cost of the alternative
Operation and Maintenance	The relative cost of operating and maintaining the alternative based on factors such as overall maintenance frequency and intensity, equipment needs and future permit requirement
Infrastructure protection	Potential to protect existing or proposed infrastructure including storm outfalls, sanitary sewers, pedestrian bridges, etc.

Table 5.3 Social/Cultural Evaluation Criteria

Social/Cultural evaluation criteria	Description of criteria
Aesthetics/Recreation	Potential for the alternative to be an asset to the community by integrating the alternative into existing site activities (walking, jogging, park usage) and/or improve aesthetics; or to impact existing park usage or detract from aesthetics
Compatibility with adjacent land use	There are potential impacts associated with construction of retrofit facilities, or future maintenance particularly with respect to adjacent land use Access/egress also needs to be considered
Community disruption	The potential of the alternative to disrupt the community, more specifically given the surrounding land use – business activities during, or after the construction process
Public/User acceptance	Public/user acceptability of proposed alternative including construction impacts, property value, life style changes, noise/odour issues

Table 5.4 Implementation Evaluation Criteria

Implementation Evaluation criteria	Description of criteria
Timing to implementation	Length of time required to implement the proposed alternative
Technical feasibility	The feasibility of implementing the proposed alternative

5.4 Selection of preferred alternatives

In order to evaluate alternatives and compare them in a quantitative manner, a ranking system is proposed that is based on five (5) measures of effectiveness and shaded circles that represent effectiveness. Effectiveness of each alternative ranges from least effective using an unshaded circle, to most effective, using a full shaded circle. Quarter, half and three quarter shaded circles were also used where alternatives respond only slightly or moderately well to criterion, respectively. The alternatives which received a favorable rating (i.e. most effective) were brought forward and forms the basis for the preferred strategy.

Tables 5.5 and 5.6 represent the evaluation matrices for traditional alternatives and non-traditional alternatives, respectively. Each alternative was evaluated based on effectiveness in addressing the evaluation criteria as explained in **Tables 5.1, 5.2, 5.3 and 5.4**, and a decision to bring it forward or not was taken. Chapter 6 describes the Recommended Plan, which is a collection of alternatives that have received the highest mark in the evaluation exercise.

Table 5.5 Evaluation matrix for Traditional alternatives















Evaluation Criteria	Watercourse Capacity Upgrade	Crossing Capacity Upgrade	Dykes / Berms	Flood Proofing	Land Acquisition
Natural Environment	<ul style="list-style-type: none"> Good potential to reduce riverine flooding 	<ul style="list-style-type: none"> Good potential to reduce riverine flooding 	<ul style="list-style-type: none"> Moderate potential to reduce riverine flooding 	<ul style="list-style-type: none"> Limited potential to reduce riverine flooding 	<ul style="list-style-type: none"> Limited potential to reduce riverine flooding
Economic	<ul style="list-style-type: none"> Moderate construction cost Low operation and maintenance cost 	<ul style="list-style-type: none"> Moderate construction cost Low operation and maintenance cost 	<ul style="list-style-type: none"> Low to moderate construction cost Moderate to high operation and maintenance cost 	<ul style="list-style-type: none"> Low to moderate construction cost Moderate to high operation and maintenance cost 	<ul style="list-style-type: none"> Moderate to high construction cost Low operation and maintenance cost
Social / Cultural	<ul style="list-style-type: none"> Generally accepted by public and agencies Limited disruption during construction Compatible with adjacent land uses 	<ul style="list-style-type: none"> Generally accepted by public and agencies Limited disruption during construction Compatible with adjacent land uses 	<ul style="list-style-type: none"> Generally accepted by agencies, may be issue if constructed on private property Limited disruption during construction Compatibility with adjacent land uses to be assessed on site by site basis 	<ul style="list-style-type: none"> Generally accepted by agencies Acceptance by homeowners site specific 	<ul style="list-style-type: none"> Last resort alternative by agencies Generally does not meet with landowner approval
Technical	<ul style="list-style-type: none"> Technically feasible Short implementation period 	<ul style="list-style-type: none"> Technically feasible Short implementation period 	<ul style="list-style-type: none"> Technically feasible Moderate implementation period 	<ul style="list-style-type: none"> Feasibility dependent upon site conditions and flooding extent Short implementation period 	<ul style="list-style-type: none"> Technically feasible Moderate implementation period
Overall Alternative Rank					
Comment	Brought forward	Brought forward	Brought forward, but limited to public lands or with homeowner consent	Not brought forward, but to be implemented independently by homeowner	Not brought forward
Most Preferred     Least Preferred					

Table 5.6 Evaluation matrix for Non-Traditional alternatives

Evaluation Criteria	Storage in upstream locations	In-channel storage	Source control measures	Conveyance control measures	Tunnel
Natural environment	<ul style="list-style-type: none"> • Good potential to reduce riverine flooding, limited for basement flooding • Good potential for reducing erosion, improving water quality and aquatics 	<ul style="list-style-type: none"> • Moderate potential to reduce riverine flooding • Moderate potential to reduce erosion 	<ul style="list-style-type: none"> • Good potential to reduce riverine flooding, limited for basement flooding • Good potential for reducing erosion, improving water quality and aquatics 	<ul style="list-style-type: none"> • Good potential to reduce riverine flooding, limited for basement flooding • Good potential for reducing erosion, improving water quality and aquatics 	<ul style="list-style-type: none"> • Good potential to reduce riverine flooding
Economic	<ul style="list-style-type: none"> • Moderate construction cost • Moderate operation and maintenance cost • Moderate benefit in protecting existing infrastructure within floodplain 	<ul style="list-style-type: none"> • Moderate construction cost • Moderate operation and maintenance cost 	<ul style="list-style-type: none"> • Low construction cost • Low to moderate operation and maintenance cost • Moderate benefit in protecting existing infrastructure within floodplain 	<ul style="list-style-type: none"> • Moderate construction cost • Moderate operation and maintenance cost • Moderate benefit in protecting existing infrastructure within floodplain 	<ul style="list-style-type: none"> • High construction cost • High operation and maintenance cost
Social/Cultural	<ul style="list-style-type: none"> • Generally accepted by public agencies • Low to moderate community disruption • Potential to be asset to community 	<ul style="list-style-type: none"> • Generally accepted by public agencies • Low to moderate community disruption • Potential to be asset to community 	<ul style="list-style-type: none"> • Generally accepted by public agencies • Low community disruption • Potential to be asset to community 	<ul style="list-style-type: none"> • Generally accepted by agencies • Low community disruption • Potential to be asset to community 	<ul style="list-style-type: none"> • Compatibility with adjacent land uses unknown • Questionable agency acceptance • Considerable community disruption
Technical	<ul style="list-style-type: none"> • Technically feasible • Short to moderate implementation period 	<ul style="list-style-type: none"> • Feasibility dependent upon site condition • Short to moderate implementation period 	<ul style="list-style-type: none"> • Technically feasible • Short implementation period 	<ul style="list-style-type: none"> • Technically feasible • Short to moderate implementation period 	<ul style="list-style-type: none"> • Feasibility dependent upon site condition • Long implementation period
Overall alternative rank					
Comment	Brought forward	Brought forward	Brought forward, but to be implemented as part of City Wide Water Quality Study Implementation	Brought forward, but to be implemented as part of City Wide Water Quality Study Implementation	Not brought forward

6.0 RECOMMENDED PLAN

Chapter 5 presented and described a long list of potential alternatives. It also presented an evaluation criteria that was used to identify the most and least effective alternatives to undertake in order to address four (4) sets of criteria, namely Natural Environment, Social/Cultural, Economic and Implementation considerations. This chapter presents the Recommended Plan, which is a group of preferred alternatives within the following framework:

- Existing conditions: reviews hydrologic and hydraulic considerations that define existing flooding issues along Cooksville Creek. The review is mostly based on the EWRG (2002) report which is a comprehensive flood remediation study that included hydrologic and hydraulic modeling of Cooksville Creek. The report also proposed several traditional measures to mitigate flood damages for the Regulatory Storm;
- Technical assessment of the Recommended Plan.

6.1 Existing conditions

Previous studies identified actual and potential flooding issues within the Cooksville Creek watershed. The studies showed that development before 1975 did not consider floodplain management in areas that are generally located south of Hwy 403. Development after 1975 is generally outside the Regulatory floodplain (generally north of Hwy 403).

Previous hydrologic analysis (EWRG, 2002) showed that the 100-year flows along Cooksville Creek ranges between 80 m³/s at the Creek headwaters (i.e. Matheson Ave, West) to 210 m³/s at Lakeshore Avenue located at the mouth of Cooksville Creek as shown in **Table 6.1** and **Figure 6.1**.

A comprehensive evaluation of the performance of road crossings (culverts, bridges, etc) was carried out by EWRG (2002). **Table 6.2** shows the capacity of road crossings along Cooksville Creek, flow events with frequencies that range from 2-year to Regional flow, and the impact of these flows on road crossings and buildings in terms of overtopping/bypassing or flooding, respectively. **Table 6.2** shows that channel and crossing capacity of road crossings is less than 10 year flow in many locations (e.g. Queen Elizabeth Way and Camilla Road). Many of the crossings would be overtopped or bypassed by flows that range from the 2-year storm to the Regional storm. For example, Paisley Boulevard East and King Street East are overtopped by all flows exceeding the 2-year storm flow.

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

Location	Flow (m ³ /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

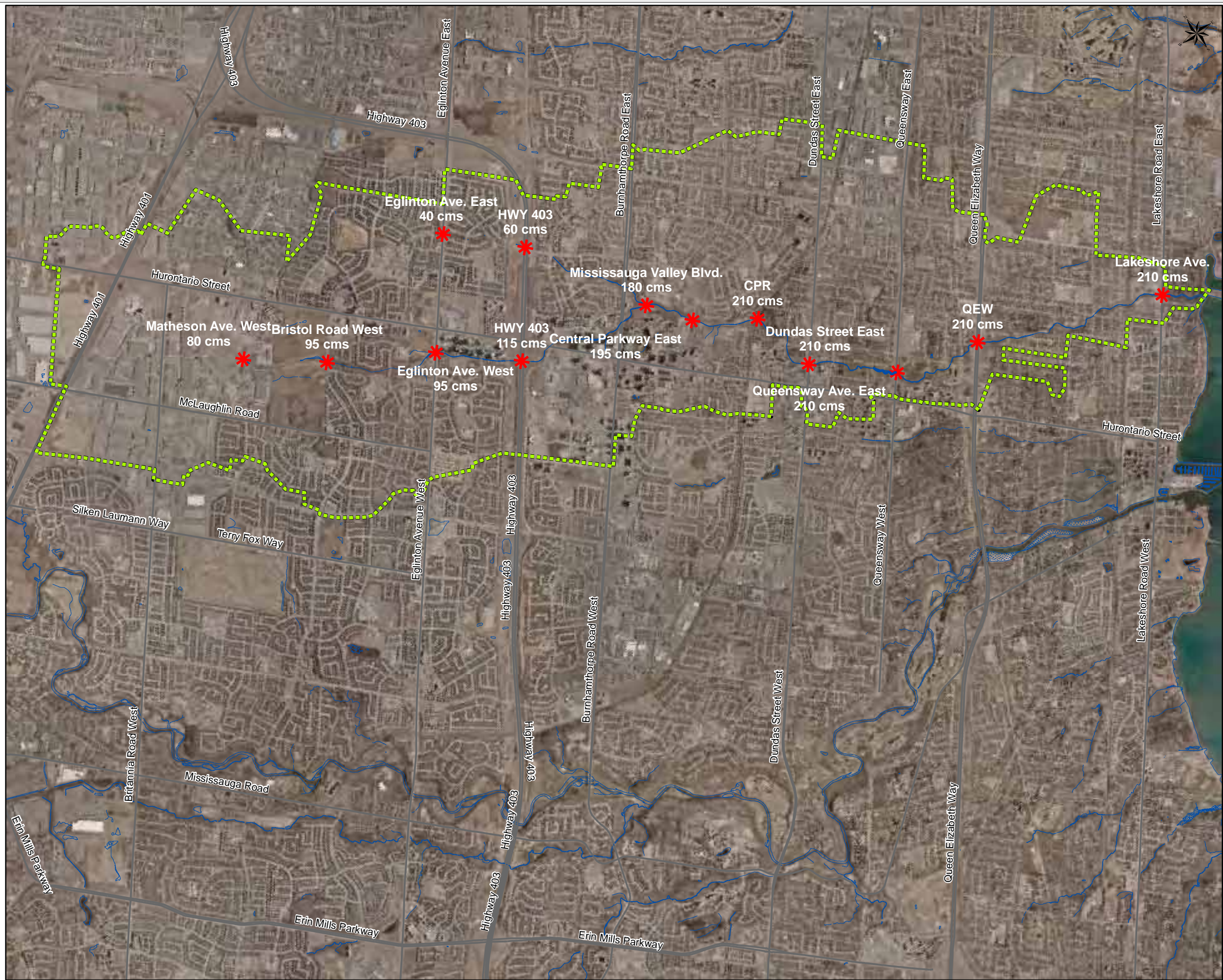
In order to mitigate actual and potential flood damages for the Regulatory storm along Cooksville Creek, EWRG (2002) identified and proposed a long list of alternatives that included:

- 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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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

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**):

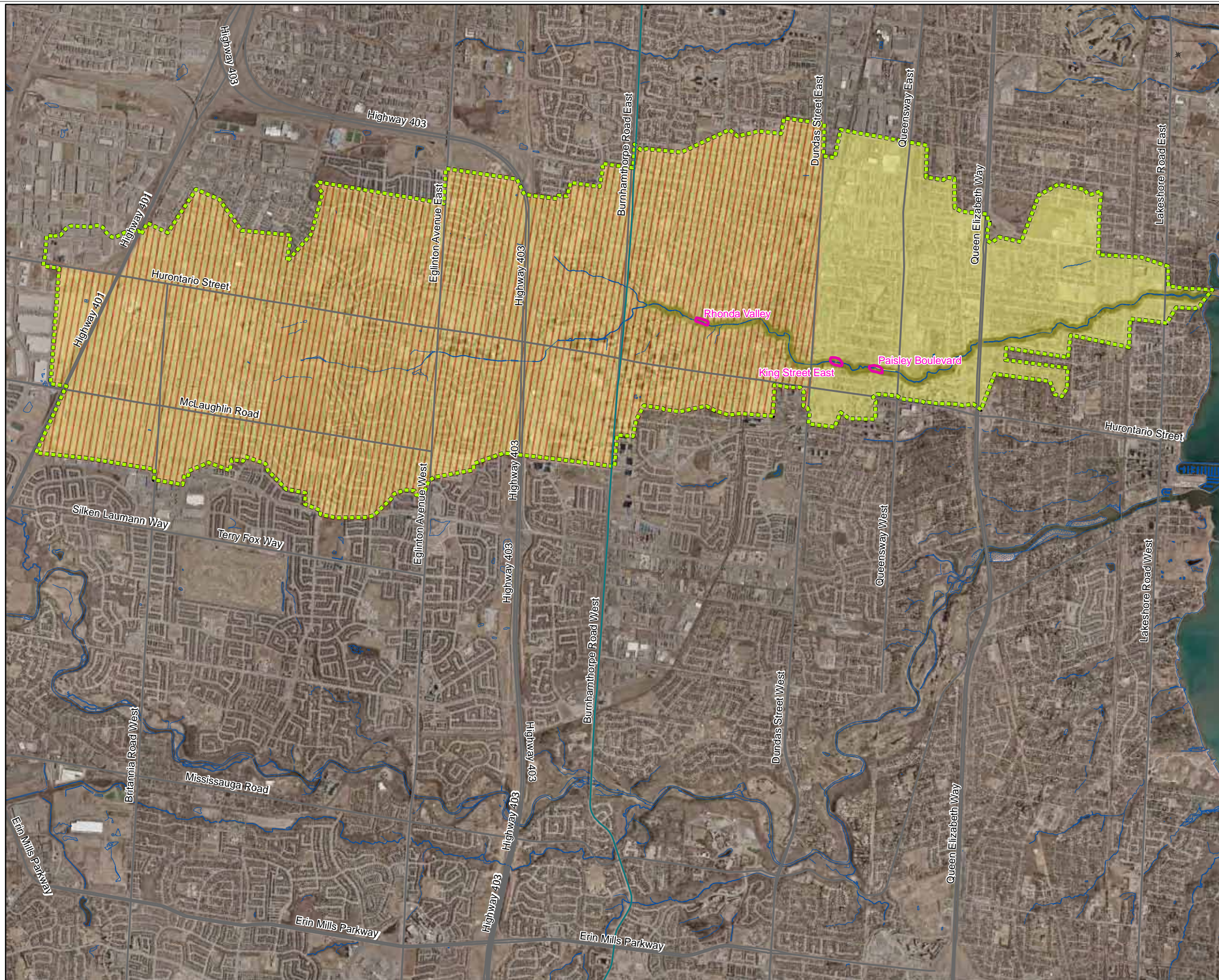
- Storage in the upstream locations to reduce flows within Cooksville Creek to acceptable levels.
- Watercourse and channel capacity upgrades together with creation of a berm in the King Street and Paisley Blvd areas where homes are more susceptible.
- Construction of a berm adjacent to Cooksville Creek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



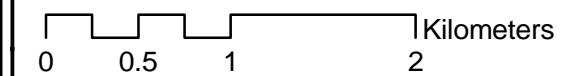
KEY MAP

LEGEND:

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

NOTES:

Base Mapping was provided by City of Mississauga



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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

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 m³/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

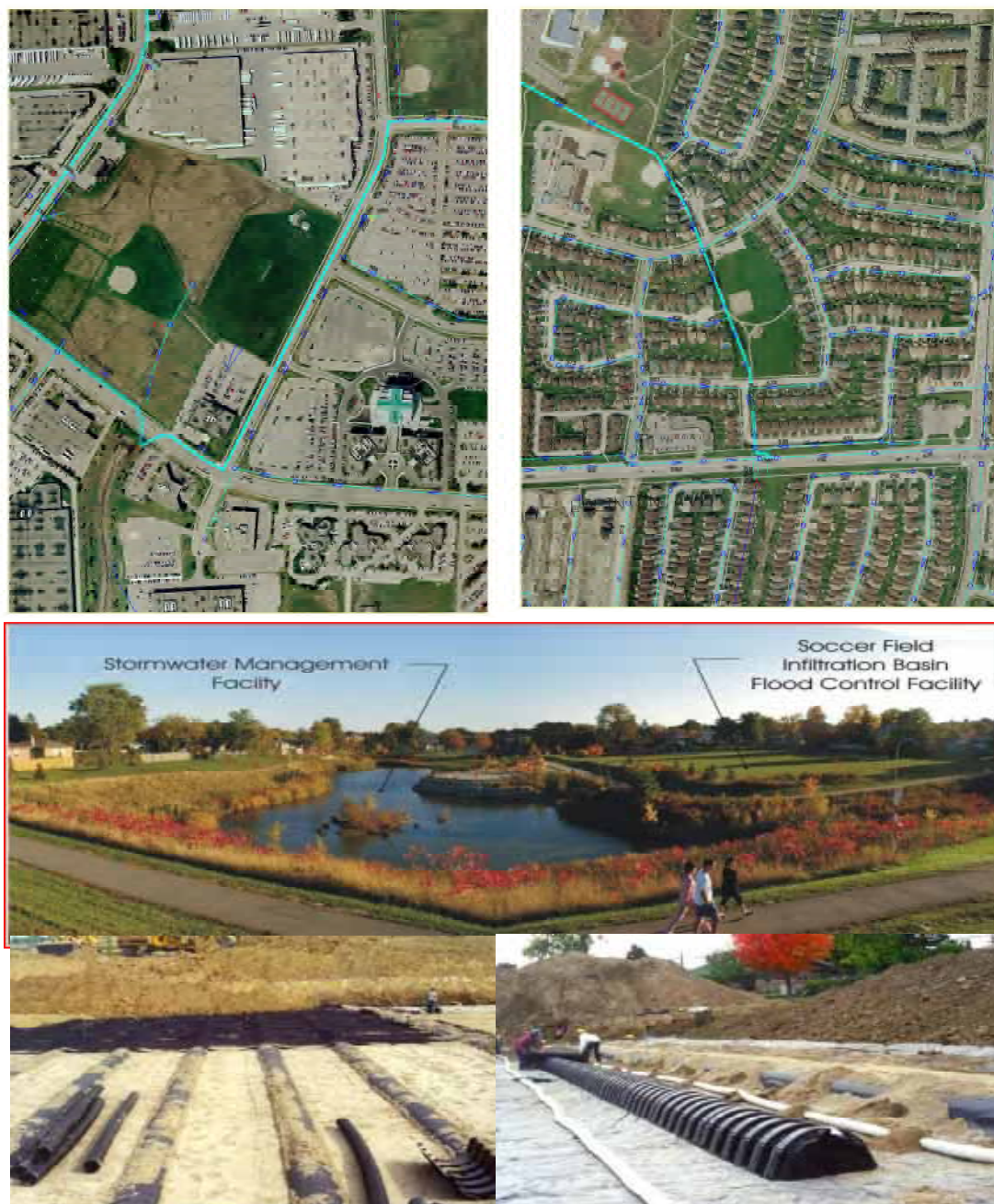
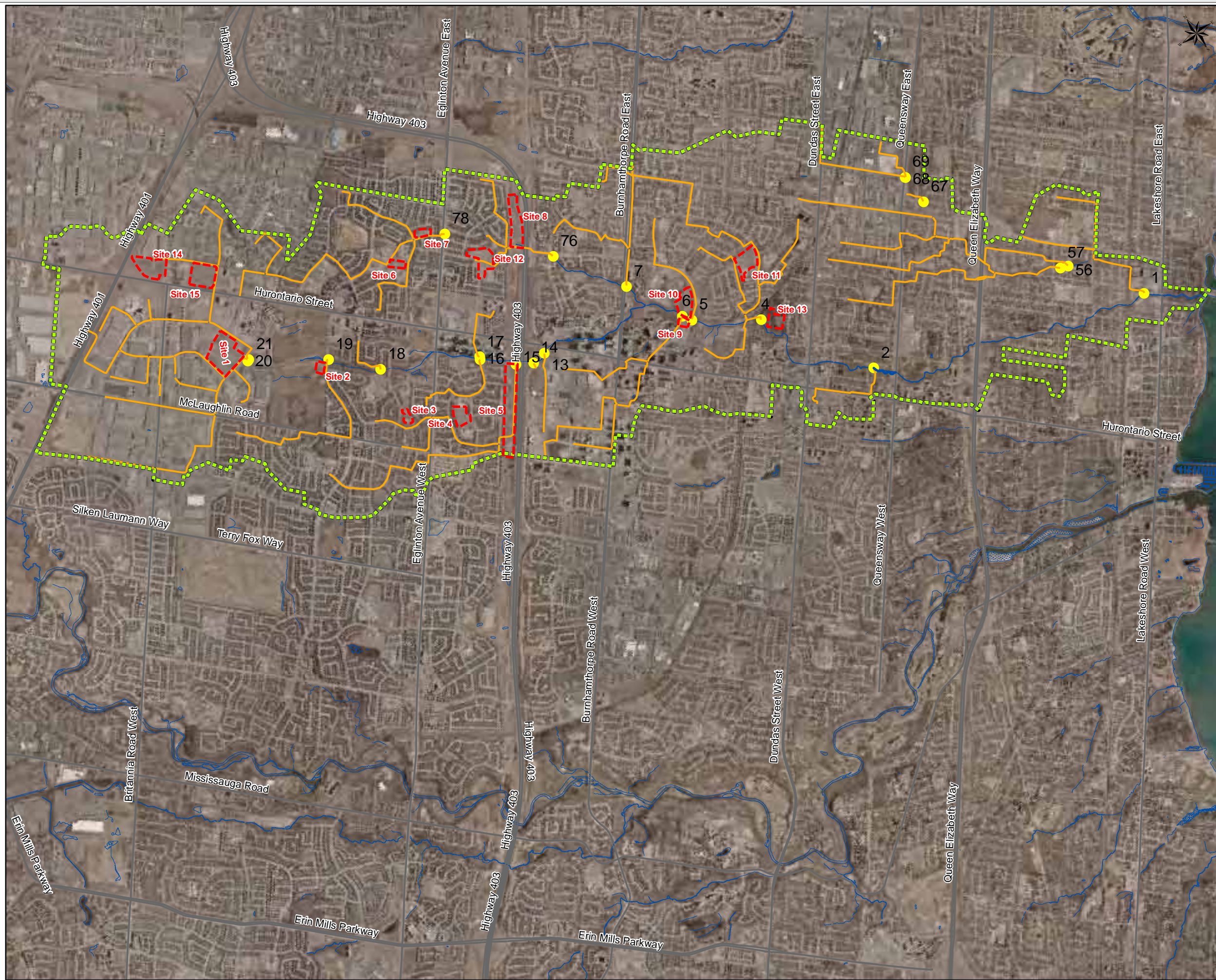


Figure 6.3 Examples of Potential flood storage sites identified during site visits (top left: Avebury Road (undeveloped property), top right: Eastgate Park (Public park). Underneath: an example of constructed storage facility (i.e. Terraview Park)



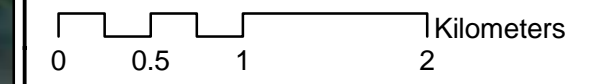
KEY MAP

LEGEND:

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

NOTES:

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**COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA**

Identifying Potential Storage Sites
Using GIS Analysis

FIGURE No. 6.4

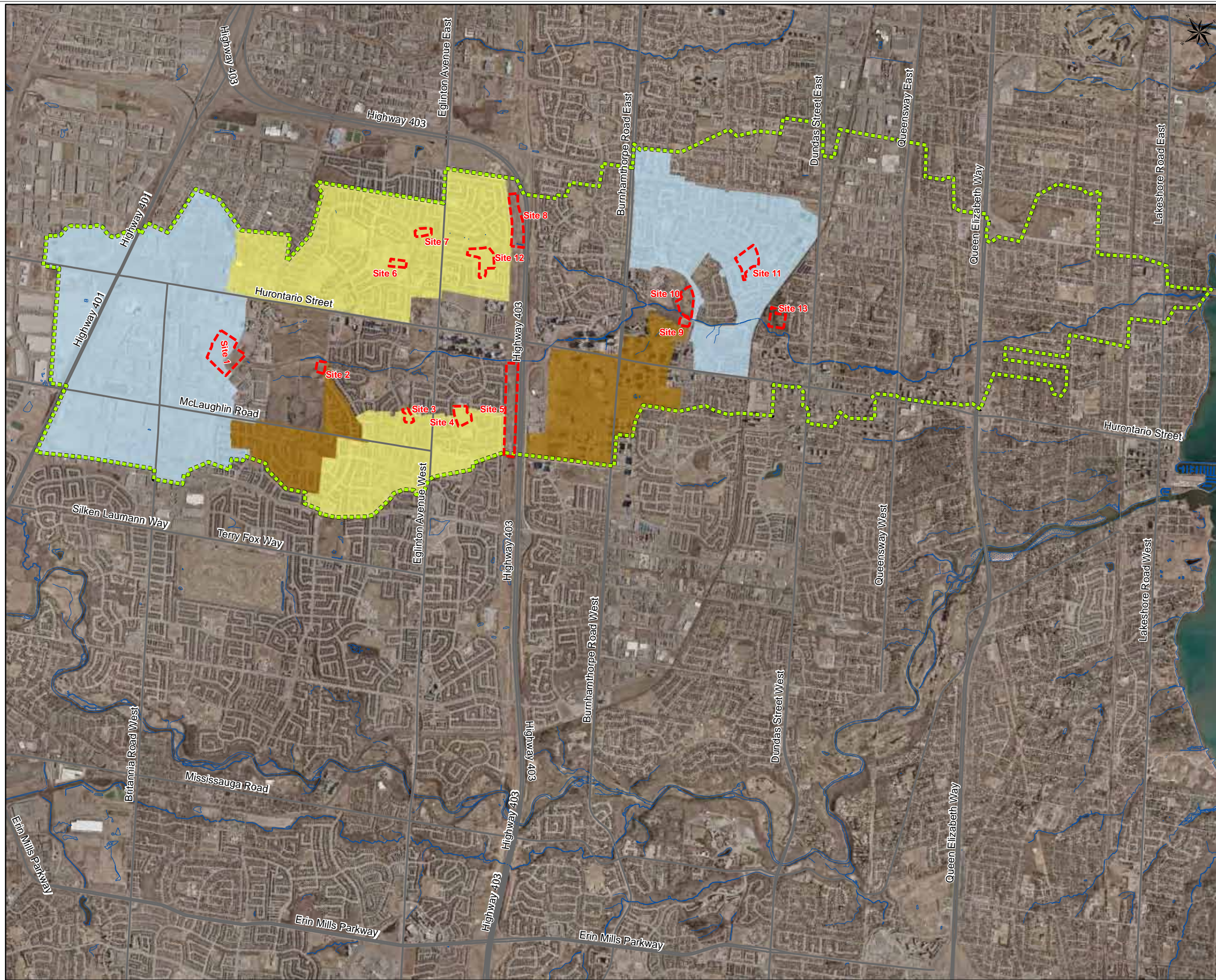
DATE: May 2012

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



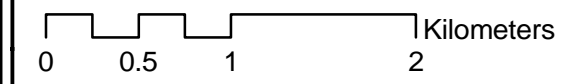
KEY MAP

LEGEND:

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

NOTES:

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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

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 m³/s compared to 207 m³/s).

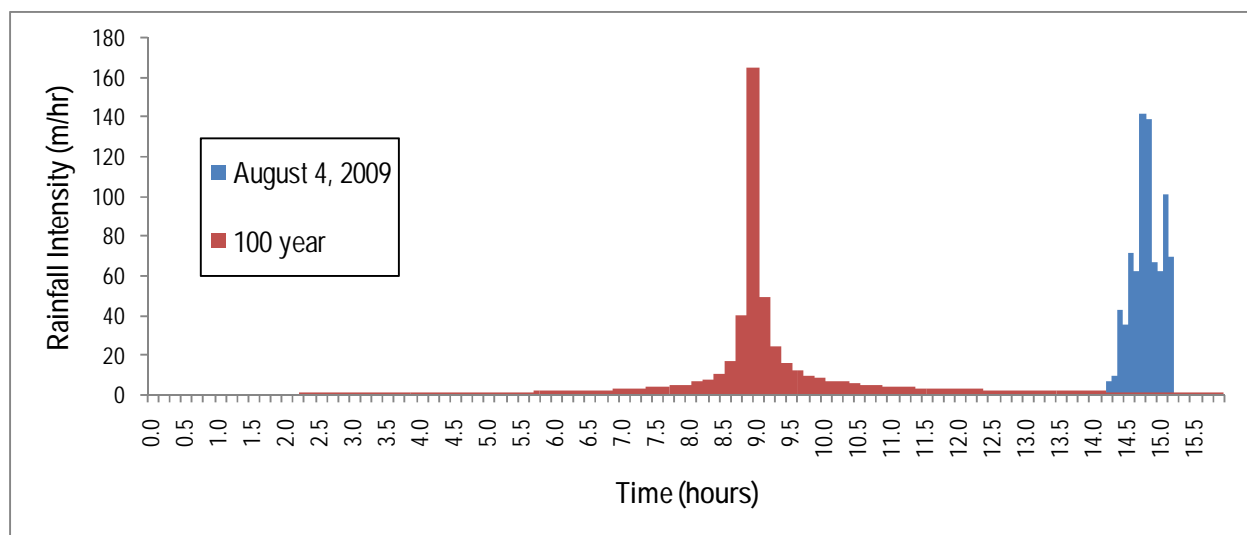


Figure 6.6 The Hyetographs of the 100-Year Storm and the August 4th 2009 Storm

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 m³/s to 127 m³/s. This corresponds to a 39% reduction of peak flow. For the August 4th 2009 storm (which is close to the 100-year storm), the hydrologic

model predicted a peak flow reduction from 235 m³/s to 129 m³/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 m³/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 m³/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.

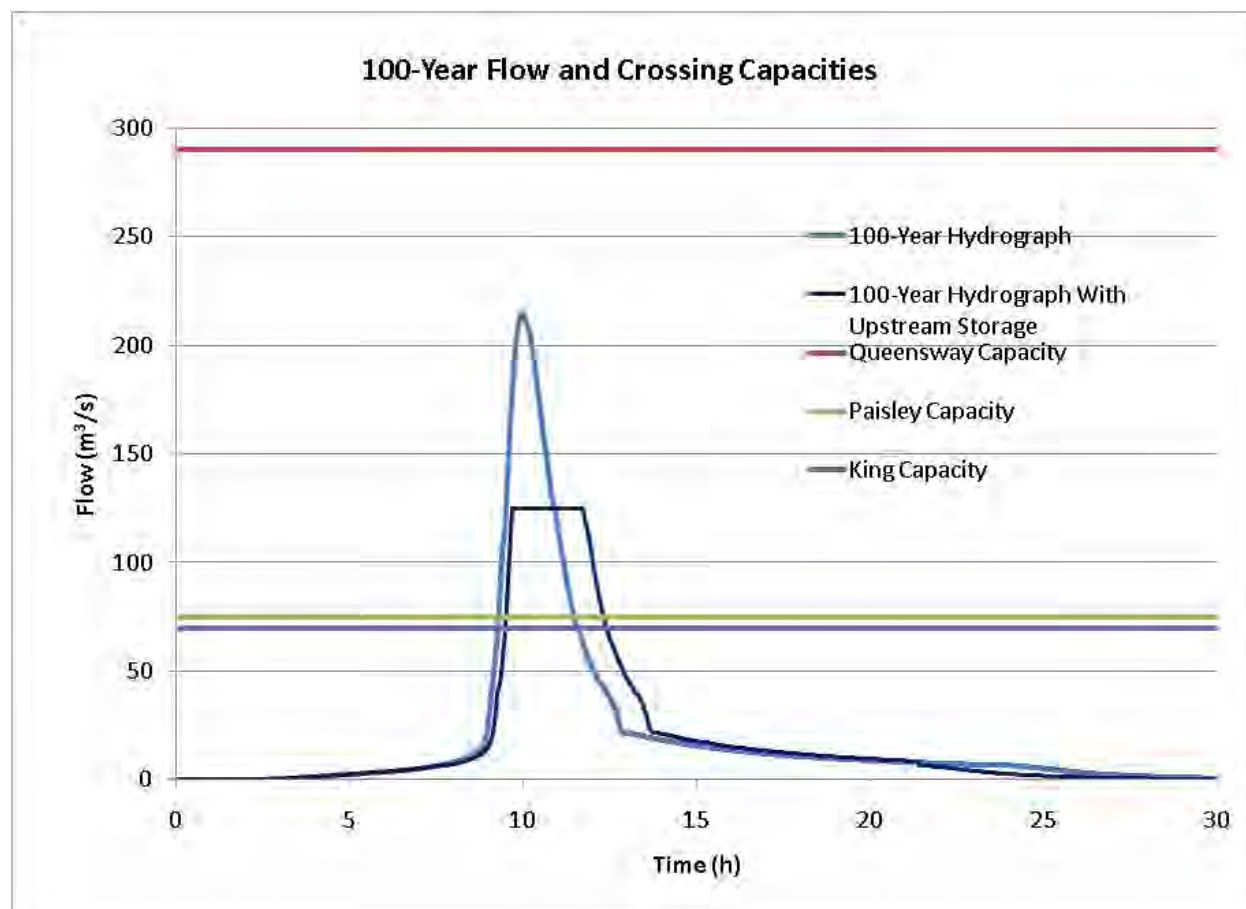


Figure 6.7 The 100-Year Hydrograph with Upstream Storage

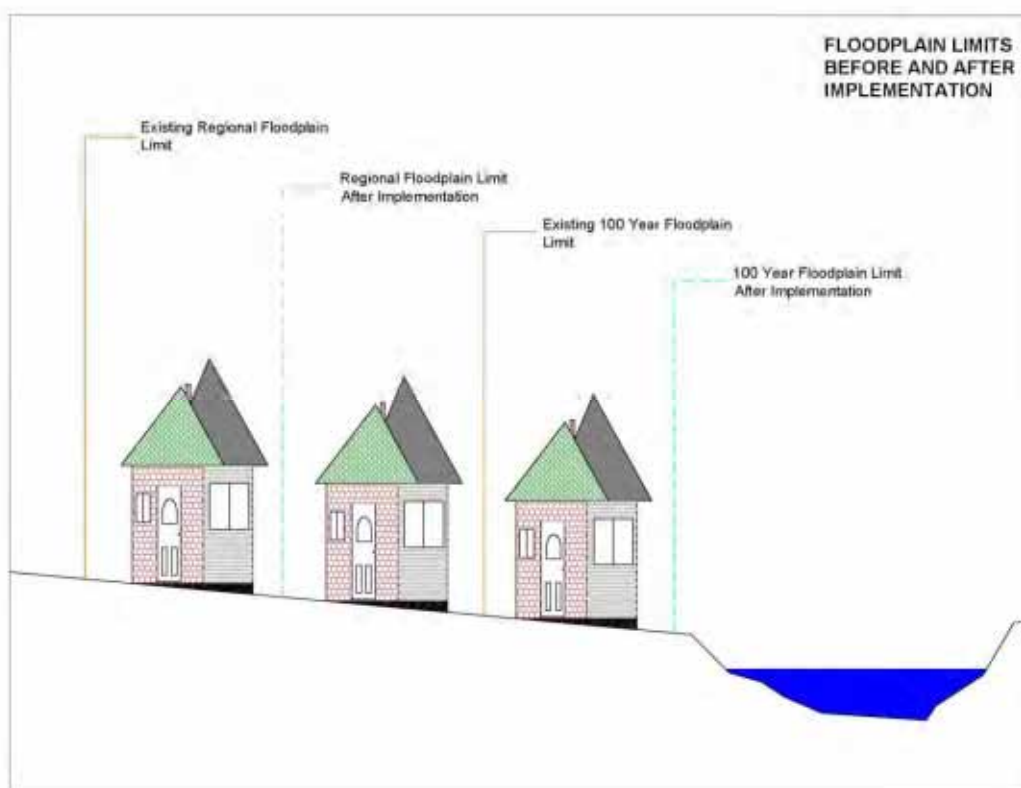


Figure 6.8 Conceptual Floodplain limits before and after the implementation of flood storage

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.

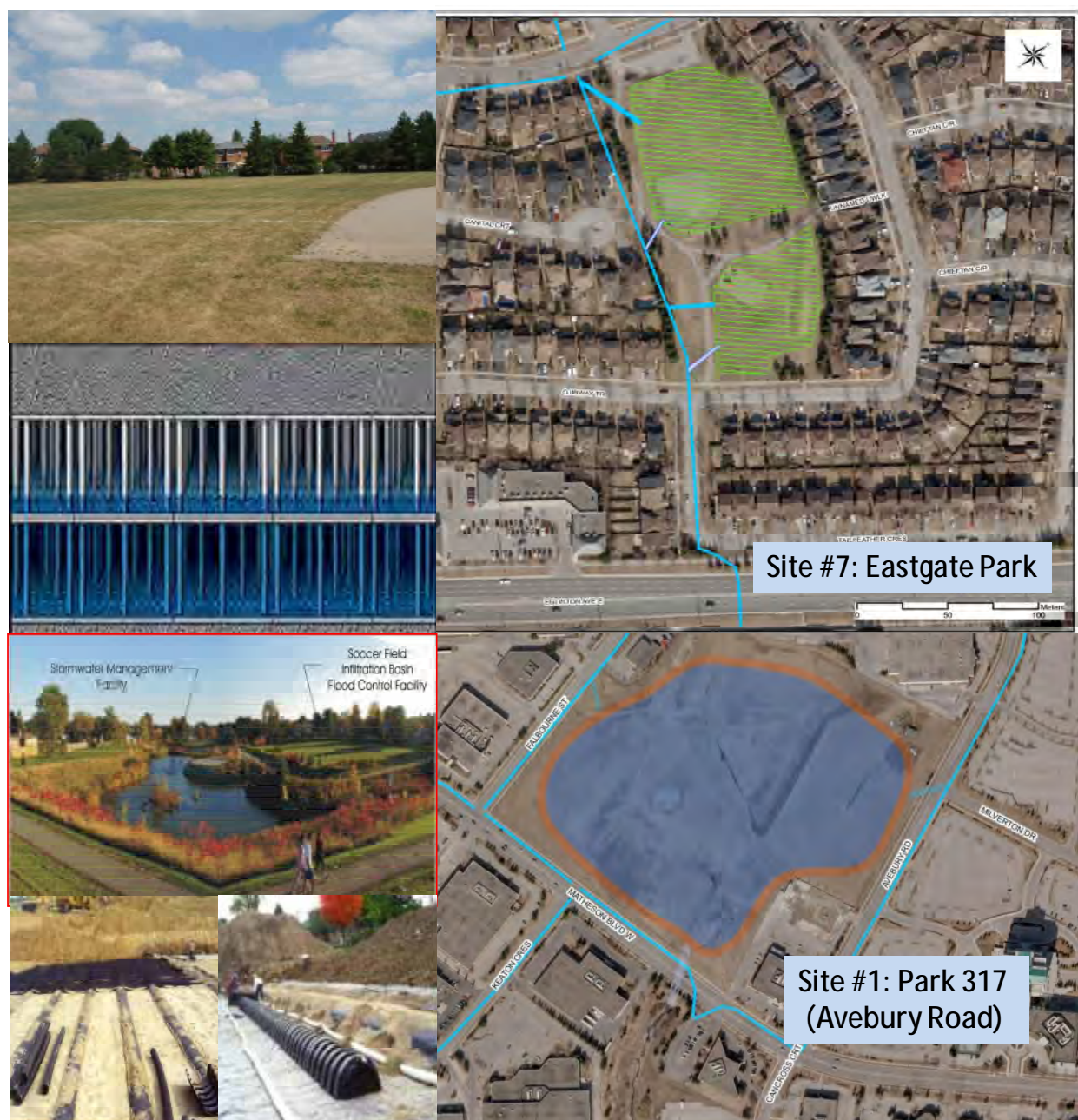


The benefits associated with subsurface stormwater storage facilities may include, but are not limited to:

- 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.



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 $75 \text{ m}^3/\text{s}$) 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 $75 \text{ m}^3/\text{s}$ to $125 \text{ m}^3/\text{s}$). The proposed changes would include raising the road elevation from 103.4 m to 103.7 m. Increasing the crossing capacity to $125 \text{ m}^3/\text{s}$ 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 (m³/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

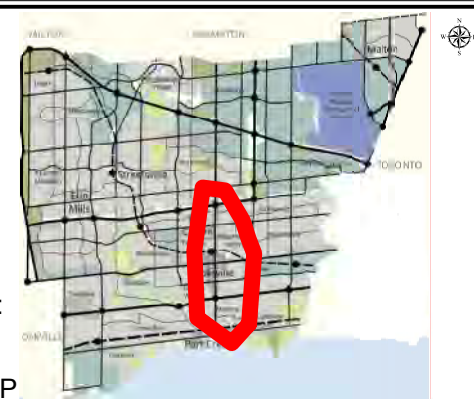
The City of Mississauga has done some flood remediation works at King Street crossing which included a new culvert cell. Proposed measures to complement previous undertakings to mitigate flood damages in the area include:

- 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 m³/s to 125 m³/s). The proposed changes would include raising the road elevation from 105.9 m to 106.3 m. Increasing the crossing capacity to 125 m³/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 (m³/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



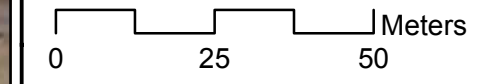
LEGEND:

KEY MAP

- Proposed Berm
- Proposed Creek Expansion
- Proposed Bridge Extension

NOTES:

Base Mapping was provided by City of Mississauga



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COOKSVILLE CREEK FLOOD EVALUATION MASTER PLAN EA

Paisley Boulevard East Proposed Upgrades

FIGURE No. 6.10

DATE: May 2012



Existing



Proposed



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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COOKSVILLE CREEK FLOOD EVALUATION MASTER PLAN EA

King Street East Proposed Upgrade

FIGURE No. 6.11

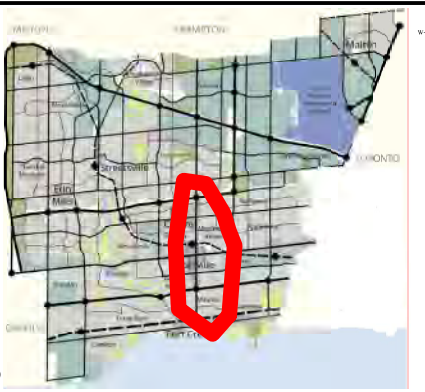
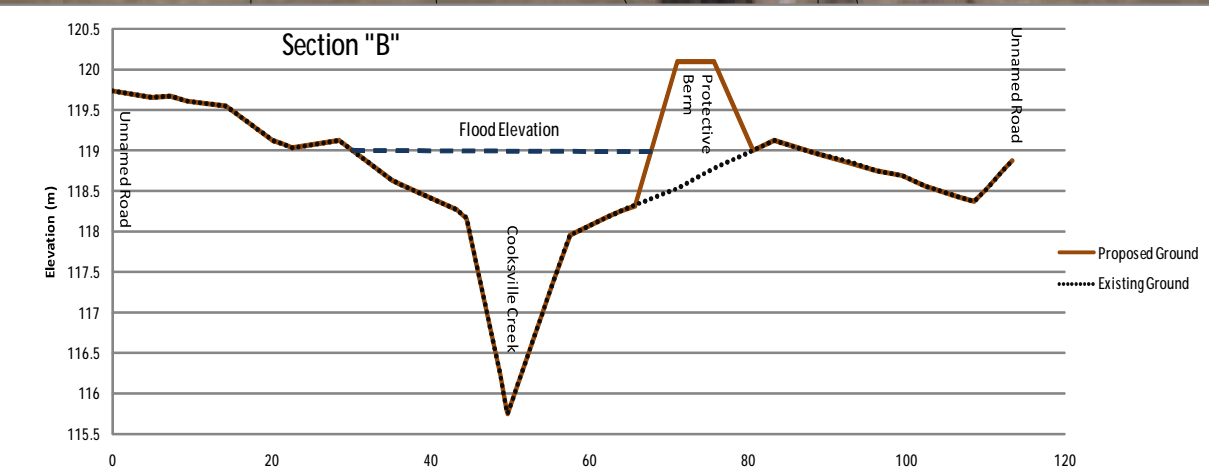
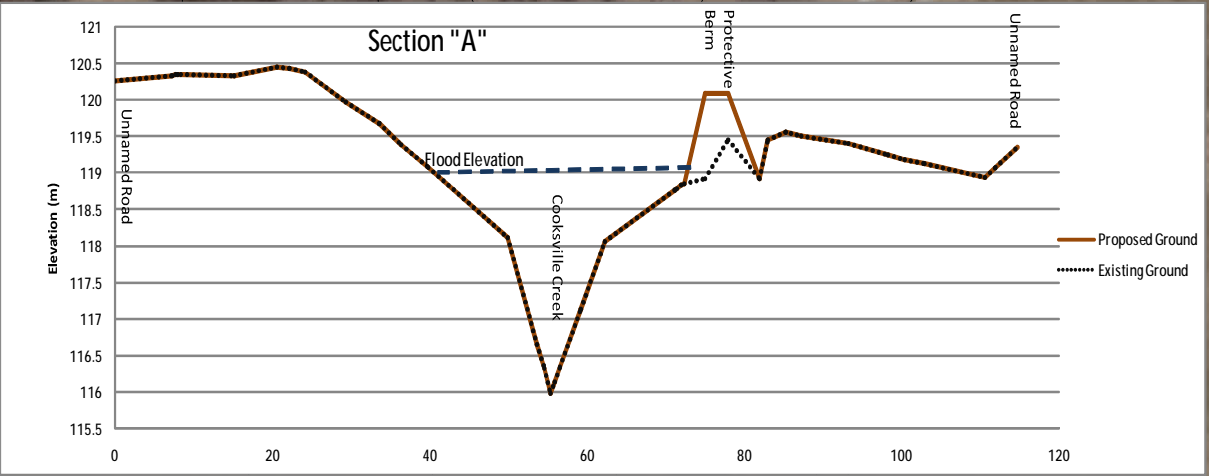
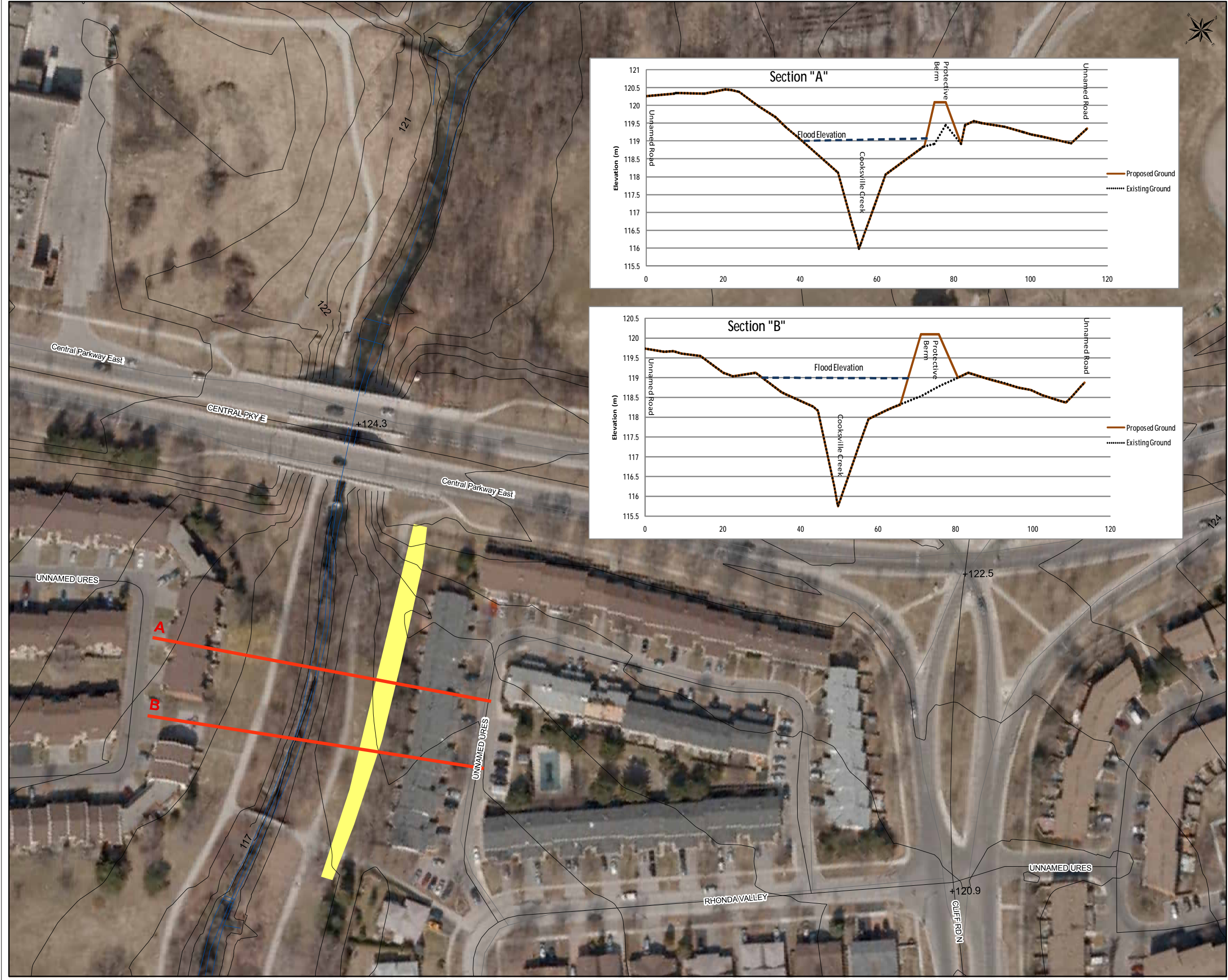
DATE: May 2012

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



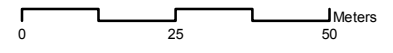
KEY MAP

LEGEND:

- Cross-Section
- Protective Berm

NOTES:

Base Mapping was provided by City of Mississauga



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COOKSVILLE CREEK FLOOD EVALUATION
MASTER PLAN EA

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
<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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/m³. For the case of aboveground flood storage, the unit rate is approximated as \$130/m³.

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	<ul style="list-style-type: none"> Coordination with the Community Services Department re: parks programs and policies Purchase of two properties 	<p>Park 317 (Site # 1) : 1 – 3 Years</p> <p>The remainder of sites (3 – 20 Years)</p>	<ul style="list-style-type: none"> 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	7,500,000	Capital Funding	Purchase of vacant lot within floodplain at Paisley Boulevard	1 – 3 Years	Reduction of flood frequency at King St. and Paisley Boulevard	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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/ m ³	16.8	Also called Park 317. Further upstream
	Site # 2	m³	25,272	\$250/ m ³	6.4	
	Site # 3	m³	7,767	\$250/ m ³	1.9	
	Site # 4	m³	12,545	\$250/ m ³	3.1	
	Site # 5	m³	38,774	\$250/ m ³	9.7	
	Site # 6	m³	20,991	\$250/ m ³	5.2	
	Site # 7	m³	19,332	\$250/ m ³	4.8	
	Site # 8	m³	25,698	\$250/ m ³	6.4	
	Site # 9	m³	26,574	\$250/ m ³	6.6	
	Site # 10	m³	17,096	\$250/ m ³	4.3	
	Site # 11	m³	52,587	\$250/ m ³	13.1	
	Site # 12	m³	5,622	\$250/ m ³	1.4	
	Site # 13	m³	58,965	\$250/ m ³	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 source control measures (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 identified for conveyance control measures (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

Flood storage sites

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.

Watercourse and Channel capacity upgrades

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:

- Flood storage sites:
 - 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)
- Site-specific capacity improvement and flood mitigation at King, Paisley and Rhonda Valley:
 - Develop construction monitoring program to be followed during and following the construction to protect the natural environment
- Source and conveyance control measures:
 - 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* - Design 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, TSS, 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

- Aquafor Beech Limited. 2009. *City of Mississauga Development Charges Study*
- Aquafor Beech Limited and Shoreplan Engineering Limited. 2011 *Lake Ontario Integrated Shoreline Strategy*. Draft Report
- Aquafor Beech Limited. 2011. *The City of Mississauga Stormwater Quality Control Strategy Update*
- Credit Valley Conservation (CVC), 2010. *Cooksville Creek Watershed Study*
- Dillon, 1979. *Cooksville Creek Watershed Study*
- Environmental Water Resources Group (EWRG). 2002. *Cooksville Creek Flood Remediation Plan*.
- Environmental Water Resources Group (EWRG). 2010. *Cooksville Creek Flooding 2009 Study*.
- Municipal Engineers Association. 2007. *Municipal Class Environmental Assessment*
- North South Environmental Inc. 2009. *City of Mississauga Natural Areas Survey*
- Peel Climate Change Strategy Background Report. June 2011
- Philips. 2003. *Special Policy Area Study for the Cooksville Creek Floodplain*
- R.V. Anderson. 1996. *Cooksville Creek Floodline Mapping Study*