

TOWN-WIDE FLOOD STUDY

TOWN OF OAKVILLE

April 2008

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TOWN-WIDE FLOOD STUDY

TOWN OF OAKVILLE

EXECUTIVE SUMMARY

The Town of Oakville is serviced by several watercourses that outlet to Lake Ontario. The watercourses are situated in both older and more recently developed areas. Early development within the Town of Oakville proceeded with little understanding of the watercourse system's hydrology and hydraulics. Early development was allowed to be located in close proximity to watercourses, with the resulting creation of flood-prone areas. Development planning today considers the hydrologic function of watercourses and locates development accordingly, thus reducing or eliminating flood-prone areas adjacent to watercourses.

Ministry of Natural Resources funding for flood reduction/proofing programs has not been available for at least ten years, therefore, the responsibility for flood management programs has been shifted to the municipalities. The Town of Oakville therefore has identified the need to define and determine the flood-prone areas in the Town, and to develop a priority-based program to systematically alleviate/minimize flood risk where necessary and feasible. This study provides Town staff with the information and tools to develop a flood risk reduction program associated with open watercourse systems.

The assessment of flood-prone areas has been conducted using available historical studies and documents and the local flooding knowledge of Town of Oakville and Conservation Halton staff. Up-to-date mapping provided by the Town of Oakville has been used to delineate flood-prone areas.

An Evaluation Matrix has been developed to rank and prioritize each site for implementing flood protection measures. The Site Evaluation Matrix consists of the following Site Evaluation Categories and Criteria:

Level I: Site Evaluation Categories

- Human Ingress/ Egress and Emergency Response
- Flood Exposure
- Economic

Level II: Criteria

Human Ingress/Egress

- Private vehicle ingress/ egress
- Emergency vehicle ingress/ egress
- Access to emergency facilities
- Access to multiple user land use driveways

Flood Exposure

- Threat to life

Economic

- Direct Damages
- Indirect Damages

Each Evaluation Criteria is measurable and has been provided a Level of Significance based on the Evaluation Criteria's importance, e.g. Threat to Life is more important than Direct Damages. For each flood-prone site a cumulative score from the individual evaluation criteria results has been determined, which has been used to rank the sites and place them in a prioritized sequence.

To reduce flood conditions at flood-prone sites, recommendations for each site have been developed based on an evaluation of a long-list of potential flood remediation measures. Recommendations have been subdivided into Structural/Capital options and Non-Structural Options as follows:

Structural/ Capital Options

- Culvert/Bridge Upgrade – replace/ supplement existing culverts and bridges to increase flow capacity of the watercourse crossing.
- Flood plain/ Channel Improvements – improve flood plain and channel flow capacity
- Roadway Profile Modifications – adjust roadway profiles to reduce flood elevations
- Floodproofing buildings – floodproof buildings using various methods such as berming
- Flood Control via stormwater quantity controls – reduce flood flows by temporarily storing runoff within a stormwater management facility

Non-Structural Options

- Regulation (updated): The Conservation Authorities ensure that flooding conditions are not negatively impacted by creek or flood plain alterations/development.
- Flood Forecasting and Warning: Conservation Authorities maintain flood warning systems that assist in alerting residents and municipal staff of potential flooding conditions within the Conservation Authority's jurisdiction.
- Emergency Preparedness: Conservation Authority staff and Town of Oakville emergency services staff are active prior to, and during, flooding conditions. Emergency services staff are on alert prior to flooding conditions in order to evacuate citizens in flood-prone areas.
- Acquisition: At risk properties could be acquired to improve upstream flooding conditions or to eliminate or reduce threat to life. Acquisition of property would typically be one of the last alternatives selected, due to the high social and economic considerations involved.

Preferred flood reduction alternatives have been selected based upon the potential flood reduction, functionality and economics. To implement the flood management recommendations

additional studies would be required. Studies would be completed on a creek reach basis and implemented through the Town of Oakville’s Capital Works Program using a priority based approach. Timing of projects will be dependant on the evolving Capital Works Program, although an estimate of the study initiation year has been provided in Table 1.

TABLE 1 STUDY COSTS		
Initiation Year	Priority Reach For Study	Reach Based Flood Mitigation Study Cost
2009	McCraney – Fourteen Mile Creeks	\$200,000
2010	Lower Wedgewood Creek	\$150,000
2011	Lower Morrison Creek	\$150,000
2012	Sheldon and Joshua’s Creeks	\$125,000

TOWN-WIDE FLOOD STUDY

TOWN OF OAKVILLE

1. INTRODUCTION

1.1 Purpose

The Town of Oakville is situated along the north shore of Lake Ontario. Its lands are supported and serviced by several natural watercourses that traverse its topography. Oakville like most lake-side communities, finds its earliest development in close proximity to the lake and its more recent development migrating inland over time. This development evolution places the more mature neighborhoods within the tailwaters of the urbanizing watersheds.

Early development requirements had little to no regard for the natural watercourses that serviced these lands and in most cases these watercourses were assimilated into private land parcels, as there was high regard for the perceived value (aesthetic) which the watercourse added to the land.

The importance of these conveyance systems evolved over time. At the time, little was understood of the stream's hydrologic function, therefore urban development was permitted within close proximity to these systems.

Today, contemporary development planning recognizes the importance of natural stream systems for both the hydrologic and ecologic function. As the understanding of these systems evolved over time, so have municipal requirements for protecting them and inherently the public. Today administrators employ set-backs, riparian buffers along with quality and quantity control requirements.

Over the past number of years, the Town, in cooperation with the area Conservation Authorities (Conservation Halton and Credit Valley Conservation) has studied the drainage needs of municipal watersheds through numerous sub-watershed studies. Each of these studies examined the needs of both the watercourses and the developed lands which drain to them. These studies have documented numerous situations where the stable watercourse corridors have been infringed upon or overlapped with development(s). These situations create areas of potential conflict which, from time to time, give rise to flooding. Where flood waters are contained within undeveloped lands the risk of damage or loss of life is minimized. In situations where flood waters envelope or occupy developed lands, this risk becomes elevated. These latter situations are present in Oakville, particularly and almost exclusively in the older development areas. On May 12/13 2000, many south-western Ontario municipalities, including Oakville, were impacted by a significant rainfall event, damaging infrastructure, parks, trails, and private property.

To quantify the magnitude of flood risk expose in Oakville, the Town has compiled the findings from its many historical studies into one comprehensive Flood Study Document. This study comprehensively identifies flood-prone areas within Oakville. The study includes an assessment of the risks associated with flooding and therein prioritizes each location into high, medium and

low risk categories. The study document provides sufficient information to manage the issues of flood risk within Oakville. The management approach includes a wide range of options for consideration including, flood reduction projects, public awareness campaigns and public warning systems.

Historically flood mitigation projects were carried out through flooding reduction/proofing programs funded by the Ministry of Natural Resources (MNR) and implemented by the local conservation authority and local municipality.

Funding for these programs has not been available for over a decade, consequently proactive flood mitigation projects are not a common undertaking.

With this being the case, municipalities must now consider the merits of undertaking these types of projects. There is no dedicated funding stream for such projects, therefore this new program will need to be considered in parallel with other competing community interest projects. Should provincial, federal or private Flood Reduction/Mitigation funding programs become available, the Town would be able to respond promptly with quantified and prioritized needs list. In the absence of available funding for undertaking these projects, the Town will be able to focus its educational efforts to areas of the Town which are flood susceptible.

***Note:** This study was limited to information contained within historical documents that were completed over a significant period of time using a variety of modelling techniques. The flood study herein focuses on flooding potentials along open watercourse systems only. The Town recognizes that the aged and challenged closed conduit underground storm network presents another avenue for flooding action. A future study of the underground closed pipe network will resolve and report on any risks associated with its function and operational needs. A study of this nature however will require substantially more work than that invested in the open channel review.*

1.2 Scope

The study scope was established by the Town of Oakville, and refined through a consultation process with the Conservation Halton (CH) and Philips Engineering Ltd. The Conservation Halton mandate covers flood protection and management of all regulated watercourses across Oakville (with the exception of Clearview Creek, which is under the jurisdiction of Credit Valley Conservation). Conservation Halton has been integral in establishing the study scope. The study's scope has been to focussed on developing an implementation program for key flood-prone sites. Philips Engineering Ltd. has characterized flood-prone sites based on background data review and field reconnaissance. Each flood-prone site has been ranked using an evaluation system to determine site priority relative to each other. For each site, recommendations have been established to reduce or eliminate flooding of property and/or municipal infrastructure. To assist the Town of Oakville in implementing and managing the recommendations, an implementation program has been established, which include a relational database incorporating all relevant data for each flood-prone site.

1.3 Work Plan

The Work Plan was comprised of three study phases. The complete Work Plan has been provided in Appendix 'B' and includes detailed descriptions of each of the following tasks:

Phase 1- Review of Existing Reports and Studies

1. Consult with Town of Oakville and Conservation Halton to define the full-list of flood-prone sites and to gather background information on each flood-prone site.
2. Review and synthesize background information
3. Meet with the Town of Oakville to discuss development of an information database with a GIS link
4. Conduct site reconnaissance of flood-prone sites to document the characterization of each site.

Phase 2 – Reporting of Flooding Issues and Recommendations

5. Develop an Evaluation Scale for ranking flood-prone sites
6. Review and refine field reconnaissance information and Evaluation Scale following discussions with Town of Oakville and Conservation Halton
7. Evaluate flood-prone sites using the Evaluation Scale
8. Develop recommendations and cost estimates for each flood-prone site
9. Develop Implementation Program
10. Prepare Draft Report
11. Review and discuss Draft Report with Conservation Halton and Town of Oakville

Phase 3 – Compilation of Inventory and Database

12. Compile Inventory and Prepare information database with GIS link
13. Meet with the Town of Oakville to review the database and GIS link development
14. Conduct a Workshop with Town of Oakville staff

1.4 Steering Committee

Direction for this study has been provided by a Technical Steering Committee comprised of the following members:

<i>Town of Oakville</i>	Darnell Lambert Kristina Laretei Rita Juliao Cindy Toth
<i>Conservation Halton</i>	Ray Guther Janette Brenner
<i>Philips Engineering Ltd.</i>	Ron Scheckenberger Steve Chipps

2. BACKGROUND INFORMATION

2.1 Sources

Background information has been provided by the Town of Oakville and Conservation Halton. Each organization has provided reports and site documentation including design briefs and relevant correspondence. The following information has been provided:

Town of Oakville

- 2005 topographic mapping
- 2005 aerial orthophotography
- Creek mapping
- Storm sewer infrastructure mapping
- Road layout classification and names
- Town of Oakville property
- School locations
- Sensitive property mapping (related to pesticide use)
- Road maintenance hierarchy information (winter maintenance)

Conservation Halton

- Digital flood plain mapping
- Watercourse HEC-2 hydraulic models

Reports

The following is a comprehensive list of the reports that have been reviewed as part of this study:

- Jan-05 Clearview Creek Subwatershed Study Final Report, McCormick Rankin Corporation
- May-03 Devon Road Culvert Replacement, Marshall Macklin Monaghan
- Mar-03 Town of Oakville Project No. EA-023-01, Elton Park Storm Drainage Study EA Update, Philips Engineering Ltd.
- Apr-02 Town of Oakville, Response to Conservation Halton Comments dated January 28, 2002 Permit Applications Main & East Branches of Sheldon Creek. South of Rebecca Street, New Province Homes Ltd.
- Jan-02 Town of Oakville, Fourteen Mile Creek, Main and West Branches Subwatershed Plan, Philips Engineering Ltd.
- Sep-00 Fourteen Mile Creek Assessment Study, Final Report, Totten Sims Hubicki Associates /Parish Geomorphic/Schroeter & Associates
- Jun-00 May 12/13, 2000 Storm Events – General Flooding and Damage, Town of Oakville Staff Report

- Apr-00 Town of Oakville, Joshua's Creek Sub-basin 7B, Subwatershed Impact Study, Final Report, Marshall Macklin Monaghan Limited
- Sep-99 Oakville Golf Club Food Remediation Study, Munn's Creek, Oakville Golf Club
- May-95 Town of Oakville, West Oak Trails, Subwatershed Impact Study for Taplow Creek, McCraney Creek and the East Branch of Fourteen Mile Creek, Final Report, Cosburn Patterson Wardman Limited/Ecoplans Ltd./Golder Associates
- Oct-94 Proposed Cornwall Road Crossings Memorandum, EWRG
- May-94 Town of Oakville Morrison Creek Cornwall Road Culvert Crossings, Halton Region Conservation Authority Report, HRCA
- Dec-93 Glen Oak Creek Subwatershed Impact Study, Final Report, UMA Engineering Ltd.
- Oct-93 Town of Oakville, Sheldon Creek Watershed Master Plan, Philips Planning & Engineering
- Oct-93 Town of Oakville/City of Burlington, Sheldon Creek Watershed Master Plan, Philips Planning & Engineering Ltd./Ecoplans Limited/Golder Associates Limited /Cartologix Corporation
- Jan-93 Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Technical Report, R.V. Anderson Associates Limited
- Jan-93 Town of Oakville, Building Inventory Lower Morrison/Wedgewood Creek Flood Erosion and MDP
- Jul-92 Town of Oakville, Draft Report Subwatershed Impact Study Sub-basin 8, Joshua's Creek, Marshall Macklin Monaghan Limited
- May-92 Town of Oakville, Joshua's Creek Watershed Plan Study, Final Report, Volume 1: Main Report, Marshall Macklin Monaghan Limited/LGL Environmental Research Associates
- May-92 Town of Oakville, Joshua's Creek Watershed Plan Study, Final Report, Volume 2: Technical Appendices, Marshall Macklin Monaghan Limited/LGL Environmental Research Associates
- Feb-92 Town of Oakville, Fourteen Mile Creek-McCraney Creek, Watershed Planning Study, Final Report, Triton Engineering Services Ltd., J.L. Cox Planning Consultants /Ecological Services for Planning/D.W. Draper/Terraqua Investigations Ltd.
- Oct-91 Town of Oakville, Environmental Study Report, Elton Park Storm Drainage Study, McConnell Maughan Limited
- Jun-91 Oakville Golf & Country Club, Erosion Protection Works on Munn's Creek, Cosburn Patterson Wardman Limited

- May-90 Markborough Properties Incorporated, Halton Region Conservation Authority Report
- Jan-90 Stormwater Management Report Wedgewood Creek Business Park Town of Oakville, R.V. Anderson Associates Limited
- Jan-90 Town of Oakville, City of Burlington, Secondary Stormwater Management Study, East Sheldon Creek and Bronte Creek Tributary, Philips Planning & Engineering Ltd.
- Jun-88 Halton Region Conservation Authority, Joshua's Creek Floodplain Mapping Study, Flood Damage Reduction Program Technical Report, Dillon Consulting Engineers
- Jul-88 Halton Region Conservation Authority, Joshua's Creek Floodplain Mapping Study, Flood Damage Reduction Program Technical Report, Dillon Consulting Engineers
- Jun-88 Town of Oakville, Stormwater Management Study for the Anprop River Oaks Development, within the Munn Creek Watershed, Fred Schaeffer & Associates Ltd.
- Apr-86 Fourteen Mile Creek-McCraney Creek System, Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering Ltd.
- Apr-86 Town of Oakville/City of Mississauga, Sheridan Creek Flood Control Study, Draft, Totten Sims Hubicki Associates
- Dec-85 Halton Region Conservation Authority, McCraney Creek, Town of Oakville, Technical Report on Erosion Control, Philips Planning & Engineering Ltd.
- Jul-85 Halton Region Conservation Authority, 14 Mile Creek-McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Interim Report, Philips Planning & Engineering Ltd.
- Jun-85 Halton Region Conservation Authority, 14 Mile Creek-McCraney Creek System Flood Control Study, Technical Report Summary of Hydrology, Hydraulics and Flood Damages, Philips Engineering Ltd.
- Feb-84 Halton Region Conservation Authority, 14 Mile Creek Flood Damage Reduction Study, Notes on Review of Draft Report, Philips Planning & Engineering Ltd.
- Aug-83 Halton Region Conservation Authority, Sheldon Creek Water Management Study, MacLaren Plansearch Inc.
- Jul-83 Halton Region Conservation Authority, Interim Watershed Plan, Ministry of Natural Resources
- Jan-83 Town of Oakville, Southeast Area Master Drainage Plan, Gore & Storrie Limited
- Aug-79 Town of Oakville, Morrison and Wedgewood Creeks Master Drainage Plan, The Proctor & Redfern Group/Andrew Brodie Associates Inc.

2.2 Summaries of Relevant Information

Although a substantial number of reports have been reviewed for background information, the following reports have been considered key resources.

Clearview Creek Subwatershed Study Final Report, McCormick Rankin Corporation, January 2005: Provides hydrologic and hydraulic characterization of Clearview Creek upstream of Winston Churchill Blvd. The report outlines recommendations to alter the watercourse to mitigate existing flooding and spill concerns. The recommendations would be conducted to facilitate potential future development within the area.

Town of Oakville Project No. EA-023-01, Elton Park Storm Drainage Study EA Update, Philips Engineering Ltd., March 2003: The report provides recommendations for the storm minor and major drainage systems within the Elton Park area to mitigate existing flooding conditions. Recommendations include improvements to the storm sewer system and flow diversion.

Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Technical Report, R.V. Anderson Associates Ltd., January 1993: Report outlines recommendations for flooding mitigation within both the Lower Morrison and Lower Wedgewood based on hydrologic and hydraulic characterization of the creeks. Recommendations include culvert upgrades, building flood proofing and others.

Town of Oakville/City of Burlington, Sheldon Creek Watershed Master Plan, Philips Planning and Engineering Ltd./Ecoplans Limited/Golder Associates Limited/Cartologix Corporation, October 1993: Report outlines key flooding concerns within Sheldon Creek and provides preliminary recommendations for flooding mitigation.

Fourteen Mile Creek-McCraney Creek System, Flood Damage Reduction Preliminary Engineering Study, Philips Planning and Engineering Ltd., April 1986: Flood damages for both Fourteen Mile Creek and McCraney Creek are documented. The report provides preliminary recommendations and considerations for reducing flooding conditions and flood damages.

3. FLOOD RISK SCREENING

3.1 Approach/Methodology

The available background information has been reviewed to identify documented flood-prone sites. The approach to establishing the “long-list” of flood-prone sites has included the following tasks:

- Identify documented flood-prone sites as described or mapped within reports or current flood plain mapping
- Determine the appropriate extent and frequency of flooding
- Determine the extent of property and building flooding and flooding conditions at roadways, for both the 100 year storm and Regional Storm (based on Hurricane Hazel).
- Based on 100 year storm and Regional Storm, ascertain whether flooding conditions may occur for lesser storm events such as the 2 to 50 year storms.
- Determine a preliminary “qualitative” rank for flood-prone sites based on extent of property, building and roadway flooding

The application of the foregoing protocol produced over 40 flood-prone sites, which required further investigation and screening, based on preliminary field reconnaissance, discussions with Town of Oakville and Conservation Halton staff and, as necessary, a “high level” review of existing hydraulic modeling (if available). Preliminary field reconnaissance included verification of crossing details and channel form. Town of Oakville and Conservation Halton staff conveyed through discussions, historical flooding incidents, records of channel work, road work and other site associated information that was not readily available within reference documentation.

Once, the flood-prone sites had been generally ranked, the sites identified as “High” or “Medium” were further investigated. The additional investigation work included in-depth field reconnaissance and more detailed assessment of available hydraulic modeling and flood plain mapping. The hydraulic modeling and flood plain mapping have been reviewed for verification of channel and crossing details through field reconnaissance.

Field reconnaissance results have been incorporated into the relational database (ref. Appendix ‘C’ for a sample site). The reconnaissance documented channel conditions, flood plain conditions, upstream and downstream crossing details, information on adjacent properties and observations of potential flooding mechanisms. Reconnaissance included taking measurements of the creek system and estimating elevations and distances to adjacent buildings.

3.2 Flooding Impacts

Flooding for the initial flood risk screening has typically either been considered to be *Direct* or *Indirect*. *Direct* flooding impacts are considered to involve the flooding of buildings, such as homes, commercial establishments etc. *Indirect* flooding impacts are the flooding of out buildings on private property, which may include rear yard sheds, swimming pools etc. *Direct* and/or *Indirect* flooding can occur from spills resulting from lack of flood plain or crossing flow capacity. *Direct* impacts are typically considered more significant than *Indirect* impacts, as *Direct* impacts carry a greater threat to life. *Indirect* flooding also includes other factors such as the loss of business, closure of community facilities and disruption to people’s normal patterns of living.

4. FLOOD INVENTORY

4.1 Description of Flood-prone sites

As noted in Section 3, flood-prone sites have been determined through review of background information, flood plain mapping, site reconnaissance and hydraulic data. Table 4.1 provides a listing of sites identified using the flood risk screening protocols. Each site has been provided a preliminary ranking based on the flooding information gathered during the study, namely the *Direct* and *Indirect* flooding conditions noted within reports and associated flood plain mapping. Certain sites have been screened from further evaluation, based on discussions with Conservation Halton and the Town of Oakville. Each of the sites screened has been discussed further following Table 4.2 outlining the screening rationale. The location of each site has been depicted on Drawing 1, along with Figures showing each site in further detail.

**TABLE 4.1
FLOOD-PRONE SITES**

Site #	Name	Preliminary Priority	Stream	# of Properties/Buildings Impacted	Documented Description / Recommendations	Reference Material
2	SHEL1088E	HIGH	Sheldon Creek	Petro Canada Plant, Commercial Plaza, Future Water Treatment Plant	Flooding of a hydrogen plant and a waste effluent treatment plant during Regional Storm. Spill water enters the drainage ditch at Petro Canada Refinery and flow to the watershed to the east	Sheldon Creek Water Management Study - McLaren Plansearch / Aug 1983 Secondary Stormwater Management Study East Sheldon Creek and Bronte Creek Tributary, Philips Planning & Engineering / No date
5	FOUR2895M	HIGH	14 Mile Creek	2 properties only & 5 buildings/properties	Properties too close to the stream and deficiently graded	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
6	FOUR2213M	HIGH	14 Mile Creek	9 properties only & 4 buildings/properties	Properties too close to the stream and deficiently graded	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
7	FOUR1018M	HIGH	14 Mile Creek	17 properties only & 11 buildings/properties	Properties too close to the stream and deficiently graded	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
8	FOUR0440M	HIGH	14 Mile Creek	8 properties only & 15 buildings/properties	Properties too close to the stream and deficiently graded	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
9	MCCR2177M	HIGH	McCraney Creek	7 buildings & 9 properties	Upstream flood controls	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
10	MCCR1920M	HIGH	McCraney Creek	3 properties only & 4 buildings/properties	Upstream flood controls	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
11	MCCR1705M	HIGH	McCraney Creek	4 properties only & 10 buildings/properties	Upstream flood controls	14 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
12	MCCR0630M	HIGH	McCraney Creek	10 properties only & 19 buildings/properties	Upstream flood controls	15 Mile Creek - McCraney Creek System Flood Damage Reduction Preliminary Engineering Study, Philips Planning & Engineering / Apr 86
22	WEDG2190M	HIGH	Wedgewood Creek	1 building/property	Road flooding	Wedgewood Creek Flood plain Mapping
23	WEDG0895T	HIGH	Wedgewood Creek	5 buildings/properties	Erosion protection, replace rip rap	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
25	WEDG0145T	HIGH	Wedgewood Creek	10 buildings/properties	Enlarge Drummond Rd culvert and Floodproof 4 buildings	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
26	WEDG1810M	HIGH	Wedgewood Creek	7 buildings/properties	N/A	Wedgewood Creek Flood plain Mapping
30	WEDG0634M	HIGH	Wedgewood Creek	9 buildings/properties	N/A	Wedgewood Creek Flood plain Mapping
31	WEDG0200M	HIGH	Wedgewood Creek	5 buildings/properties	Enlarge park & Wedgewood, floodproof 4 buildings, retaining wall	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
33	MORR0405T	HIGH	Morrison Creek	16 buildings/properties	Floodproof buildings, erosion control	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
42	CLEA2555M	HIGH	Clearview Creek	5 properties only & 4 buildings/properties	Stream spills. Proposed realignment of the creek.	Clearview Creek Subwatershed Study Final Report, McCormick Rankin Corporation
43	JOSH3979M	HIGH	Joshua's Creek	Winston Churchill Flooding	Road flooding	Joshua's Creek Flood Plain Mapping
24	WEDG0622T	MEDIUM	Wedgewood Creek	3 buildings/properties	Erosion protection, replace rip rap	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
27	WEDG1549M	MEDIUM	Wedgewood Creek	2 buildings/properties	Enlarge Duncan Rd Culvert & Floodproof 1 building	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
32	MORR0700T	MEDIUM	Morrison Creek	3 buildings/properties	Floodproof 3 buildings	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
35	MORR0098T	MEDIUM	Morrison Creek	2 buildings/properties	Floodproof buildings, erosion control	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
36	MORR2445T	MEDIUM	Morrison Creek	3 buildings/properties	Floodproof building	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
37	MORR1910M	MEDIUM	Morrison Creek	3 buildings/properties	Floodproof building	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
38	MORR0869M	MEDIUM	Morrison Creek	3 buildings/properties	Erosion Protection	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
39	MORR0338M	MEDIUM	Morrison Creek	3 buildings/properties	Erosion Protection, Floodproof 5 buildings	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
16	ELPK000D	LOW	Elton Park Storm Drainage	4 buildings/properties	Lack of a suitable storm drainage outlet to Lake Ontario, causing local and persistent flooding	Environmental Study Report EA-009091 Town of Oakville Elton Park Storm Drainage Study Vol 1, McConnell Maughan Ltd / Oct 91
41	CLEA1640M	LOW	Clearview Creek	None	Stream spills. Proposed realignment of the creek.	Clearview Creek Subwatershed Study Final Report, McCormick Rankin Corporation

**TABLE 4.2
SCREENED FLOOD-PRONE SITES**

Site #	Name	Former Priority	Stream	# of Properties/Buildings Impacted	Documented Description / Recommendations	Reference Material
1	SHEL0876M	LOW	Sheldon Creek	Roadway flooding of Burloak Drive	NA	Sheldon Creek Water Management Study - McLaren Plansearch / Aug 1983
3	SHEL0000M	LOW	Sheldon Creek	1 building	NA	Sheldon Creek Water Management Study - McLaren Plansearch / Aug 1984
4	BRTE4440W	LOW	Bronte Creek	3 buildings/properties	Spills upstream of Burloak Dr at the QEW (south side), and south of McPherson Rd Potential property flooding south of QEW, east of McPherson. Erosion downstream of McPherson Rd	Secondary Stormwater Management Study East Sheldon Creek and Bronte Creek Tributary, Philips Planning & Engineering / No date
13	MUNN000T	LOW	Munn's Creek	Golf course	Flooding at Oakville Golf Club	Oakville Golf Club Flood Remediation Study Munn's Creek, MRC Corporation / Sep 99
14	ELPK0780D	HIGH	Elton Park Storm Drainage	6 buildings/properties	Potential property damage due to erosion	Environmental Study Report EA-009091 Town of Oakville Elton Park Storm Drainage Study Vol 1, McConnell Maughan Ltd / Oct 91
15	ELPK0365D	HIGH	Elton Park Storm Drainage	10 buildings/properties	Persistent standing water in the Lavender Lane area (due to smaller diameter culvert on Barringham Dr). Concerns with respect to local drainage along Michael Terrace	Environmental Study Report EA-009091 Town of Oakville Elton Park Storm Drainage Study Vol 1, McConnell Maughan Ltd / Oct 91
17	MUNN1270T	LOW	Munn's Creek	Undetermined	Low capacity at culverts	Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Anderson Associates Limited / Aug 79
18	MUNN1015T	LOW	Munn's Creek	Undetermined	Low capacity at culverts	Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Anderson Associates Limited / Aug 79
19	MUNN0960T	MEDIUM	Munn's Creek	Undetermined	Low capacity at culverts	Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Anderson Associates Limited / Aug 79
20	MUNN0768T	MEDIUM	Munn's Creek	Undetermined	Low capacity at culverts	Town of Oakville, Lower Morrison/Wedgewood Creeks, Flood Erosion and Master Drainage Plan Study, Anderson Associates Limited / Aug 79
21	MORR1532T	HIGH	Morrison Creek West Tributary	Sheridan College property	Very little handling capacity	Town of Oakville Master Drainage Plan - Morrison and Wedgewood Creeks. The Proctor & Redfern Group / Aug 79
29	WEDG1380M	MEDIUM	Wedgewood Creek	2 buildings/properties	Monitor, enlarge Devon Rd Culvert & Floodproof 3 buildings	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93
40	MORR0000M	LOW	Morrison Creek	1 building/property	Protect Footings, Floodproof 1 building	Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study / Jan 93

4.2 Summary of Screened Sites and Associated Screening Rationale

Site #1 (SHEL0876M):

This site is located on Sheldon Creek Main Branch at Burloak Drive. Minor roadway flooding occurs during the Regional Storm event, but there is no flooding of buildings in the vicinity of the crossing. Flooding occurs on the City of Burlington side of roadway due to the Burloak Drive crossing's limited flow capacity. Investigation of crossing improvements could be conducted when the crossing requires replacing for structural integrity. Crossing design would require input from both the City of Burlington and Town of Oakville.

Site #4 (BRTE4440W):

The Bronte Creek Tributary crossing of McPherson Road has a 50-year capacity. The Town of Oakville is currently planning to replace the existing crossing. The QEW westbound lanes are flooded and it has been proposed to extend the downstream culvert at the QEW in this location. The Town of Oakville may also consider a potential realignment of McPherson Road which would eliminate the need for the existing culvert crossing.

Site #13 (MUNN0000T):

This site is located on Munn's Creek through the Oakville Golf Club. Flooding documented within the Oakville Golf Club Flood Remediation Study Munn's Creek, McCormick Rankin Corporation, September 1999 has been largely mitigated through implementation of the report recommendations.

Sites #14 (ELPK0780D), #15 (ELPK0365D), and #16 (ELPK0000D):

The Town of Oakville has been implementing drainage improvements to the Elton Park storm drainage system as recommended within the Elton Park Storm Drainage Study EA Update, 2003. As such historical flooding concerns are in the process of being mitigated by the Town of Oakville.

Sites #17 (MUNN1270T), #18 (MUNN1015T), #19 (MUNN0960T), #20 (MUNN07678T):

Following the May 2000 Storm event and the flooding that occurred within the Culham Street area, the Town of Oakville has implemented improvements to Munn's Creek by constructing an outlet to the Oakville Golf Club, thereby, preventing future flooding.

Site #21 (MORR1532T):

Morrison Creek through Sheridan College has historically been a flooding concern. Improvements to the creek throughout the College grounds have improved flow conveyance. Based on the improvements to the creek and updated flood plain delineation, Conservation Halton no longer considers the buildings within this reach of the creek to be a flood-risk.

Site #29 (WEDG1380M):

This site has been screened from further consideration, as verification of Regional Storm flooding conditions has determined that no direct flooding would occur.

Site #40 (MORR0000M):

This site has not been considered further due to minor flooding of one building. The Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study, January 1993 has recommended that the building be flood proofed.

General flooding areas screened from consideration:

In addition to the site-specific flood-prone sites, there are also general flooding areas that require acknowledgement. These flooding areas have been screened from further evaluation for flooding mitigation due to the historical infrequency of flooding. These sites include Bronte Creek Harbour, Oakville Harbour, other creek outlets to Lake Ontario and trail systems adjacent to creeks. The public though should be aware that these areas should not be used during high water conditions or when ice conditions are present during significant melt/runoff periods, either through public awareness programs, signage and other means.

4.3 Overview of Flood Risk/Mechanics

There are various mechanisms of flooding that occur depending on flow rates and unique site conditions. Flooding can be caused by restricted channel flow capacity restricted, reduced/compromised flood plain flow capacity, channel obstructions (i.e. debris or ice jams), restricted hydraulic crossing flow capacity and limited storm sewer infrastructure flow capacity. [Note: This study has focussed on “open” waterway systems only.]

For most creeks, the channel component of the flow system is often capable of conveying the 2 year frequency storm flows. Flows greater than the 2 year storm event [5 year to Regional Storm (Hurricane Hazel)], would typically be carried outside of the channel, within the overbank area of the flood plain. As part of the flood plain system, roadway watercourse crossings are usually designed to convey flows based upon the municipal classification of the roadway such as a 100 year storm, or in the case of rail crossings, designed to protect the rail system at the time of rail construction.

The creek systems within the Town of Oakville have been highly altered by development which predominantly occurred within the last one hundred years. The historical approach to creek system management generally involved narrowing, straightening and constructing manmade

channel systems to allow for development, often resulting in development being located within the flood plain. Creek crossings, such as roadways, have not always been constructed to provide adequate conveyance of flows, therefore exacerbating the flooding conditions produced indirectly by development.

For this assessment, flooding mechanisms have been considered under the following categories:

- Restrictive channel capacity
- Restrictive flood plain capacity
- Spill prone area
- Limited culvert/bridge capacity
- Obstruction zone

5. EVALUATION OF FLOOD-PRONE SITES

5.1 Overview of (Ministry of Natural Resources) Protocols

The Ministry of Natural Resources (MNR), as part of the former Flood Damage Reduction Program identified various flood risk factors to evaluate flood-prone sites. The Flood Damage Reduction Program involved the definition of flood risk related to Direct and Indirect property damages, expressed as Annual Average Damages. The Ministry of Natural Resources has also established measures related to assess human exposure to flooding, which incorporate flood frequency and severity. The various measures specific to these protocols are outlined in the following sections and the accompanying assessment charts.

5.2 Evaluation Matrix Development

Based on the MNR's flood risk factors and input from the Town of Oakville and Conservation Halton, the Flood-prone Site Evaluation Matrix has been developed to rank sites and to determine a priority sequence for implementing the associated flood protection measures to reduce risk at each flood-prone site. The Evaluation Matrix has been established based upon the following Site Evaluation Categories and Criteria:

Level I: Site Evaluation Categories

- Human Ingress/ Egress and Emergency Response
- Flood Exposure
- Economic

Level II: Criteria

Human Ingress/Egress

- Private vehicle ingress/ egress
- Emergency vehicle ingress/ egress
- Access to emergency facilities
- Access to multiple user land use driveways

Flood Exposure

- Threat to life

Economic

- Direct Damages
- Indirect Damages

Each Category Criteria is measurable (i.e. Direct Damages is measured by damage costs). Depending on the Category Criteria, measures have been adjusted by the storm frequency to account for flooding impacts for the full flow regime. As an example, if 10 people are endangered during flooding conditions at a site, it is important to determine if this risk exposure occurs during a 2 year storm or during the Regional Storm (Hurricane Hazel), obviously over weighting more frequent occurrences.

Subsequent to Category Criteria measurements being adjusted or normalized by storm frequency, a 0 to 10 weighting has been applied reflecting the product of the measure and frequency weighting (ref. Table 5.1). As an example, if Direct Damages are less than \$20,000 Average Annual Damages, a weighting of 2 would be set, versus if Direct Damages have been determined to be greater than \$500,000 Average Annual Damages, for which a weighting of 10 would be given to the Category Criteria.

Each Category Criteria has also been provided a *Level of Importance or Significance* (0-10). As an example, the Threat to Life Category Criteria has a Level of Importance or Significance of 10. The Level of Importance or Significance is multiplied by the Category Criteria Weighting and Storm Frequency Weighting to develop a final product used in ranking the site relative to others.

5.3 Evaluation Categories

5.3.1 Human Ingress-Egress/ Emergency Response

Related to the Threat to Life Category is the ability of residents and emergency response workers to safely move in and out of flooded areas. The Ministry of Natural Resources has developed a Vehicular Access flood risk factor for both private and emergency vehicles as per the following:

Private vehicle access ingress/egress based on flood depths and velocity as follows:

- $d < 0.3$ m, $v > 4.5$ m/s (shallow flood depths with high velocities can prevent vehicle ingress/egress due primarily to the flood elevation)
- $0.3 < d < 0.4$, $v > 3$ m/s (flooding depths greater than 0.3 m are typically above the exhaust systems of vehicles and will stall vehicle's engines)
- $d > 0.4$, $v > 0.3$ m/s (all vehicles are impacted by flood depths greater than 0.4 m, unless it is a full-size truck. The low velocities can move a vehicle with the flood depth greater than 0.4 m)

Emergency vehicle access ingress/egress (as per private vehicle access) with the addition of the occurrence of the following flooding depth velocity relationship:

- $[d > 0.9$ m, $v > 4.5$ m/s] diesel fire trucks.

Evaluation Scale Criteria for the Human Ingress-Egress/ Emergency Response have been developed as shown within Table 5.1. An explanation of each Evaluation Scale Criteria has been provided hereafter:

Ministry of Transportation (MTO) design flood criteria for road crossings:

The Ministry of Transportation provides design flood criteria for each type of road. As the level of importance of a road increases, so does the flood criteria established by the Ministry of Transportation. Within the Evaluation Matrix, each road classification has been provided a weighting. As it is important to know if a road is flooded by the 2 year storm versus the 100 year storm, storm frequency weighting modifiers have been applied, therefore resulting in a greater weight to those roads flooded by lesser storm events. The MTO design flood criteria has been given a lower Category Importance/ Significance, as it is a government agency criteria and is not a direct measure of the impacts on human ingress and egress at a flooded roadway.

Private and Emergency Vehicle Ingress/ Egress:

Flooding depths and velocities at creek roadway crossings and roadways within the Regulatory flood plain have been used to determine the impacts to private and emergency vehicle ingress and egress.

To evaluate the *Human Ingress-Egress /Emergency Response*, the Measure Weighting has been based on Daily traffic loadings for each road, as provided by the Town of Oakville. This has been used as a metric to gauge roadway importance (i.e. higher traffic volumes reflect greater importance). In addition, if the road has been classified by the Town of Oakville as an Emergency Services (EMS) Route or if the road has been considered by the Town of Oakville as integral in providing routes for Emergency Service vehicles, then it has been weighted as a 10.

<i>Traffic Volumes</i>	
EMS Route	10 (Not applicable)
Level 1 Road	10 (10000 – 50000)
Level 2 Road	8 (5000 – 9999)
Level 3 Road	6 (1000 – 4999)
Level 4 Road	4 (0 – 999)

Storm frequency weighting modifiers have been applied, as per all the Evaluation Scale Criteria within the Human Ingress-Egress/ Emergency Response Evaluation Scale Category.

Access to Emergency Facilities:

The Evaluation Scale Criteria, *Access to Emergency Facilities* provides a method of determining if access to critical buildings such as hospitals, fire halls, community centres and other Town of Oakville buildings would remain during flooding conditions. Under this Evaluation Scale Criteria both private and emergency vehicle passage has been assessed. The assessment has been conducted using the weighting for complete, partial or no prevention of vehicle passage to an emergency facility.

Access to Multiple User Driveways

The *Access to Multiple User Driveways* Category Criteria is used to indicate whether or not private vehicle access would remain to buildings, such as day care centres, apartment buildings, shopping malls etc, as these buildings should be accessible during flooding. The Evaluation Scale Criteria has been weighted based on the level of vehicle usage, ranging from low to high.

5.3.2 Flood Exposure

The *Threat to Life* flood risk factor is a method of measuring the number of people potentially endangered by flooding conditions. The number of people endangered by various flooding depths and velocities for the complete flow regime is based on the following MNR protocols:

- No. of people in flooding depth <0.98 m (applies only to children in standing water)
- No. of people in flooding depth >0.98 m (applies to all people in standing water)
- No. of people in flooding with a depth/ velocity product of 0.4 m/s² (applies to all people within moving water)

The number of people at risk has been determined using the land use, occupancy rates and flood conditions for flooded areas. The weighting for the Evaluation Scale Criteria has been developed based on the number of people at risk, with a higher weighting for an increased number of people at risk. No storm frequency weighting modifier has been applied. The Category Importance/Significance has been subdivided to recognize day time and day and night time usage.

5.3.3 Economics

Direct Damages

The *Direct* property damages are assessed based on Damage Curves developed by MNR (ref. Baird 2007) for various types of land use. Damage costs are related to the depth of flooding that would occur within a building. Costs per unit depth have been established based on historical damage data provided by insurance companies, municipalities, conservation authorities and others. Weighting increases with estimated damages. No storm frequency modifier has been used as storm frequencies are implicitly considered within the damage estimation.

Indirect Damages

Indirect damage costs have been estimated by the Ministry of Natural Resources to be approximately 15% of the Direct Damages.

The foregoing flood risk factors and others have been incorporated into a Flood-prone Site Evaluation Matrix for refining the ranking order for each of the flood-prone sites.

**TABLE 5.1
TOWN OF OAKVILLE FLOOD-PRONE SITE EVALUATION MATRIX**

Evaluation Scale Category	Evaluation Scale Criteria	Evaluation Scale Description	Measure	Weighting (0-10)	Frequency Weighting Modifier	Category Importance/ Significance (1-10)	Product
Human Ingress-Egress / Emergency Response	1. Ministry of Transportation (MTO) design flood criteria for road crossings.	This relates to which storm event floods the crossing and the MTO design flood criteria for various crossing spans and Town of Oakville Criteria - overland - crossings.	Classification/frequency (emergency route)	Arterial 10 Collector 8 Urban local 6 Rural local 4	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	2	
	2. Private vehicle access ingress/egress based on the following flood depths and velocity • d <0.3 m, v >4.5 m/s, • 0.3 <d < 0.4, v > 3m/s, • d >0.4, v >0.3 m/s.	These criteria relate to the egress of vehicles in flooding conditions based on muffler height (usually <0.3 m) and vehicle stability in floods using depth/velocity relationships.	Depths and frequency of events with prevent private vehicle passage	Traffic Volumes EMS Route 10 (Not applicable) Level 1 Road 10 (10000 – 50000) Level 2 Road 8 (5000 – 9999) Level 3 Road 6 (1000 – 4999) Level 4 Road 4 (0 – 999)	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	5	
	3. Emergency vehicle access ingress/egress (as per private vehicle access) with the addition of the occurrence of the following flooding depth velocity relationship: • [d >0.9 m, v >4.5 m/s] diesel fire trucks.		Depths and frequency of events with prevent emergency access (emergency route)	Traffic Volumes EMS Route 10 (Not applicable) Level 1 Road 10 (10000 – 50000) Level 2 Road 8 (5000 – 9999) Level 3 Road 6 (1000 – 4999) Level 4 Road 4 (0 – 999)	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	6	
	4. Access to government facilities and potential emergency. Facilities include malls. Does flooding of roads prevent private and emergency vehicle access to facilities	These criteria relate to the egress of vehicles in flooding conditions based on muffler height (usually <0.3 m) and vehicle stability in floods using depth/velocity relationships	Depths and frequency of events which prevent private vehicle passage	Yes 10 Partial 5 No 0	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	3	
			Depths and frequency of events which prevent emergency access (emergency route)	Yes 10 Partial 5 No 0	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	7	
	5. Access to private driveways for users: such as apartments, malls, nursing homes, businesses (does not include low- medium density housing). -Daycare (Low vehicle usage) -Nursing home (Medium vehicle usage) -Business (Medium-High vehicle usage) -Apartment building (Medium-High vehicle usage) -Mall (High vehicle usage)	These criteria relate to the egress of vehicles in flooding conditions based on muffler height (usually <0.3 m) and vehicle stability in floods using depth/velocity relationships	Depths and frequency of events which prevent private vehicle passage	High Vehicle Usage 10 Med-High Vehicle Usage 8 Med Vehicle Usage 6 Low Vehicle Usage 4	2 Year 1.0 5 Year 0.4 10 Year 0.2 25 Year 0.08 50 Year 0.04 100 Year 0.02 Regional 0.008	4	

**TABLE 5.1
TOWN OF OAKVILLE FLOOD-PRONE SITE EVALUATION MATRIX**

Evaluation Scale Category	Evaluation Scale Criteria	Evaluation Scale Description	Measure	Weighting (0-10)	Frequency Weighting Modifier	Category Importance/ Significance (1-10)	Product
Flood Exposure	1. The number of people endangered by various flooding depths and velocities for the complete flow regime as per the following: <ul style="list-style-type: none"> No. of people in flooding depth <0.98 m No. of people in flooding depth >0.98 m No. of people in flooding with a depth/ velocity product of 0.4 m/s² 	Based on land use, occupancy rates, and flood conditions, the number of people at risk could be determined.	Normalized number of people threatened	More than 1,500	10	NA	Day Time Only Usage 9
				1,001 – 1,500	6		
				501 – 1,000	5		
				101 – 500	4		
				51 – 100	3		
				11 – 50	2		Day and Night Time Usage 10
				1 – 10	1		
				None	0		
Economics	1. Direct Damages Flood damage to buildings varies based on flooding occurrence frequency, lowest opening elevations and potential structural damage. Damage costs also depend on the building type and value. For the full flow regime flooding damage costs to building would depend upon the following: <ul style="list-style-type: none"> No. and type/ value of property flooded < lowest opening and < 0.8 m (structural damage does not occur) No. and type/ value of property flooded < lowest opening and > 0.8 m (structural damage occurs) No. and type/ value of property flooded > lowest opening and < 0.8 m (structural damage does not occur) No. and type/ value of property flooded > lowest opening and >0.8 m (structural damage occurs) 	Cost of building flooding damage	\$ Estimated Damage (curves)	\$70,001 - \$90,000	10	NA	8
				\$50,001 - \$70,000	8		
				\$25,001 - \$50,000	6		
				\$10,001 - \$25,000	4		
				\$1 - \$10,000	2		
				\$0			
	2. Indirect Damages -Property damage to out buildings, pools, decks, etc. for the full flow regime. -Clean up cost -Loss of business	Cost of property flooding and loss of business	\$ Estimated Damage	\$10,001 - \$14,000	10	NA	4
				\$7,501 - \$10,000	8		
				\$4,001 - \$7,500	6		
				\$1,501 - \$4,000	4		
				\$1 - \$1,500	2		
				\$0			

5.4 Application of Evaluation Scale

To apply the Evaluation Scale for each site, the hydraulic conditions for the 2 year to the 100 year storm and Regional Storm (Hurricane Hazel) are required. Conservation Halton has provided the most current hydraulic models, flood plain mapping sheets and digital flood lines for each creek and has also provided any data on site specific hydraulic modifications that have not been incorporated into the hydraulic models.

The Town of Oakville has provided 2005 digital topographic mapping, which has been used to establish elevations within each site. In evaluating flooding depths for each site, the Town of Oakville topographic mapping has been used in conjunction with the flood elevations provided by Conservation Halton. Conservation Halton has noted that the flood plain mapping has over time been developed using different elevation datums compared to the Town of Oakville mapping, and as such requested that a spot elevation check be conducted to ensure that flooding depths for each site have been established accurately. Table 5.2 provides the results of the spot elevation check. From a comparison of the Town of Oakville mapping and Conservation Halton flood plain mapping spot elevations, the majority of sites have not required elevation adjustment. Spot elevations with a difference of more than 0.3m have been adjusted to Conservation Halton datum.

In determining whether or not a building is flooded, the building elevations have been estimated using the Town of Oakville topographic mapping. The building first floor elevation has been based on the approximate elevations at the front of the house plus a 0.6m +/- allowance for the rise to the first floor. Basement elevations have been estimated based on the first floor elevation minus 2.44 m (8 feet), and basement windows have been estimated to be 1.83 m (6 feet) above basement elevations. Site reconnaissance has been used to determine whether a basement is a walkout or regular buried basement.

To evaluate the accuracy of the building elevation approximations (first floor), building elevations from previous flood damage reports have been used as a comparison to the building elevation approximations. Table 5.3 provides the results of the elevation comparison. Building elevations with a difference greater than 0.3m have been adjusted to the flood damage report elevations where available.

As outlined in the previous sections, for each Evaluation Scale Criteria, a process has been developed to establish the data required for the evaluation and to determine a product for each criteria. For each site, these criteria products have been totaled to yield a total score (ref. Appendix 'E'). A summary of each site's Evaluation Scale Criteria products and total score has been provided in Table 5.4. The total score for each site has been used to rank each site in order of highest flood risk to lowest flood risk, and to prioritize the recommended flooding mitigation / reduction measures.

**TABLE 5.2
SPOT ELEVATION CHECK/VERIFICATION**

Location	Stream	Site No.	Building Elevation (m)		Difference (m)	Approximate Distance (m)	Comment
			CH (.tif)	Town (CAD)			
East of 1439 Speers Rd	14 Mile Creek	5 (FOUR2895M)	97.1	96.9	0.2	7	Interpolation between 2 spot elevations was not possible
Open area south of Bridge Rd	14 Mile Creek	6 (FOUR2213M)	92.2	92.3	-0.1	6	Interpolation between 2 spot elevations was not possible
On Willowbrook Rd (near bend)	14 Mile Creek	7 (FOUR1018M)	87.8	87.7	0.1	9	Interpolation between 2 spot elevations was not possible
Centre of bridge on Lakeshore Rd West	14 Mile Creek	8 (FOUR0440M)	81.8	81.8	0	0	Interpolation between 2 spot elevations was not possible
South of 477 Wycroft Rd	McCraney Creek	9 (MCCR2177M)	106.9	107	-0.1	10	Interpolation between 2 spot elevations was not possible
Property west of McCraney Creek	McCraney Creek	10 (MCCR1920M)	101.6	101.4	0.2	10	Interpolation between 2 spot elevations was not possible
North of 572 Pinegrove Rd	McCraney Creek	11 (MCCR1705M)	98.8	98.7	0.1	4	Interpolation between 2 spot elevations was not possible
Rebecca St & 4th Line Intersection	McCraney Creek	12 (MCCR0630M)	85.94	85.9	0.04	0	
Ford small office	Wedgewood Creek	22 (WEDG2190M)	105.1	105.1	0	0	
Ford small office	Wedgewood Creek	22 (WEDG2190M)	105.2	105.2	0	0	
Morrison Rd bridge	Wedgewood Creek	23 (WEDG0895T)	98.4	98.93	-0.53	0	
Morrison Rd & Baldwin Dr intersection	Wedgewood Creek	24 (WEDG0622T)	99.2	99.7	-0.5	0	
Amber Crt	Wedgewood Creek	25 (WEDG0145T)	93.4	93.4	0	0	
Amber Crt & Drummond Rd intersection	Wedgewood Creek	25 (WEDG0145T)	93.2	93.2	0	0	
Drummond Rd	Wedgewood Creek	25 (WEDG0145T)	93.4	93.4	0	0	
Duncan Rd & Avon Crt intersection	Wedgewood Creek	26 (WEDG1810M)	94.7	94.7	0	0	
Duncan Rd bridge	Wedgewood Creek	26 WEDG1810M)	93.8	93.7	0.1	0	
Devon Rd bridge	Wedgewood Creek	27 (WEDG1549M)	90.5	90.5	0	0	
Wedgewood Dr bridge	Wedgewood Creek	30 (WEDG0634M)	82.4	82.88	-0.48	0	
Open area north of Lakeshore Rd E	Wedgewood Creek	31 (WEDG0200M)	78.8	78.8	0	0	
Immediately south from CNR	Wedgewood Creek	32 (MORR0700T)	97.2	96.93	0.27	5	Interpolation between 2 spot elevations was not possible
Maple Avenue & Bohemia Crt intersection	Morrison Creek	33 (MORR0405T)	95.1	95.4	-0.3	0	
Centre of creek d/s of Maple Ave. culvert	Morrison Creek	35 (MORR0098T)	92.6	92.6	0	0	
Chartwell Rd bridge	Morrison Creek	37 (MORR1910M)	93.4	93.4	0	0	
Morrison Rd bridge	Morrison Creek	38 (MORR0869M)	82.4	82.4	0	0	
Centre of creek d/s of Lakeshore Rd culvert	Morrison Creek	39 (MORR0338M)	75.9	75.9	0	0	

**TABLE 5.3
BUILDING ELEVATION CHECK**

Address	Site No.	Building Elevation (m)		Difference
		Approximate	Previous Study	
1449 Lakeshore Rd E	31 (WEDG0200M)	80.6	80.20	0.40
151 Wedgewood Drive	31 (WEDG0200M)	81.8	81.90	-0.10
159 Wedgewood Drive	31(WEDG0200M)	81.3	81.10	0.20
169 Wedgewood Drive	31 (WEDG0200M)	81.6	81.20	0.40
179 Wedgewood Drive	31 (WEDG0200M)	81.8	81.40	0.40
200 Wedgewood Drive	30 (WEDG0634M)	82.8	82.50	0.30
230 Alscot Court	30 (WEDG0634M)	82.6	82.50	0.10
208 Wedgewood Drive	30 (WEDG0634M)	82.7	83.70	-1.00
216 Wedgewood Drive	30 (WEDG0634M)	83.7	83.50	0.20
244 Alscot Court	30 (WEDG0634M)	83.7	84.00	-0.30
236 Alscot Court	30 (WEDG0634M)	83.5	82.60	0.90
1355 Devon Drive	27 (WEDG1549M)	89.6	90.00	-0.40
1351 Devon Drive	27 (WEDG1549M)	90.1	90.00	0.10
1347 Devon Drive	27 (WEDG1549M)	90.6	90.00	0.60
396 Ash Rd	27 (WEDG1549M)	90.9	92.20	-1.30
402 Ash Rd	27 (WEDG1549M)	90.9	91.80	-0.90
1356 Amber Court	27 (WEDG1549M)	91.4	91.30	0.10
1365 Amber Court	27 (WEDG1549M)	92.9	92.60	0.30
1357 Amber Court	27 (WEDG1549M)	92.7	92.98	-0.28
1373 Duncan Rd	26 (WEDG1810M)	94	93.10	0.90
1372 Acton Court	26 (WEDG1810M)	95.5	94.00	1.50
1368 Acton Court	26 (WEDG1810M)	95.6	94.50	1.10
1300 Amber Court	25 (WEDG0145T)	92.6	92.60	0.00
410 Drummond Rd	25 (WEDG0145T)	92.5	92.00	0.50
420 Drummond Rd	25 (WEDG0145T)	92.6	92.40	0.20
426 Drummond Rd	25 (WEDG0145T)	93	93.30	-0.30
432 Drummond Rd	25 (WEDG0145T)	92.5	93.70	-1.20
438 Drummond Rd	25 (WEDG0145T)	93.6	93.00	0.60
444 Drummond Rd	25 (WEDG0145T)	93.6	93.60	0.00
448 Drummond Rd	25 (WEDG0145T)	93.6	93.60	0.00
1219 Baldwin Drive	24 (WEDG0622T)	98.5	97.60	0.90
528 Morrison Rd	23 (WEDG0895T)	98.6	98.80	-0.20
1203 Cynthia Lane	23 (WEDG0895T)	98.5	98.40	0.10
1197 Cynthia Lane	23 (WEDG0895T)	98.5	98.60	-0.10
Canadian Rd (Ford Small Office)	22 (WEDG2190M)		103.83	
Note: Previous Study elevations from Lower Morrison/Wedgewood Creek Flood, Erosion and MDP				

**TABLE 5.4
SUMMARY OF SITE EVALUATION RESULTS**

Site	Name	Priority	Rank	Location	Road Crossings	Private Vehicle Access	Emergency Vehicle Access	Private Vehicle Access To Facilities	Emergency Vehicle Access To Facilities	Private Multi-User Driveway Access	Threat To Life	Direct Damages	Indirect Damages	Cumulative Score
12	MCCR0630M	1	High	4th Line & Rebecca St	0.0	0.0	0.0	0.0	0.0	0.0	100.0	80.0	40.0	220.0
25	WEDG0145T	2	High	Morrison Rd & Cumnock Cr	0.6	0.0	0.0	0.0	0.0	0.0	60.0	80.0	40.0	180.6
30	WEDG0634M	3	High	Wedgewood Dr & Alsott Cr	0.2	4.0	1.3	0.1	2.8	1.3	40.0	64.0	32.0	145.6
23	WEDG0895T	4	High	Morrison Rd & Cynthia Ln	8.0	0.0	0.0	0.0	0.0	0.0	50.0	48.0	24.0	130.0
26	WEDG1810M	5	High	Duncan Rd & Avon Cr	0.6	30.0	0.0	0.0	0.0	0.0	50.0	32.0	16.0	128.6
10	MCCR1920M	6	High	4th Line & Bridge Rd	0.2	0.4	0.0	0.0	0.0	0.0	80.0	32.0	16.0	128.6
27	WEDG1549M	7	High	Wedgewood Dr & Devon Rd	0.0	0.0	0.0	0.0	0.0	0.0	50.0	32.0	16.0	98.0
33	MORR0405T	8	High	Maple Ave & Anthony Dr	0.6	0.4	0.5	0.6	0.7	0.5	40.0	32.0	16.0	91.3
31	WEDG0200M	9	High	Wedgewood Dr & Lakeshore Rd	0.2	1.0	0.5	0.3	1.4	0.5	40.0	16.0	8.0	67.8
11	MCCR1705M	10	High	Shaw St & Winston Rd	0.0	0.4	0.0	0.1	0.3	0.0	40.0	16.0	8.0	64.8
36	MORR2445T	11	High	Morrison Rd & Baldwin Dr	0.0	0.0	0.0	0.0	0.0	0.0	40.0	16.0	8.0	64.0
37	MORR1910M	12	High	Chartwell Rd & Cedar Grove Blvd	0.0	0.0	0.0	0.0	0.0	0.0	40.0	16.0	8.0	64.0
9	MCCR2177M	13	High	4th Line & Speers Rd	0.2	0.0	0.3	0.0	0.0	0.3	36.0	16.0	8.0	60.7
35	MORR0098T	14	High	Chartwell Rd & Cedar Grove Blvd	1.6	0.0	0.0	0.0	0.0	0.0	30.0	16.0	8.0	55.6
22	WEDG2190M	15	High	Ford Plant	20.0	0.0	0.0	0.0	0.0	0.0	9.0	16.0	8.0	53.0
38	MORR0869M	16	High	Morrison Rd & Cleaver Dr	0.6	0.5	0.2	0.0	0.4	0.2	20.0	16.0	8.0	46.0
7	FOUR1018M	17	High	Rebecca St & Willowbrook Rd	0.0	0.0	0.0	0.0	0.0	0.0	20.0	16.0	8.0	44.0
8	FOUR0440M	18	High	Lakeshore Rd & Willowridge Ct	0.0	0.0	0.0	0.0	0.0	0.0	20.0	16.0	8.0	44.0
5	FOUR2895M	19	Med	3rd Line & Speers Rd	0.4	1.0	0.3	0.6	1.4	0.3	9.0	16.0	8.0	36.9
6	FOUR2213M	20	Low	Bridge Rd & Warminster Dr	0.0	0.0	0.0	0.0	0.0	0.0	10.0	16.0	8.0	34.0
24	WEDG0622T	21	Low	Morrison Rd & Cynthia Lane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	8.0	24.0
2	SHEL1088E	22	Low	Rebecca St & Great Lakes Blvd	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0
43	JOSH3979M	23	Low	Royal Windsor Dr	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
39	MORR0338M	24	Low	Lakeshore Rd & Morrison Rd	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	MORR0700T	25	Low	Cornwall Rd & Trafalgar Rd	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	SHEL0010M	NA	NA	South of Lakeshore R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1. Site 39 has received a 0 product due to flooding being property related only. Road flooding occurs on Site 38 upstream
2. Site 32 has received a 0 product due information provided by Conservation Halton that changes hydraulic conditions on-site, mitigating the original flooding concerns. As-such Site 38 has been revised from a Medium ranking to a Low ranking.
3. Site 3 has not been assessed as it is part of an on-going EA which will assess and recommend flood control measures

6. RECOMMENDATIONS TO ADDRESS FLOOD-PRONE SITES

6.1 Overview of Flood Protection Works

Recommendations to reduce flooding conditions at flood-prone sites have been developed for each site. In developing recommendations, existing information sources and standardized methodologies have been used. Prior to evaluating each site for potential remediation opportunities, a long-list of potential flood remedial measures has been prepared. Recommendations for reducing threat to life and flood damages have been subdivided into Structural/ Capital options and Non-Structural Options as follows:

6.1.1 Structural/ Capital Options

Culvert/Bridge Upgrade – Replace/ Supplement: Should a culvert/bridge crossing's flow capacity restrict conveyance and produce flooding conditions upstream, a possible mitigation could include either replacing or supplementing the existing culvert/bridge crossing.

Flood plain/ Channel Improvements: Improve channel and flood plain flow conveyance capacity by widening the channel, local grading improvements, removal of flow obstructions within the channel and the flood plain and possible channel profile improvements.

Roadway Profile Modifications: Roadway profiles can be modified to reduce the upstream backwater affect and therefore reduce upstream flooding elevations.

Floodproofing buildings: Buildings can be flood proofed below openings with various type of construction practices or local berming to preventing direct flooding to the building.

Flood Control via stormwater quantity controls: Stormwater quantity controls whether on-line or off-line can reduce flows within watercourses. Various studies have been completed for watercourses within the Town of Oakville, which have listed alternatives for flood storage to reduce flooding downstream. The alternatives have either not been recommended or have not been implemented due to issues that have not been resolved.

In addition to previous studies, the possibility of implementing flood controls north of Dundas Street within the proposed North Oakville development area has also been considered as part of this study. Stormwater management control requirements are in the process of being established for North Oakville, through a consultative approach with various stakeholders. Additional stormwater controls could be provided in North Oakville that may reduce existing flows downstream in flood-prone areas for lesser storm events (i.e. 2 year to 100 year storms). This could be achieved by implementing additional storage within each stormwater management facility proposed in North Oakville, above the typical required post-development to pre-development quantity controls, particularly for those areas which require Regulatory controls, as these locations may have supplemental storage capacity to optimize the downstream controls.

Currently quantity controls may be required in North Oakville to control the Regional Storm (Hurricane Hazel), post-development to pre-development. An option to the foregoing approach of oversizing stormwater management facilities in North Oakville would be to use the storage required for the Regional Storm, to over control the 2 to 100 year storm events. Establishing the cost-benefits of each scenario would be necessary before establishing the specific quantity

control requirements. For the purpose of this study the proposed stormwater control within North Oakville can only be identified as a potential flood management alternative specific to certain areas based on area-specific considerations. Once stormwater control requirements have been established, the benefits/impacts to downstream public and private infrastructure and threat to life would have to be assessed for each flood-prone site. Creeks that receive drainage from North Oakville include:

- Fourteen Mile Creek
- McCraney Creek (contributes to Fourteen Mile Creek)
- Taplow Creek (contributes to McCraney Creek south of the QEW)
- Glen Oak Creek (contributes to McCraney Creek south of the QEW)
- Sixteen Mile Creek
- Munn's Creek (contributes to Sixteen Mile Creek north of the QEW)
- West and East Morrison Creeks (contribute to Sixteen Mile Creek north of the QEW)

Diversion: Drainage may be able to be diverted from one location to another within a subwatershed or to another subwatershed to reduce flooding conditions. This has historically occurred within the Town of Oakville for several waterways (e.g. Morrison-Wedgewood Diversion). Drainage diversions are possible within developed areas, but may be limited by the existing infrastructure, development and property ownership and environmental factors.

Combinations: Combinations of various alternatives that would reduce flooding conditions may be possible, when a stand-alone alternative does not provide adequate flood remediation.

6.1.2 Non- Structural Options

Regulation (updated): Conservation Halton regulates most of the watercourses and flood-prone sites. The Conservation Authorities apply their respective regulations to ensure that flooding conditions are not negatively impacted by creek or flood plain alterations/development.

Flood Forecasting and Warning: Conservation Authorities maintain flood warning systems that assist in alerting residents and municipal staff of potential flooding conditions within the Conservation Authority's jurisdiction. The Conservation Authorities have a working knowledge of the creek systems that they regulate and have flood modeling tools that allow for the forecasting of flood conditions. Conservation Authority staff notify municipalities of potential flooding conditions, in order that municipal staff can mobilize and prepare required emergency planning tasks prior to flooding conditions.

Emergency Preparedness: Both Conservation Authority staff and Town of Oakville emergency services staff are active prior to, and during, flooding conditions. Conservation Authority staff following forecasting of the flooding conditions and notifying Town of Oakville staff, are active in monitoring flooding conditions throughout the Town of Oakville and assisting in determining where flooding conditions may require emergency services. Emergency services staff are made aware of potential flooding conditions in order to evacuate citizens in flood-prone areas prior to flooding and during flooding.

Acquisition: At risk properties that are located within the flood plain, could be acquired to improve upstream flooding conditions or to eliminate or reduce the threat to life of persons living

or working on the property. Acquisition of property would typically be one of the last alternatives to select, due to the high social and economic considerations involved.

6.1.3 Climate Change

The recommendations for preventing and managing flooding conditions at the Town of Oakville flood-prone sites will be impacted by changes in typical storm conditions. Recent severe storms in Ontario, May 2000 (Halton), July 2004 (Peterborough), August 2005 (North Toronto), as well as various world-wide weather events, have led to an increased awareness in terms of the potential shift in climatological factors, which are generally considered to be leading to more extreme weather conditions. These weather conditions have been speculated to potentially influence the flood conditions in the creek systems. As-such there is a need to consider climate change and the potential impacts to the vulnerability of flood-prone areas and other potential changes to stream hydrology that might occur and require further mitigation and/or adaptation.

It has been postulated that, perhaps in the future, the flow rates associated with the current 100 year storm event will in fact increase in frequency, such that a current 100 year event may reflect a 50 or 25 year return period. This would potentially result in undersized creek and associated conveyance systems to safely manage flood flows.

As such, the opportunity/need may exist to design and retrofit creek systems that would allow for future flexibility to provide flood protection for a current 250 year or 500 year standard. A combined flood risk and economic assessment would need to be conducted to determine the cost benefits of this type of approach. The economic assessment and associated flood risk sensitivity analysis for specific flood sites has not been conducted as part of this study, but rather it has been recommended that future detailed studies for the local sites should establish and design flood mitigation measures incorporating consideration for climate change impacts on existing flooding conditions.

6.2 Overview of Flood Mitigation Actions

Each flood-prone site has been assessed using a long-list of potential flood prevention and management alternatives, with the preferred alternatives selected based on potential flood reduction, functionality and economics. Within Appendix 'E', each flood site has a Specific Flood Management Alternative Assessment sheet which outlines the reasons and rationale associated with the preferred flood management approach. Table 6.1 provides a summary of the recommended alternatives for each site.

An additional flood-prone site at the Morrison Wedgewood Diversion Channel at Trafalgar Road has, during the course of the study, been identified by Conservation Halton. The diversion channel potentially spills to the south just east of Trafalgar Road. Assessment of the flood-prone site has commenced under a separate study being conducted by Philips Engineering Ltd. on behalf of Conservation Halton. Based on the findings of the study, this site would be added to the overall flood-prone site inventory. As Conservation Halton manages the diversion channel, potential spill mitigation works would be managed by Conservation Halton and would not become part of the Town of Oakville work program.

**TABLE 6.1
SUMMARY OF FLOOD-PRONE SITE SOLUTIONS**

Site	Name	Rank	Location	Description of Solution
12	MCCR0630M	1	4th Line & Rebecca St	<ul style="list-style-type: none"> Flood plain/channel improvements – remove or reduce height of downstream drop structure and lower channel invert Diversion from McCraney Creek to 14 Mile Creek Flood-proofing – approximately 25 homes most of which are flooded on all sides Regulate Consideration of flood storage within North Oakville
25	WEDG0145T	2	Morrison Rd & Cumnock Cr	<ul style="list-style-type: none"> Upgrade culvert crossing on Drummond Road to 6m by 1.8 m concrete box Flood proof homes on Drummond Road –Nos. 410,420, 426, 432, 438, 444, and 448 to an height of 0.33m Regulate
30	WEDG0634M	3	Wedgewood Dr & Alsott Cr	<ul style="list-style-type: none"> Flood-proofing for 3 homes not flooded on all sides Regulate
23	WEDG0895T	4	Morrison Rd & Cynthia Lane	<ul style="list-style-type: none"> Morrison Road culvert upgrade using 6m by 1.2 m box culvert
26	WEDG1810M	5	Duncan Rd & Avon Cr	<ul style="list-style-type: none"> Culvert upgrades – 6 m by 2.1 m box culvert Flood-proofing of 1373 and 1379, by 0.15 m and 0.25 m respectively Regulate
10	MCCR1920M	6	4th Line & Bridge Rd	<ul style="list-style-type: none"> Acquisition of 565 and 568 Pinegrove Rd Culvert upgrades to be determined if acquisition is possible Diversion of flow to 14 Mile Creek Regulate Consideration of flood storage within North Oakville
27	WEDG1549M	7	Wedgewood Dr & Devon Rd	<ul style="list-style-type: none"> Amber Cres. culvert improvement Flood-proof homes to extent possible Regulate
33	MORR0405T	8	Maple Ave & Anthony Dr	<ul style="list-style-type: none"> Flood storage at site Flood-proof Regulate
31	WEDG0200M	9	Wedgewood Dr & Lakeshore Rd	<ul style="list-style-type: none"> Regulate¹
11	MCCR1705M	10	Shaw St & Winston Rd	<ul style="list-style-type: none"> Culvert/crossing upgrades – due to marginal existing backwater culvert upgrades have little effect on flooding Road profile – road is low and is effective in flow conveyance, raising it would increase flooding upstream and further lowering not possible Diversion from McCraney Creek to 14 Mile Creek Flood proofing of 537 and 561 Wildwood Drive Consideration of flood storage within North Oakville
36	MORR2445T	11	Morrison Rd & Baldwin Dr	<ul style="list-style-type: none"> Culvert upgrade for 446 Chartwell Road – put in 1.8 m by 1.6 m+ box culvert Flood proofing of 446, 460 Chartwell Road and 479 Caesar Ave.
37	MORR1910M	12	Chartwell Rd & Cedar Grove Blvd	<ul style="list-style-type: none"> Upstream crossing (see Site 35) Flood proofing of 1020 Linbrook Road Regulate
9	MCCR2177M	13	4th Line & Speers Rd	<ul style="list-style-type: none"> Culvert/crossing upgrades – would require at least twinning of existing 3.6 m by 2.1 m box culvert Channel/flood plain improvements – would require lining the semi-natural channel in the vicinity of the crossing Diversion from McCraney Creek to 14 Mile Creek Consideration of flood storage within North Oakville

**TABLE 6.1
SUMMARY OF FLOOD-PRONE SITE SOLUTIONS Con't**

35	MORR0098T	14	Chartwell Rd & Cedar Grove Blvd	<ul style="list-style-type: none"> • Culvert/crossing upgrades for Chartwell Road crossing by adding a 3 m by 1.6 m box (or equivalent) • Culvert/crossing upgrades for Maple Avenue crossing in combination with other alternatives for Site 33
22	WEDG2190M	15	Royal Windsor Dr.	<ul style="list-style-type: none"> • Further hydraulic assessment based on updated topographic survey of crossings, leading to potential crossing upgrades
38	MORR0869M	16	Morrison Rd & Cleaver Dr	<ul style="list-style-type: none"> • Crossing upgrades by twinning existing 3.6 by 1.8 m concrete box culvert
7	FOUR1018M	17	Rebecca St & Willowbrook Rd	<ul style="list-style-type: none"> • Flood-proofing of homes remaining in the flood plain after culvert upgrades and flood storage (potentially 2 homes) • Flood storage – need to reduce flows to approximately the 100 year flow for all homes to be out of the flood plain • Consideration of flood storage within North Oakville
8	FOUR0440M	18	Lakeshore Rd & Willowridge Ct	<ul style="list-style-type: none"> • A culvert/crossing upgrade to a 20 m span would be preferred hydraulically. Cost/ benefits would have to be reviewed for a 20 m span versus other spans • Flood-proofing of homes remaining in the flood plain after culvert upgrades and flood storage (potentially 2 homes) • Consideration of flood storage within North Oakville
5	FOUR2895M	19	3rd Line & Speers Rd	<ul style="list-style-type: none"> • Flood storage – need to reduce flows to approximately the 100 year flow for all homes to be out of the flood plain. • Regulate • Consideration of flood storage within North Oakville
6	FOUR2213M	20	Bridge Rd & Warminster Dr	<ul style="list-style-type: none"> • Flood proofing of 1379 Bridge Road • Flood storage – need to reduce flows to approximately the 100 year flow for all homes to be out of the flood plain • Consideration of flood storage within North Oakville
24	WEDG0622T	21	Morrison Rd & Cynthia Lane	<ul style="list-style-type: none"> • Flood plain grading improvements are possible in vicinity of 1253 to 1239 Baldwin Dr. • Morrison Road culvert upgrades (Site 23)
2	SHEL1088E	22	Rebecca St. at Great Lakes Blvd.	<ul style="list-style-type: none"> • Spill prevention, through berming along Rebecca Street and east side of watercourse
43	JOSH3979m	23	Royal Windsor Dr.	<ul style="list-style-type: none"> • CNR culvert upgrades • Royal Windsor Drive Profile Lowering • Hydraulic modeling update
39	MORR0338M	24	Lakeshore Rd & Morrison Rd	<ul style="list-style-type: none"> • Flooding predominantly occurs within Site 39 due to the spill from Morrison Road at the upstream limit of the site. Spill reduction is a recommendation of Site 38.
32	MORR0700T	25/ NA	Cornwall Rd & Trafalgar Rd	<ul style="list-style-type: none"> • NA, the site has received a ranking, although based on verbal information from Conservation Halton there would be no threat to life. Based on the verbal information on the Cornwall Road crossing improvements provided by Conservation Halton, Cornwall Road is not overtopped. As flooding is not a concern at this site, this site has been screened from further assessment
3	SHEL0010M	NA	South of Lakeshore Rd.	<ul style="list-style-type: none"> • NA, the site has not received a ranking as it is part of an on-going EA that will assess and recommend flood control measures

1. As the recommendation is to regulate existing conditions, Site 31 has been removed from the list of sites for flood mitigation works.

6.3 Cost and Timeline Estimate

Costs to implement the flood management recommendations have to be determined through additional studies that would further provide a higher level of detail of the recommendations herein. The additional studies would be conducted on a creek reach basis in order that recommendations impact multiple flood prone sites on a single reach can be assessed.

Studies would either consist of Class Environmental Assessments or Pre-design Reports. For each type of study, the scope would depend upon the nature of the creek reach, site area and local hydraulic features. A ranking system of *Low*, *Medium* and *High* has been used to define the scope of studies impacting short creek reaches to studies that may have an impact upon longer reaches of creeks.

Capital costs for the projects recommended herein typically consist of new Capital works such as: hydraulic crossings, crossing replacements, creek/flood plain improvements, road work, grading, flood controls and flood proofing. In addition to the foregoing Capital costs, some projects in order to be implemented may require that land be acquired (either through ownership or easement); therefore costs for land have been included where appropriate.

Engineering design costs and other specialty professional services would be required to support the design, permitting, and construction of the recommended flood management program. Professional services in addition to engineering may include geotechnical engineers, terrestrial specialists, geomorphologists and fisheries biologists.

Table 6.2 provides a summary of the estimated study costs for each flood-prone site. Timing and phasing for site projects would be as per Town of Oakville Capital Works Program based on priority ranking established herein. A preliminary estimate of the study's initiation timeline has been provided within Table 6.2, although the timing may change depending on the budgeting and project priorities for the Town.

**TABLE 6.2
SUMMARY OF FLOOD PRONE SITES**

Site	Name	Rank	Location	Engineering Study Cost
12	MCCR0630M	1	4th Line & Rebecca St	\$25,000
25	WEDG0145T	2	Morrison Rd & Cumnock Cr	\$25,000
30	WEDG0634M	3	Wedgewood Dr & Alsott Cr	\$15,000
23	WEDG0895T	4	Morrison Rd & Cynthia Lane	\$25,000
26	WEDG1810M	5	Duncan Rd & Avon Cr	\$25,000
10	MCCR1920M	6	4th Line & Bridge Rd	\$25,000
27	WEDG1549M	7	Wedgewood Dr & Devon Rd	\$25,000
33	MORR0405T	8	Maple Ave & Anthony Dr	\$70,000
11	MCCR1705M	10	Shaw St & Winston Rd	\$25,000
36	MORR2445T	11	Morrison Rd & Baldwin Dr	\$15,000
37	MORR1910M	12	Chartwell Rd & Cedar Grove Blvd	\$15,000
9	MCCR2177M	13	4th Line & Speers Rd	\$25,000
35	MORR0098T	14	Chartwell Rd & Cedar Grove Blvd	\$15,000
22	WEDG2190M	15	Royal Windsor Dr.	\$25,000
38	MORR0869M	16	Morrison Rd & Cleaver Dr	\$10,000
7	FOUR1018M	17	Rebecca St & Willowbrook Rd	\$25,000
8	FOUR0440M	18	Lakeshore Rd & Willowridge Ct	\$25,000
5	FOUR2895M	19	3rd Line & Speers Rd	\$25,000
6	FOUR2213M	20	Bridge Rd & Warminster Dr	\$25,000
24	WEDG0622T	21	Morrison Rd & Cynthia Lane	\$25,000
2	SHEL1088E	22	Rebecca St. at Great Lakes Blvd.	\$50,000
43	JOSH3979M	23	Royal Windsor Dr.	\$50,000
39	MORR0338M	24	Lakeshore Rd & Morrison Rd	\$25,000
3	SHEL0010M	NA	South of Lakeshore Rd.	\$25,000

TBD: To Be Determined

1. Cost shown next to 'Linked to Site #', represents the Study Cost of Site #.

7. IMPLEMENTATION PROGRAM

7.1 Priority-Based Work Program

The recommendations outlined within Table 6.1 and Appendix 'E' are to be implemented using a priority-based work program established by the Town of Oakville. Timing will be determined based on the relative priority of each project and how the project has been incorporated into the Town of Oakville's annual Capital Works Program. The Town of Oakville should continually adjust the project timing based on the evolving Capital Works Program project requirements, objectives and budget.

Depending on the scope of the recommendations for each site, further study (such as Class EA's) may be required before detailed design of the flood prevention works could occur. The additional study(s) requirements would have to be considered when determining the timing of the flooding mitigation project.

7.2 Implementation Considerations

Each flood-prone site has been assigned a priority ranking based on various factors related to flood risk. The flood management works would be implemented by the Town of Oakville based on available budget. In addition to budgetary constraints, implementation of flood management works would have to consider the following:

Appropriate lead for undertaking:

The majority of flood control projects would be conducted as Town of Oakville's capital work projects, in that the Town of Oakville would incorporate the projects into its Capital Works Program. There may be occasion where development proponents may assume a partner or stakeholder role (i.e. such as potential North Oakville stormwater management over control).

Governing protocol and legislation:

Each project would be subject to the protocols and legislation from various levels of governmental agencies in addition to the Town of Oakville's various guidelines. Projects such as potential flood control storage areas and diversions that have been identified through previous studies would require further study before becoming programmed capital works. The further study(s) would typically follow the Municipal Engineers Class Environmental Assessment process and the recommendations of the study(s) would be conducted accordingly by the Town of Oakville.

Approval Requirements:

The approval requirements will vary depending upon the flood project scope. Creek works would require at the Town of Oakville and Conservation Halton's approval and there may requirement for Department of Fisheries and Oceans approval depending on the nature of creek improvements. Other governmental agencies may need to review and approve projects depending on project location and scope such as the Region of Halton, Ministry of Natural Resources and the Ministry of Environment.

Need for, and scope of, follow-up assessment/analysis:

Prior to implementation, each flood control project should be reviewed for possible improvements or necessary adjustments to the scope, to ensure that the broad objectives of the project are met.

Possible implementation issues (i.e. constructability, property ownership, etc.):

Flood control projects, as recommended within this study, would require further assessment prior to, and during, the detail design stage to determine potential implementation issues. Issues may consist of site access, property ownership and constructability; these have been identified at a high-level (ref. Appendix 'E').

Possible monitoring requirements:

Monitoring may be required as condition of approval for projects from various government agencies. The Department of Fisheries and Oceans typically require a 2 to 3 year monitoring program for creek works; other requirements may stem from Class EA requirements related to flood control. There may be the potential to partner with Conservation Halton to monitor stream flows strategically throughout the Town. This monitoring information would prove beneficial to improve the predictive accuracy of hydrologic models in order to refine the design of future works.

Need for maintenance:

Maintenance requirements for each project need to be established as part of the detailed design of the project works. Preliminary maintenance requirements would be determined as part of this exercise. Maintenance may include, but would not be limited to: creek adjustments during and following monitoring programs, vegetation planting or removal, and adjustment to potential flood control systems.

Potential interface with other Town/Agency programs:

Potential interfacing opportunities for Flood Control Projects with other Town of Oakville/ Agency programs and projects needs to be established. Possible Town/ Agency programs would include but not be limited to the Town's Creek Erosion Study, on-going road upgrades and maintenance work, creek improvement, and bridge/culvert projects. In addition, the possibility of the Town of Oakville assisting Conservation Halton in updates to flood plain mapping as work/alterations within the flood plain are completed should be investigated.

Other Funding opportunities:

Funding opportunities, both public and private should be investigated for each project. Various programs are available, including Canada/Ontario Municipal Renewal Infrastructure Fund (COMRIF), Great Lakes Sustainability Fund (GLSF), and others. Each opportunity should be considered.

APPENDIX 'A'

FLOOD-PRONE SITE INDEX MAP

APPENDIX 'B'

WORK PLAN

TOWN-WIDE FLOOD STUDY REVIEW

TOWN OF OAKVILLE TOWN PROJECT # EC-87-05

WORK PLAN

The following work plan has been prepared to reflect the three study phases, as per the Town's Terms of Reference.

PHASE 1 – REVIEW OF EXISTING REPORTS AND STUDIES

Task 1: Start Up Meeting with Town and Conservation Halton

The first meeting will be an opportunity for Town and Conservation Halton staff and the Study Team to meet. The key purpose will be to confirm the scope of work, discuss issues and opportunities, and transfer background information. There will be a focus on communicating any known or perceived locations which are flood-prone or pose a risk. As discussed with Town staff, there may be some benefit to communicating with long term Town staff who may have anecdotal accounts of flooding in Oakville. The schedule will also be reviewed at this meeting and various mutual commitments discussed. An important matter will be the approach to ensuring that access is provided to all flood-prone areas, as a substantial portion are expected to be on private lands. A “Draft” Table of Contents of the study report will be circulated for comment and review, to facilitate efficient preparation of study deliverables.

Task 2: Review Background Information

A substantial amount of existing data (both site-specific and watershed-wide) is available for review as per the Terms of Reference Summary (ref. Schedule ‘A’ in Appendix ‘C’). All relevant available reports, maps, aerial photography, studies, hydrologic and hydraulic models and existing plans will be reviewed. Of particular note, is the information base prepared by the Town following the May 2000 flood. Reports of flooding claims, location maps and Town and agency follow-up, will prove to be invaluable resources for this assessment.

Key information sources will include the Town, Conservation Halton and the Region of Halton. The most current topographic base mapping will be secured from either the Town and/or Conservation Halton. It is understood that Conservation Halton, as part of the recent “Generic Regulations” initiative, updated its’ regulation mapping, defining flood limits, stability setbacks, environmental setbacks/buffers and meander belt widths. However, it is understood that this information is not yet available for the Town of Oakville. It is suggested that a status and timing update be secured from Conservation Halton staff at the start-up meeting, with the potential to work consultatively with Conservation Halton to use the new Generic Regulations mapping to screen flood prone areas as it becomes available, should the timing allow for this. While it is recognized that due to the scale of the undertaking and its ultimate purpose, much of the information produced by Conservation Halton is approximated and general in nature, it may provide an excellent basis from which to screen and catalogue areas.

Task 3: Meeting with Town GIS Department

It is understood, based on consultation with Town staff, that the GIS deliverable will be comprised of an “uploadable” database with appropriate geo-referencing.

In order to effectively achieve this objective, a meeting is proposed, (shortly after available data has been reviewed, but prior to the physical site reconnaissance), with Town staff from both the Engineering and Construction, and GIS Departments. The purpose would be to confirm the procedures, software and expectations associated with this study. Various protocols associated with identifiers, co-ordinate systems, referencing data and other meta data matters will be reviewed. The protocols and other information secured from this consultation, will streamline data collection and cataloguing efforts, as well as the building of the database. This meeting will be attended by our database specialist.

Task 4: Physical Reconnaissance

Further to the December 19, 2005 meeting held with Town staff, and as confirmed by the Town’s Addendum (ref. Appendix ‘C’), a physical reconnaissance of some twenty (20) flood prone sites within the study area will be conducted, specifically to determine the nature of the flood risk, associated flooding mechanics and other relevant factors guiding the assessment and management of risk. During this evaluation, the following will be undertaken:

- Photographs and geo-referenced co-ordinates of flood-prone sites and other notable features will be taken;
- Standardized Flooding assessment forms will be used to document the sites and fluvial/hydraulic conditions at each location;
- High-level or first order flood impact assessments of individual sites and reaches will be conducted;
- The orientation and relative condition of hydraulic structures at each location, such as bridges, culverts and outfalls will be identified;
- Distances to property limits, fence lines, number of homes, properties and out buildings will be noted;
- High-water marks and signs of flooding will be documented;
- Signs of watercourse obstructions (debris, beaver dams, etc.) will be noted; and
- Floodplain properties will be documented, relative to top-of-bank land uses

An important aspect of this study task will be the need for the Field Engineer to consistently and comprehensively assess and document the observations made at each site. This will lead to confidence related to continuity and quality control associated with the Town-wide assessment. To this end, Philips Engineering Ltd. proposes the use of highly experienced staff members for the physical reconnaissance to ensure that flooding risk is consistently identified throughout the study area.

Any time sensitive findings from the site reconnaissance, that require the immediate attention of the Town, will be summarized, along with advice regarding each particular issue. This will be provided to the Town directly upon completion of the inspection of flood-prone sites. The

results of the physical reconnaissance will also provide the basis for the development of the proposed evaluation scale and overall evaluation of the flood-prone sites.

As discussed with Town staff, the study will focus on the fluvial or open waterways and related flooding, rather than closed conduit or storm sewer systems. Notwithstanding, there may be some overlap whereby local sewer flooding and creek-based flooding interact, in terms of flood mechanics. These sites will be addressed as part of this study using the recent storm sewer inventory prepared by our firm as a base. Various known flooding sites will be specifically investigated including Munn's Creek, Coronation Park, Chartwell Drive and North Service Road at Deerfield, among many others.

PHASE 2 – REPORTING OF FLOODING ISSUES AND RECOMMENDATIONS

Task 5: Develop Evaluation Scale

Currently the Town does not have a scale used to rank flood risk of flood-prone locations within the community. It is proposed that a long-list of potential flood risk factors be prepared, premised on Ministry of Natural Resources protocols. The intent in this regard would be to define possible factors and then review the appropriateness of use to rank sites, with Town and Conservation Halton staff. Only meaningful and useful factors will be short-listed.

Since flooding risk arises from both direct and indirect situations, the Evaluation Scale needs to be designed to account for these unique characteristics. The Ministry of Natural Resources, as part of the Flood Damage Reduction Program, identified various components of risk related to direct and indirect property damages, which expressed as Annual Average Damages, takes into account flood severity and frequency factors. Other Ministry of Natural Resources measures include human exposure to flooding, weighted by frequency. These measures also account for occupancy factors of residential homes and commercial/industrial areas.

The extent to which each factor can be accurately and meaningfully determined by past information or new assessment through this study, will be important to the supportability of the ranking of flood-prone sites.

Task 6: Meeting with Town and Conservation Halton to review Field Work and Proposed Evaluation Scale

Once the Physical Reconnaissance is complete and Evaluation Scale prepared, the information (in general terms) will be reviewed with Town and Conservation Halton staff, prior to conducting the detailed analysis and ranking. The purpose of this meeting will be multi-fold and will include:

- Advising staff on critical flood-prone areas in need of early attention
- Ensuring full coverage of the flood-prone sites (Note: At this stage the potential need for an assessment of more than the 20 +/- locations will be brought forward as necessary)
- Confirming the Evaluation Scale for the flood-prone locations
- Confirm the extent and scope of analytical methods to evaluate and develop preliminary-level solutions for each flood-prone site

Task 7: *Evaluate Flood-prone Sites*

The agreed upon Evaluation Scale and assessment methodology will be systematically applied to the twenty (+/-) flood-prone sites. This will be a ranking exercise intended to provide the Town with a range of the worst or most severe flooding locations, posing the highest risk to property, life and limb, to the least sensitive locations. While the ranking system will be objectively applied, due to the inherent differences between the type of flooding and those at risk (i.e. direct property impacts to residential homes versus deficient culvert capacity causing excess flooding of emergency routes), there will need to be an element of subjectivity and engineering judgement in order to account for the differences. This will be discussed directly with the Town and Conservation Halton.

Task 8: *Develop Recommendations and Cost Estimates*

This task will be exceptionally important to the success and utility of the study findings. Supportable and practical solutions to flooding will need to be developed for each site. Notwithstanding, due to the number of sites, the highly variable conditions and the scope of this study, new hydrology/hydraulics are not proposed. Rather, existing information sources and tools, along with standardized methodologies to evaluate hydraulic conditions will be developed to guide the study recommendations. For instance, where culvert hydraulics are deemed to be the source of flooding and a hydraulic model exists, it will be used to define the scope of upgrade. Should a model not exist, simplified analytical techniques will be applied, as discussed with the Town and Conservation Halton, under Task 6.

Historical studies completed by Philips and others in the Town, have shown the potential benefit of centralized headwater storage and/or diversions to protect downstream properties. These types of potential solutions will also need to be addressed as part of this study.

As noted in the Introduction, the threat of Climate Change has recently heightened local flooding concerns. As noted in the excerpts in Appendix ‘E’, the risk of flooding and increased insurance claims is anticipated to result from more severe weather patterns. What was once a 50-year storm may become a 30-year or even 15-year event. This study will examine this prospect and make recommendations accordingly.

Based on the evaluation of flooding issues, potential recommendations will be advanced on a site-by-site basis. Preliminary cost estimates will also be provided, and as discussed with Town staff, a range of costs will be generated to reflect potential uncertainties in each location. As part of the evaluation of potential recommendations, the following will be considered:

- Need for private property;
- Proximity of property lines, fences, out buildings and local infrastructure;
- Possible need for Erosion protection works in the same or nearby locations;
- Cost of materials and extent of proposed works;
- Construction issues with respect to implementation of potential works;
- Possible environmental conflicts (generally);
- Potential related issues and opportunities; and
- New technologies.

In addition to the foregoing, as part of the Town-wide assessment, various broad-based Public issues and opportunities will be reviewed with a specific focus on education. The intent in this regard will be to identify what private residents and businesses can do to become aware of flood risks and to assist the Town and Conservation Halton in better managing associated risks. This element will require consultation with Cindy Toth's group as part of the Town's Environmental Management Strategy.

Task 9: *Develop Implementation Program for Flood-prone Sites*

An Implementation Program will be developed for the prioritized works/recommendations developed as part of Task 8. The Implementation Program will include the following information for each flood control project:

- Appropriate lead for undertaking;
- Governing protocol and legislation;
- Approval Requirements;
- Need for, and scope of follow-up assessment/analysis;
- Suggested timing; need for phasing;
- Possible implementation issues (i.e. constructability, property ownership, etc.);
- Possible monitoring requirements;
- Need for maintenance;
- Potential interface with other Town/Agency programs; and
- Other Funding opportunities.

Each flood-prone site, as a potential stand-alone flood control project, will be packaged in a convenient form for use by Town staff during the next phase of implementation.

Task 10: *Prepare Draft Report*

Tasks 1 to 9 will be compiled into a draft report, using the updated Table of Contents generated as part of Task 1, with subsequent input from Town and Conservation Halton staff (4 copies). All graphics, photos, text and mapping will be offered for review, prior to final assemblage of the GIS-based database under Phase 3.

Task 11: *Meeting with Town staff to review "Draft Report"; Submit Final Report*

Prior to finalizing the reporting for this study, and prior to GIS Database assembly, input from key Town and Conservation Halton staff will be required, in order that all findings and recommendations are appropriately documented and supported. Philips will make a presentation to Senior Management staff at the Town, Committee of Town Council and Conservation Halton on the "Draft" reporting. After which, Town and Conservation Halton staff would be requested to provide input/direction, in order to finalize the report. Ten (10) copies of the final report will subsequently be provided to the Town, plus an electronic copy of same (in PDF format).

PHASE 3 – COMPILATION OF INVENTORY AND DATABASE

Task 12: Compile Inventory and Prepare GIS-based Database

Throughout the study, the inventory of flood-prone sites, and the assessment/analytical components of the Tasks outlined in Phases 1 and 2, will be documented in the Draft and Final reports. The digital inventory of this information will form the basis of the associated database developed under this task.

Specifically, the various study products identifying and documenting each flood-prone site will include:

- Spatial co-ordinates and referencing system
- Photographs
- Spreadsheets
- Text
- Ranking(s)
- Graphics
- Map layers
- Linkages with Erosion Stream-based inventory

The foregoing will be integrated into a study database system, harmonized with Town of Oakville GIS conventions, to allow for uploading into the Town's system. A key aspect of this exercise will involve the development of a referencing system. This is a potential point of overlap with the Erosion Inventory study, whereby "smart-segments" using a zero reference system starting at Lake Ontario, and chainage carried upstream, could be jointly used to organize and manage the information. The referencing system will be the cornerstone to linking textual/numerical data to spatial databases. Craig Gemmell, our database specialist, will work closely with Philips Engineering Ltd., as he has in the past on other Municipal applications, to ensure that the specific needs of Oakville are met.

Task 13: Meeting with Town to Review Database

A meeting will be held with Town staff including representatives of both the Department of Engineering and Construction, and GIS Department. The intent would be to review the structure and content of the database. Any input provided, will be used to modify the information prior to final delivery.

Task 14: Conduct Workshop

A workshop including Team members from Philips Engineering Ltd. and Computer Resource Group will be held with Town staff to provide direction on the use and maintenance of the database.

APPENDIX 'C'

DATABASE FLOOD-PRONE SITE EXAMPLE

Flood Study - [Study Sites]

File Edit View Insert Format Records Tools Window Help

MS Sans Serif 8 B I U

Type a question for help

Flood Study New Site << >> >>> Preview Report Close

Site ID: MCCR1895MAIN ? Date of Last Change: 05/04/07
 Creek Name: McCraney Creek Changed by User: J. Carlos Ulujanov

Adjacent Properties | **Potential Flooded Properties** | **Flooding Observations** | **Flooding Mitigation** | **Photos/Files**
Site | **Site Data** | **Characterization** | **Downstream Crossing** | **Upstream Crossing** | **Bank Channel** | **Floodplain** | **Valley Wall**

Site Location: 20m upstream of Pinegrove Rd bridge City: Oakville Province: ON
 Ortho-Coordinates: 605308.000, 4809845.000 Priority: 7 Ranking: High
 Site Description: Creek lined with gabion basket in a residential area
 Creek Station: 1+908 Crossing Distance-Downstream: 20m (Map) Upstream: 189m (Map)
 Flow Direction: SE Fenced? Nearest Intersection: Pinegrove Rd & Burton Rd

Flooding References

Flooding Reference	Reference Date
Town of Oakville, Fourteen Mile Creek, McCraney Creek, Watershed Planning Study, Final Draft Report, Appendices	01/01/90
Town of Oakville, Fourteen Mile Creek-McCraney Creek, Watershed Planning Study, Final Report, Triton Engineering Service	01/02/92
Haltom Region Conservation Authority, 14 Mile Creek-McCraney Creek, System Flood Damage Reduction Preliminary Engineer	01/07/85

Record: 1 of 5

Access Locations

Site Access
Bridge at Pinegrove Road

Record: 1 of 1

Record: 11 of 32

Site Location NUM

Start 3:40 PM

Flood Study - [Study Sites]

File Edit View Insert Format Records Tools Window Help

MS Sans Serif 8 B I U

Type a question for help

Flood Study New Site << >> >>> Preview Report Close

Site ID: MCCR1895MAIN ? Date of Last Change: 05/04/07
 Creek Name: McCraney Creek Changed by User: J. Carlos Ulujanov

Adjacent Properties | **Potential Flooded Properties** | **Flooding Observations** | **Flooding Mitigation** | **Photos/Files**
Site | **Site Data** | **Characterization** | **Downstream Crossing** | **Upstream Crossing** | **Bank Channel** | **Floodplain** | **Valley Wall**

Site Study Date: 06/19/06 Site Study Time: 9:00:00 AM
 Study By: J. Carlos Ulujanov
 Firm: Philips Engineering Ltd
 Map Image: ..\..\Corr\photos\reduced file size\Site 10 - MCCR1895MAIN\Site Map 10
 File Name: ..\..\Corr\photos\reduced file size\Site 10 - MCCR1895MAI Get Image

Follow Up Site Visits

Visit Date	Visit Time	Visit By	Visit Firm	Purpose of Visit	Site Visit Notes

Record: 1 of 1

Site Inquiries

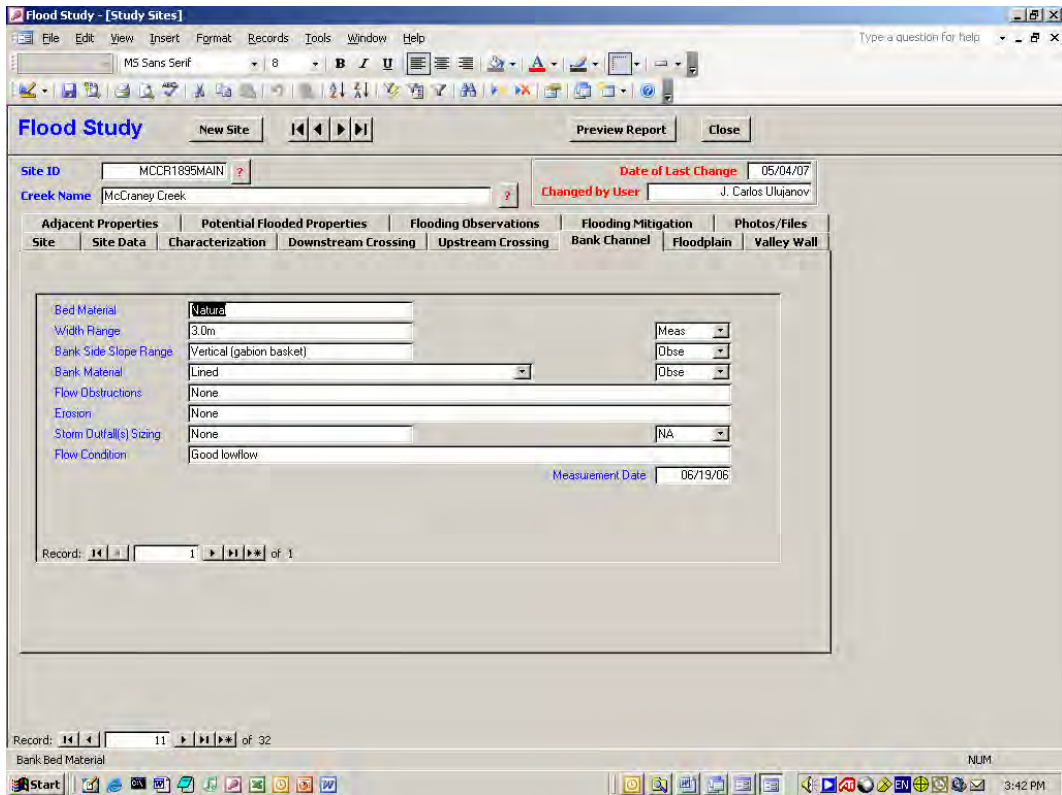
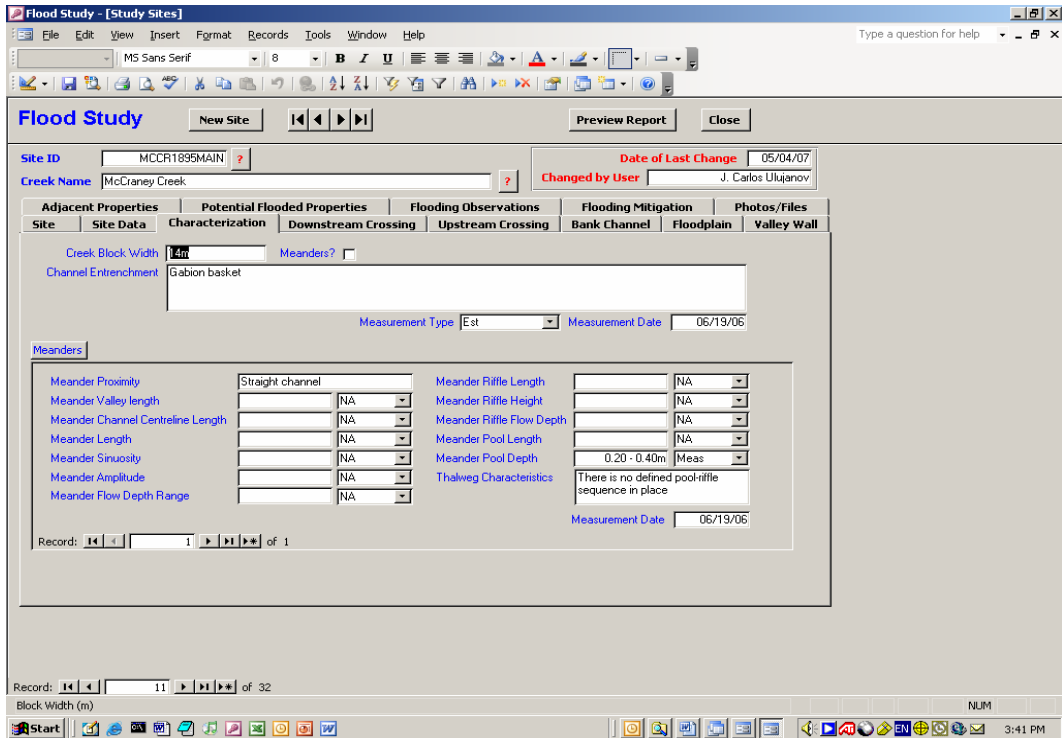
Inquiry Date	Name	Address	Telephone	Notes

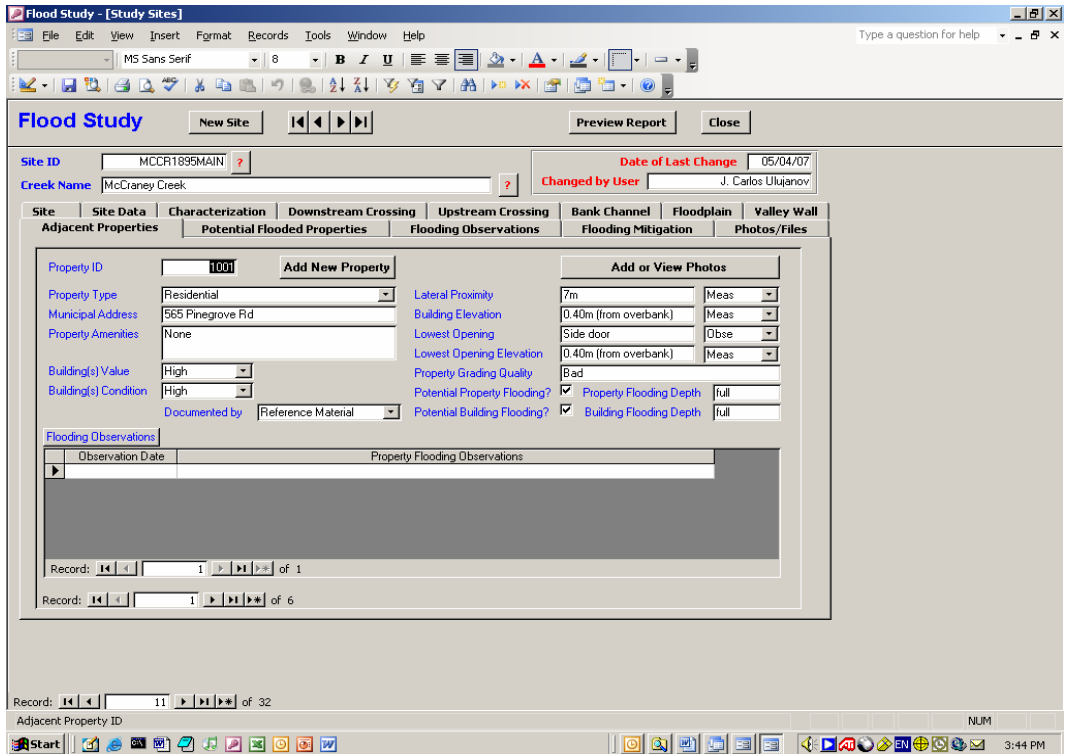
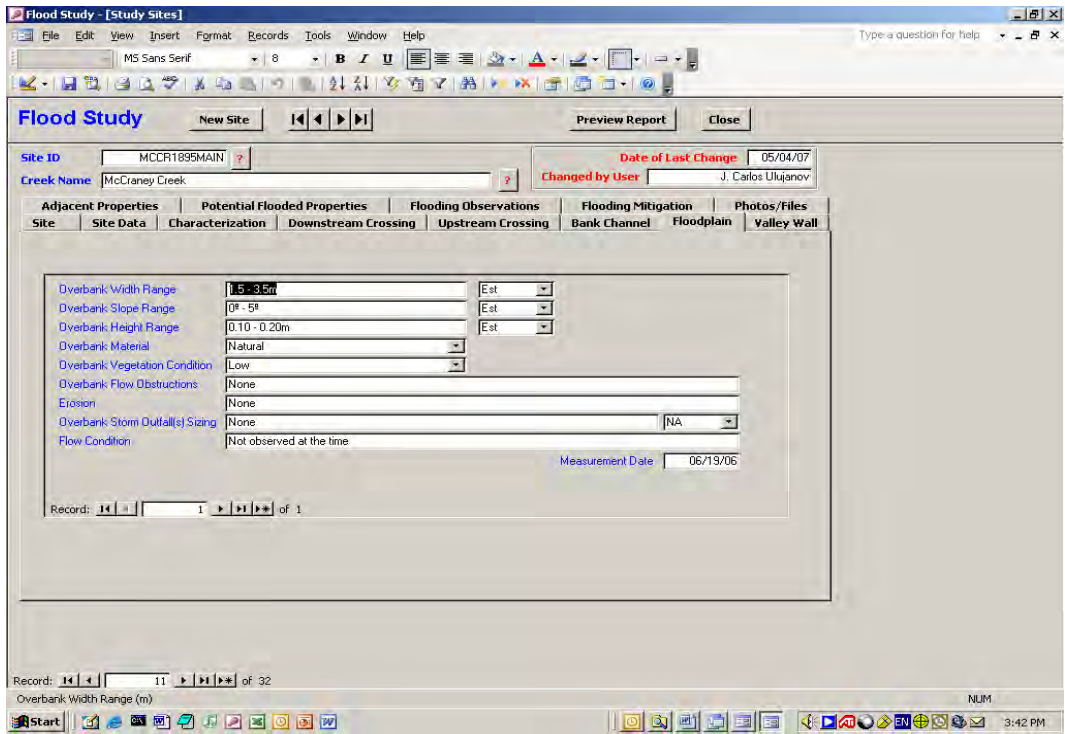
Record: 1 of 1

Record: 11 of 32

Date of Initial Site Study NUM

Start 3:40 PM





Flood Study - [Study Sites]

File Edit View Insert Format Records Tools Window Help

MS Sans Serif 8

Flood Study New Site Preview Report Close

Site ID: MCCR1895MAIN Date of Last Change: 05/04/07
 Creek Name: McCraney Creek Changed by User: J. Carlos Ulujanov

Site Site Data Characterization Downstream Crossing Upstream Crossing Bank Channel Floodplain Valley Wall
 Adjacent Properties Potential Flooded Properties Flooding Observations Flooding Mitigation Photos/Files

High Flow Markings Location: Within gabion basket Potential Number of Properties Flooded: 2
 High Flow Markings Range: 0.50 - 0.60m Potential Number of Out Buildings Flooded: 1
 Observation Date: 06/19/06 Potential Number of Buildings Flooded: 2

Flooding Outside of Creek Banks Local Infrastructure Comment Downstream Crossing Flooding Severity Upstream Crossing Flooding Severity
 Not observed None None None

Flooding Field Observations Direct Flooding Comment Indirect Flooding Comment
 Not observed at the time Flooding to Properties #1 and #2 likely to occur during strong events Downstream culvert may backup in case of a severe event affecting Properties #1 and #2

Record: 1 of 1

Record: 11 of 32

High Flow Markings Location NUM

Start 3:46 PM

Flood Study - [Study Sites]

File Edit View Insert Format Records Tools Window Help

Actual Date Microsoft Sans Serif 8

Flood Study New Site Preview Report Close

Site ID: MCCR1895MAIN Date of Last Change: 05/04/07
 Creek Name: McCraney Creek Changed by User: J. Carlos Ulujanov

Site Site Data Characterization Downstream Crossing Upstream Crossing Bank Channel Floodplain Valley Wall
 Adjacent Properties Potential Flooded Properties Flooding Observations Flooding Mitigation Photos/Files

Mitigation Option	Comments	Projected Cost	Entry Date
		\$0.00	

Flooding Mitigation Undertaken

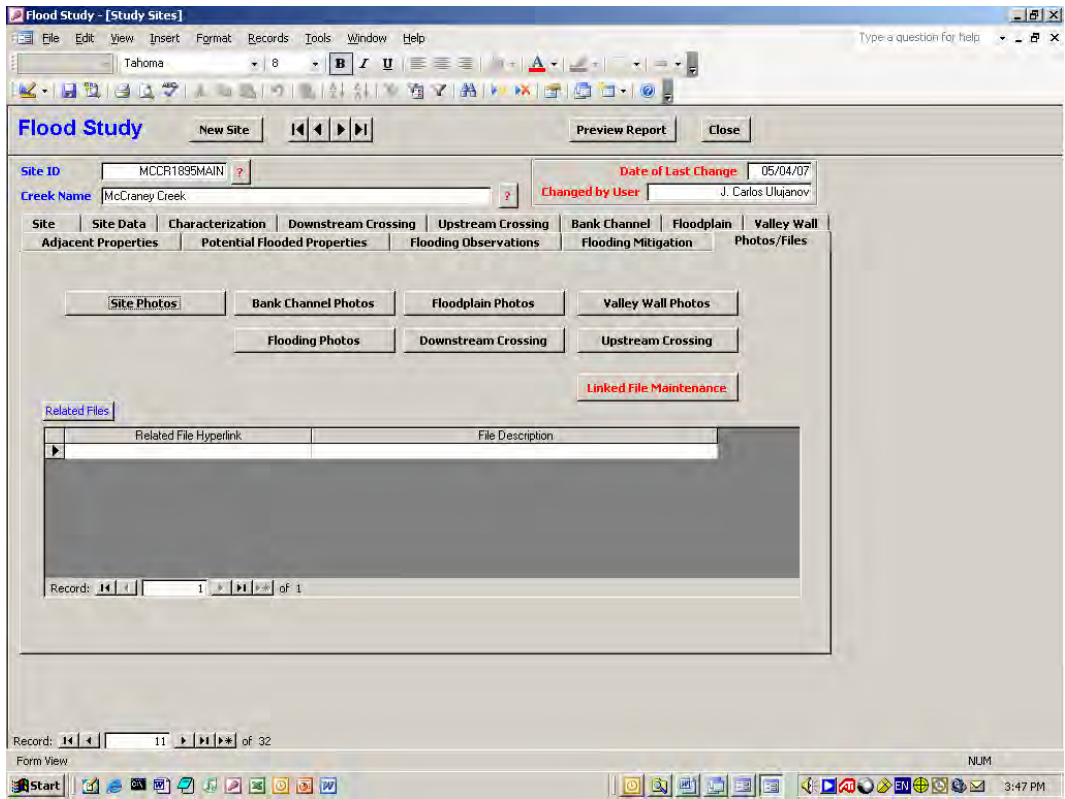
Mitigation Undertaken	Projected Cost	Projected Date	Actual Date	Mitigation Success	Engineering Cost Est
	\$0.00				

Record: 1 of 1

Record: 11 of 32

Actual Date of Action NUM

Start 3:47 PM



APPENDIX 'D'

PUBLIC FLOOD AWARENESS INFORMATION

The Town's Commitment To You

The Town of Oakville has prepared plans of action to be implemented in the event of an emergency. These plans have been designed to safeguard the wellbeing and uphold the interests of our citizens.

The Fire Department works in conjunction with senior Town management, other departments and related local emergency service agencies to ensure appropriate planning for any crisis.

Well prepared emergency services do make a difference in the number of lives saved and reduced property damage.

The Town of Oakville has a municipal emergency plan as well individual department plans outlining job responsibilities and related duties to be carried out in the event of an emergency.

Regular practice drills ensure that plans are kept current and all participating staff and support agencies (Red Cross, St. John Ambulance, Amateur Radio, Salvation Army etc.) are apprised of their roles.

Copies of plans are available upon request from the Clerk's Department, Town of Oakville, 1225 Trafalgar Road, telephone 338-4174.

A Partnership - Working With the Region of Halton & Area Municipalities

The Region of Halton has an Emergency Planning Coordinator on staff who works closely with all area municipalities. Both the Region and the Town of Oakville are committed to ensuring the safety and well being of citizens -- a commitment that includes careful planning for any crisis that may arise.

The Emergency Planning Coordinator is responsible for putting regional emergency plans and procedures in place, keeping them up to date and providing ongoing training to the area municipalities.

Potential emergencies in the Halton Region, include major storms (including tornadoes), sudden releases of chemical or toxic substances, radioactive material incidents, floods, explosions and transportation accidents.

Included In An Emergency Plan

- procedure for declaring an emergency
- a communications strategy
- coordination of emergency services through an Emergency Operations Centre
- a resource directory listing who to call for assistance -- this includes first aid support services, evacuation related requirements, shelter and other necessary survival resources

How You Can Prepare For An Emergency

1. Post emergency telephone numbers in a prominent location in your home.
2. When calling for help specify:
 - what happened
 - what help is needed
 - where you are
 - who you are
3. Teach your children *how* and *who* to call for help.
4. Keep an emergency kit handy. Include:
 - prescription medication required by family members
 - first aid kit
 - battery powered radio & flashlight
 - candles and matches
 - toiletries
5. Teach all family members how to turn off the gas, power and water.
6. Keep a survival kit in your car. Include:
 - blanket or sleeping bag
 - change of clothing with extra mittens, boots, and raincoat
 - shovel
 - first aid kit

Emergency Preparedness Checklist

In an emergency situation, ease your mind by ensuring your home has these essential items in an emergency preparedness kit:



Water

- Store four and a half litres of water per person / per day (approximately eight 500 mL bottles). Two and a half litres for drinking, two litres for food preparation / sanitation
- Ensure there is at least a three-day supply of water

Change stored water and food supply every six months so it stays fresh



Food

- Store a minimum three-day supply per person of non-perishable foods:
 - Ready to eat canned meats, fruits and vegetables
 - Canned juices
 - High energy foods (e.g. peanut butter and jelly with crackers, granola bars)
 - Vitamins
 - Comfort / stress foods (e.g. chocolate)
 - A loaf of bread frozen in the freezer to defrost for sandwiches

Remember: Keep all items in air-tight plastic bags in an easy to carry container



First Aid Kit

- Assemble a First Aid Kit, include:
 - Sterile gauze pads and bandages in various sizes
 - Surgical tape
 - Scissors
 - Tweezers
 - Moistened towelettes
 - Antiseptic
 - Latex gloves
 - Soap
 - Petroleum jelly
 - Non-prescription drugs such as aspirin, anti-diarrhea medication and antacid



Tools and Supplies

- Flashlight and extra batteries
- Battery-operated radio
- Cash or traveller's cheques, change
- Non-electric can opener, utility knife
- Compass, signal flare; pencils, paper
- Always have a telephone that doesn't require electricity to function (most cordless and multi-feature phones will not work in a power outage)
- Contact list of important numbers (update this list regularly to include loved ones, medical professionals, etc.)
- Paper plates and plasticware
- Spare car and house keys
- Rain ponchos



Sanitation

- Toilet paper
- Soap, liquid detergent
- Clothing and bedding
- Plastic bucket with tight lid (this can serve as a waste receptacle if required)
- Plastic garbage bags, sealable plastic bags
- Disinfectant

Consult a doctor or pharmacist for advice on storing prescription medications

Special Needs

- Be sure to include items for family members with special needs such as infants, elderly or disabled persons
- Keep important family documents in waterproof, portable containers (e.g. birth certificates, recent photos, health card numbers, passports, insurance policies)



Government
of Canada

Gouvernement
du Canada

Self-Help Advice

Floods

What to do

before and after



Canada

This publication was co-produced by the **Office of Critical Infrastructure Protection and Emergency Preparedness** and **Canada Mortgage and Housing Corporation** in co-operation with the **National Archives of Canada** and the **Canadian Conservation Institute**.

An electronic version of this publication is available on the Internet.

This publication is also available in alternate formats (audio cassette, large print, computer diskette and braille) through InfoTouch by calling toll-free 1-800-788-8282. Use the same number for teletypewriter (TTY).

Cette publication est disponible en français. Elle s'intitule :
Inondations — *Que faire avant et après?*

ISBN 0-662-30894-8

Catalogue No. D82-34/2001-1E

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FLOODS

BEYOND THE HUMAN TOLL
TAKEN IN LIVES AND SUFFERING,
FLOOD DAMAGE COSTS CANADIAN TAXPAYERS
MILLIONS OF DOLLARS ANNUALLY.

Though governments at every level work to reduce the risk of floods, the first line of defence always rests with the individual. Each of us has a responsibility to protect our homes and families to the greatest extent possible. By planning ahead and taking sensible precautions, you can do your part to minimize flood damage.

Flood threats to particular areas can usually be forecast in a number of ways, including:

- Constant evaluation of rising water tables that result from heavy rain,
- Surveys of snow conditions in river drainage basins, and
- Meteorological observations and forecasts.

Flash or sudden flooding, in which warning time is extremely limited, can result from other causes such as earthquakes, tsunamis or tidal waves, hurricanes, violent storms or bursting of dams.

In all cases, local government authorities try to keep residents informed of developments in areas most likely to be affected by flooding. Regular media advisories will recommend actions people should take to limit or prevent disaster. As the need arises, more detailed instructions by municipal or provincial authorities will be given.



BEFORE the FLOOD

ELECTRICITY

When there is immediate danger of flooding, shut off all power in your home.

HEATING EQUIPMENT

Special precautions should be taken to safeguard or minimize damage to electrical, natural gas or propane heating equipment. If there is enough warning time, consult your supplier for instructions on how to proceed.

GENERAL PRECAUTIONS

Ensure that you have a battery-powered radio in working order, with spare batteries, to listen to instructions from your local station.



Prepare an emergency survival kit that includes food, water and medical supplies in an easy-to-carry container. In addition to the battery-powered radio and spare batteries, it should contain at least the following items:

- Flashlight with spare batteries;
- Warm clothing, including waterproof outer garments and footwear;
- Blankets;
- All necessary medication;
- Infant care items;
- Personal toiletries;
- Identification for each member of your household; and
- Any important personal and family documents.

Move furniture, electrical appliances and other belongings to floors above ground level.

Remove such toxic substances as pesticides and insecticides from the immediate area to prevent pollution.

Remove toilet bowls, and plug basement sewer drains and toilet connections with a wooden plug.

Disconnect eavestroughs if they are connected to the house sewer.

In some cases, homes may be protected by using sandbags or polyethylene barriers. But this approach requires specific instructions that must be obtained from your local emergency officials.

EVACUATION

Vacate your home when you are advised to do so by local emergency authorities.

Ignoring such a warning could jeopardize the safety of your family or those people who might eventually have to come to your rescue.



When you leave, take your emergency survival kit with you.

Follow the routes specified by officials. Don't take shortcuts. They could lead you to a blocked or dangerous area.

Make arrangements for pets.

Should time allow, leave a note informing others when you left and where you went. If you have a mailbox, leave the note there.

If you are evacuated, register with the reception centre so that you can be contacted and reunited with your family and loved ones.

If you are using your car, try not to drive through flood waters. Fast water can sweep your car away. However, should you be caught in fast rising waters and your car stalls, leave it behind. Always consider your safety and the safety of others first.

AFTER the FLOOD

FOLLOWING A FLOOD, IT IS IMPORTANT TO RESTORE YOUR HOME TO GOOD ORDER AS SOON AS POSSIBLE TO PROTECT YOUR HEALTH AND PREVENT FURTHER DAMAGE TO YOUR HOUSE AND ITS CONTENTS.



Canada Mortgage and Housing Corporation has prepared the following handy checklist to help you organize your clean-up. However, this information is provided as self-help advice only.

Before you begin

Exercise caution when re-entering your home. Avoid electrical shock by wearing rubber boots in an area flooded with more than 5 cm (2 in.) of standing water.

ELECTRICITY

Keep extension cords out of the water. If the power is on in the flooded area, shut it off immediately at the breaker box.

If conditions are wet around the breaker box, stand on a dry board and use a dry stick to turn off the switch.

Consult with your local electrical utility if you require assistance.

THE BUILDING

Make sure the building is structurally safe. Look for buckled walls or floors. Watch for holes in the floor, broken glass and other potentially dangerous debris.

WATER

Flood water can be heavily contaminated with sewage and other pollutants, and pose a serious health hazard. If through taste, colour or odour you suspect that your drinking water has been contaminated, purify it before drinking either by boiling it for at least 10 minutes or adding purification tablets. If you choose to chlorinate your water with a non-perfumed bleaching compound, add one drop per litre of water, or three drops per litre of cloudy water, and allow it to stand for at least 30 minutes before consuming.

Household items that have been flood-damaged will have to be bagged, tagged and discarded according to local regulations.

EQUIPMENT

Assemble equipment and supplies, which should include:

- gloves, masks and other protective gear;
- pails, mops, squeegees and plastic garbage bags;
- chlorine bleach and non-ammonia dishwashing detergent (**Note:** Never mix bleach with ammonia since the fumes produced together are toxic.); and
- large containers for soaking bedding and clothing, and lines to hang them until they are dry.



You may also need to rent extension cords, submersible pumps, wet/dry shop vacuums, a carbon monoxide sensor, and dehumidifiers, fans or heaters.

Remember to store all valuable papers that have been damaged in a freezer until they are needed.

Record details of flood damage, by photograph or video if possible. Register the amount of damage to your home with both your insurance agent and local municipality immediately.

FIRST STEPS in CLEAN-UP

WATER DAMAGE

Immediately add about two litres of chlorine bleach to standing water.



Do not occupy a house that still contains standing water.

Remove water from your flooded home slowly.

Drain it in stages — about a third of the volume daily. If the ground is still saturated and

water is removed too quickly, it could cause the walls or the floor to buckle. Use pumps or pails to remove standing water, followed by a wet/dry shop vacuum to mop up the rest. For instructions on how to disinfect and restore wells and cisterns, contact your local or provincial health authorities or emergency measures organization.

HEATING

Do not heat your home to more than four degrees Celsius (about 40 degrees Fahrenheit) until all water is removed.

If you use gasoline-, kerosene- or propane-powered pumps or heaters, buy and install a carbon monoxide sensor. Combustion devices can produce large amounts of lethal carbon monoxide when out of tune or improperly ventilated.



DIRT AND DEBRIS

Remove all soaked and dirty materials and debris. Break out walls and remove drywall, wood panelling and insulation at least 500 mm (20 in.) above the high-water line. Remove residual mud and soil, furniture, appliances, clothing and bedding.

Hose down any dirt sticking to walls and solid-wood furniture. Then rinse several times.

Wash and wipe down all surfaces and structures with chlorine bleach, ensuring there is adequate cross ventilation to remove fumes. Then rinse again. Wear a charcoal respirator (which can be obtained at major safety supply or hardware stores) when using bleach in any closed space.

Wipe down surfaces that have not been directly flood-affected using a solution of one part chlorine bleach to four parts cold or tepid water, mixed with a small amount of non-ammonia dishwashing detergent. Then rinse.

STRUCTURES

Ventilate or dehumidify the house until it is completely dry. Tape clear food wrap to sections of material. If these sections are still damp inside, they will turn darker than the surrounding material. Dry until this does not occur.

Rinse, then clean all floors as quickly as possible. Replace flooring that has been deeply penetrated by flood water or sewage.

Clean all interior wall and floor cavities with a solution of water, chlorine bleach and non-ammonia dishwashing detergent and dry thoroughly.

If regular checks reveal mould, kill it with chlorine bleach. Mould can lead to serious health problems.

FLOOR COVERINGS

Carpets must be dried within the first two days. For large areas, hire a qualified professional to do the job. Carpets soaked with sewage must be discarded immediately.

WATER-DAMAGED HEIRLOOMS and ANTIQUES

General Recommendations



ACT QUICKLY
TO PREVENT
FURTHER
DAMAGE.
WET ITEMS
WILL BE
HEAVY AND
FRAGILE, SO KEEP

THEM WELL SUPPORTED WHEN HANDLING, DRYING OR FREEZING. RELOCATE ITEMS TO A COOL, DRY LOCATION. BOOKS, DOCUMENTS AND TEXTILES CAN BE PLACED IN A FREEZER UNTIL THEY CAN BE PROPERLY TREATED. CONSULT A CONSERVATOR BEFORE ATTEMPTING REPAIRS. IF ITEMS ARE CONTAMINATED WITH SEWAGE, TAKE PROPER HEALTH PRECAUTIONS (SEE PAGE 9).

DIRT

Dirty items that are saturated can be rinsed with clean water if they are strong enough to withstand it; exceptions are paper, fragile items, and items with loose parts or soluble paints and adhesives. If items are just damp, let mud dry and then brush it off.

MOULD

Mould is a health hazard; if mould is present, wear a face mask and disposable gloves. To minimize mould growth, move items to a cool, dry area within 48 hours and set up fans. Alternatively, textiles, furs, paper and books can be frozen. Wet mould will smear if wiped; let it dry and then brush it off outdoors. Materials not affected by alcohol can be lightly misted with isopropanol (rubbing alcohol) to kill mould spores.

FREEZING

Freezing can temporarily halt further damage. Freezing is appropriate for books, paper documents, furs and textiles. Gently blot (do not wring) furs and textiles first with towelling to remove excess water; keep them well supported. Place items in individual plastic bags or separate with wax paper to keep them from sticking together when frozen.

AIR DRYING

Most items can be air-dried. Move them to a cool, dry location and set up fans. If drying outdoors, keep items out of direct sunlight.



TIPS AND PRECAUTIONS FOR SPECIFIC ITEMS

Furs: Blot gently with towels to remove excess water. Air dry or freeze.

Textiles: Rinse till the water runs clear. Air dry, or bag and freeze.

Upholstered furniture: Remove cushions and dry separately. Do not remove upholstery. Raise furniture on blocks and place fans underneath.

Wooden furniture: Remove drawers and open doors. Do not dry quickly or splitting may occur.

Books: Do not squeeze. Fan open and air dry using fans, or freeze.

Framed items: Unframe and air dry.

Glossy paper: Do not let dry or pages will stick together. Freeze immediately.

Paintings: Do not remove canvas paintings from their stretchers. Do not freeze.

Contemporary photographs, negatives and slides: Remove from mounts or plastic sleeves and air dry. If stuck together, do not force apart.

A more detailed version of this section can be found on the SAFE GUARD web site.



WHAT to KEEP or DISCARD

REMOVE AND REPLACE ALL INSULATION MATERIALS AND OTHER ARTICLES THAT HAVE BEEN SOAKED, INCLUDING PARTICLEBOARD FURNITURE, MATTRESSES, BOX SPRINGS, STUFFED TOYS, PILLOWS, AS WELL AS FURNITURE COVERINGS, PADDINGS AND CUSHIONS.

Frames on high-quality furniture can often be salvaged. However, they must first be cleaned, disinfected and rinsed, then dried by ventilation away from direct sunlight or heat. Drying too quickly can cause warping and cracking.



Scrape heavy dirt from washable clothes. Rinse and wash them several times in cold water treated with one cup of chlorine bleach per washer load, and dry quickly.

Consult your lawyer to determine whether flood-damaged documents or just the information in them must be retained.

The yard area should also be cleared of all debris and refuse, which can provide a breeding ground for bacteria and mould.

Keep children away from contaminated areas during clean-up operations.

Before MOVING BACK in

ONCE THE FLOOD WATERS HAVE RECEDED, YOU MUST NOT LIVE IN YOUR HOUSE UNTIL SEVERAL STEPS HAVE BEEN FOLLOWED:

- The regular water supply has been inspected and officially declared safe for use.
- Every flood-contaminated room has been thoroughly cleaned, disinfected and surface-dried.
- All contaminated dishes and utensils have been thoroughly washed and disinfected either by using boiling water or by using a sterilizing solution of one part chlorine bleach to four parts water; then rinse dishes and utensils thoroughly.
- Adequate toilet facilities are available. (For more information, consult your local health authority.)



HEATING SYSTEMS AND APPLIANCES

Do not use flooded appliances, electrical outlets, switch boxes or fuse-breaker panels until they have been checked by your local utility.



Whether you use a wood, gas or electrical heating system, ensure that you have it thoroughly inspected by a qualified technician before using it again.

If they have been soaked, replace the furnace blower motor, switches and controls. Flooded forced-air heating ducts and return-duct pans should be either cleaned or replaced.

Replace filters and insulation inside furnaces, water heaters, refrigerators and freezers if they have been wet. However, it is often cheaper to replace this equipment.

FLOOR DRAINS

Flush and disinfect floor drains and sump pumps using undiluted chlorine bleach. Scrub them to remove greasy dirt and grime. Clean or replace footing drains outside the foundation when they are clogged. Consult a professional for advice or service.

FOOD

Any of the following food items exposed to flood waters must be disposed of:

- the contents of your freezer or refrigerator;
- all meats;
- all fresh fruit and vegetables;
- all boxed foods;
- all bottled drinks and products in jars, including home preserves since the area under the seal of jars and bottles cannot be properly disinfected; and
- all medicines, cosmetics and other toiletries.



All undamaged canned goods must be thoroughly washed and disinfected. Any cans with large dents or that reveal seepage must also be disposed of.

(REMINDER: Anything that stays wet long enough will grow mould, and mould can make people sick. Dry everything quickly to avoid future health problems.)

ADDITIONAL INFORMATION

For additional information on cleaning your house after a flood, home repair and renovation contact:

CANADIAN HOUSING INFORMATION CENTRE CANADA MORTGAGE AND HOUSING CORPORATION

700 Montreal Road

Ottawa ON K1A 0P7

Telephone: (613) 748-2367

Toll-free: 1-800-668-2642

Fax: 1-800-245-9274

E-mail: chic@cmhc-schl.gc.ca

Internet: <http://www.cmhc-schl.gc.ca>

CANADIAN CONSERVATION INSTITUTE

1030 Innes Road

Ottawa ON K1A 0M5

Telephone: (613) 998-3721

Fax: (613) 998-4721

Internet: <http://www.cci-icc.gc.ca>

For additional information on emergency preparedness, contact the Office of Critical Infrastructure Protection and Emergency Preparedness or your provincial or territorial emergency measures organization.

OFFICE OF CRITICAL INFRASTRUCTURE PROTECTION AND EMERGENCY PREPAREDNESS

Communications

122 Bank St., 2nd Floor, Ottawa, ON K1A 0W6

Telephone: (613) 991-7035

1-800-830-3118

Fax: (613) 998-9589

E-mail: communications@ociepc-bpiepc.gc.ca

Internet: <http://www.ociepc-bpiepc.gc.ca>

PROVINCIAL/TERRITORIAL EMERGENCY MEASURES ORGANIZATIONS

Newfoundland and Labrador

Emergency Measures Organization

Telephone: (709) 729-3703

Fax: (709) 729-3857

Prince Edward Island

Emergency Measures Organization

Telephone: (902) 888-8050

Fax: (902) 888-8054

Nova Scotia

Emergency Measures Organization

Telephone: (902) 424-5620

Fax: (902) 424-5376

New Brunswick

Emergency Measures Organization

Telephone: (506) 453-2133

Toll free: (800) 561-4034

Fax: (506) 453-5513

Québec

Direction générale de la sécurité civile et de la
sécurité incendie

Telephone: (418) 646-7950

Fax: (418) 646-5427

Toll Free Emergency Number: 1 866 776-8345

Emergency Number: (418) 643-3256

Or one of the Direction générale de la sécurité civile
regional offices:

Bas-Saint-Laurent–Gaspésie–

Îles-de-la-Madeleine: (418) 727-3589

Saguenay–Lac-St-Jean–Côte-Nord: (418) 695-7872

Capitale Nationale–Chaudière–

Appalaches–Nunavik: (418) 643-3244

Mauricie–Centre-du-Québec: (819) 371-6703

Montréal–Laval–Laurentides–

Lanaudière: (514) 873-1300

Montérégie–Estrie: (514) 873-1324

Outaouais–Abitibi-Témiscamingue–

Nord-du-Québec: (819) 772-3737

Ontario

Emergency Measures Ontario

Telephone: (416) 314-8615

Fax: (416) 314-3758

Manitoba

Emergency Measures Organization

Telephone: (204) 945-4772

Fax: (204) 945-4620

Saskatchewan

Saskatchewan Emergency Planning

Telephone: (306) 787-9563

Fax: (306) 787-1694

Alberta

Disaster Services Branch

Telephone: (780) 422-9000

Toll free in Alberta, dial 310-0000-780-422-9000

Fax: (780) 422-1549

British Columbia

Provincial Emergency Program (PEP)

Telephone: (250) 952-4913

Fax: (250) 952-4888

Northwest Territories

Emergency Measures Organization

Telephone: (867) 920-6133

Fax: (867) 873-8193

Yukon

Emergency Measures Organization

Telephone: (867) 667-3594

Fax: (867) 393-6266

Nunavut

Nunavut Emergency Management

Telephone: (867) 979-5822

Fax: (867) 979-4211

OTHER PUBLICATIONS IN THE SELF-HELP ADVICE SERIES:


- Be Prepared Not Scared
- Prepare to Survive a Major Earthquake
- Prepared for the Woods
- Severe Storms
- Storm Surges
- Winter Power Failures
- Winter Driving –
You, your car and winter storms
- Preparing for the Unexpected

SAFE GUARD

SAFE GUARD is a national information program based on partnerships and aimed at increasing public awareness of emergency preparedness in Canada.

The SAFE GUARD program brings together government, private organizations and voluntary agencies that are part of the emergency preparedness, response, recovery and mitigation community.

The triangle depicted in the program logo is the international symbol of emergency preparedness. The jagged line evokes the maple leaf, Canada's internationally recognized symbol.

SAFE  GUARD is a program of the Office of Critical Infrastructure Protection and Emergency Preparedness.



Government
of Canada

Gouvernement
du Canada



Self-Help Advice

Severe Storms



Canada

This publication was produced by the **Office of Critical Infrastructure Protection and Emergency Preparedness** in co-operation with **Environment Canada**.

An electronic version is available on the Internet.

This publication is also available in alternate formats (audio cassette, large print, computer diskette and braille) through InfoTouch by calling toll-free 1-800-788-8282. Use the same number for teletypewriter (TTY).

Cette publication est aussi disponible en français. Elle s'intitule : *Violentes tempêtes*.

ISBN 0-662-30879-4

Catalogue No. D82-27/2001-1E

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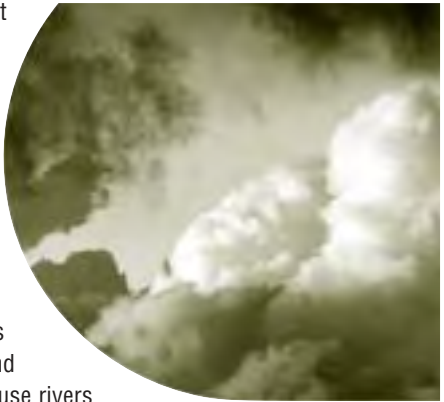


SEVERE STORMS

THUNDERSTORMS, TORNADOES, HAIL, BLIZZARDS, HIGH WINDS AND HEAVY RAIN CAN DEVELOP QUICKLY AND HIT HARD — POSING A THREAT TO LIFE AND PROPERTY.

If you are like most Canadians you have probably had to clean up after these storms and you know the damage they cause. Some problems cannot be prevented. High winds will topple trees and heavy rains will cause rivers to flood. But some damage can be avoided or at least reduced, if you take a few simple precautions such as knowing the type of storms common to your area and what time of year they are likely to strike.

The purpose of this booklet is to help you prepare for severe weather by listing a few steps which you can take to protect your family, yourself, and your property when a severe storm hits your area.



LISTEN for the WARNINGS



ENVIRONMENT CANADA MONITORS THE WEATHER 24-HOURS A DAY, SEVEN DAYS A WEEK. IF A SEVERE STORM IS ON THE HORIZON,

THE WEATHER SERVICE ISSUES WATCHES, ADVISORIES AND WARNINGS THROUGH NATIONAL, REGIONAL AND LOCAL RADIO AND TELEVISION STATIONS, AND ENVIRONMENT CANADA'S WEATHERADIO.

- **WEATHER WATCH:**

Conditions are favourable for a severe storm, even though one has not yet developed. This is usually issued early in the day. Keep monitoring weather conditions and listen for updated statements.

- **WEATHER WARNING:**

Severe weather is happening or hazardous weather is highly probable.

If a weather warning is issued for a tornado, it means that one or more tornadoes have been observed or are forecast for the specified area. Other warnings include those for a severe thunderstorm, blizzard, high winds, heavy snow, snow squall, heavy rain and significant freezing rain.



Be PREPARED

STORMS SUCH AS TORNADOES OFTEN STRIKE TOO QUICKLY TO ALLOW YOU TO CHOOSE A SHELTER OR TO PACK AN EMERGENCY KIT. YOU MAY WANT TO HAVE A PLAN THAT OUTLINES WHERE YOU WILL GO AND HOW YOU WILL KEEP IN TOUCH WITH MEMBERS OF YOUR FAMILY IF A SEVERE STORM HITS. MUNICIPAL, PROVINCIAL AND TERRITORIAL EMERGENCY MEASURES ORGANIZATIONS CAN PROVIDE VALUABLE ADVICE TO HELP YOU PREPARE FOR EMERGENCIES.

CHOOSE YOUR SHELTER AREA

A basement, storm cellar or a closet beneath the stairs are good places to take shelter in the event of a severe storm. If none of these is available, sit underneath a sturdy piece of furniture on the ground floor in the centre of the building away from the outside walls and windows. Be sure you discuss the shelter area with your family.

PACK AN EMERGENCY KIT

This should include food, clothing, blankets, medication, water purification tablets and first-aid and tool kits as well as flashlights and a battery-powered radio – with extra batteries for both.

REDUCE THE HAZARDS

Trim dead or rotting branches and cut down dead trees to reduce the danger of these falling on your house. You may also want to consider checking the drainage around the house to reduce the possibility of your basement flooding after a heavy rain.

CHOOSE A PLACE TO MEET

When a severe storm strikes, members of your household may be at work, school or a friend's place. To avoid unnecessary worry, plan a meeting place or some system of communicating with one another to check that everyone is safe.

WHEN a SEVERE STORM is FORECAST

SEVERE WEATHER CAN OCCUR ANY TIME OF THE YEAR, WINTER OR SUMMER. MAKE IT A HABIT TO LISTEN TO THE LOCAL RADIO OR TELEVISION STATIONS FOR SEVERE WEATHER WARNINGS AND ADVICE. MAKE SURE YOU HAVE A BATTERY-POWERED RADIO ON HAND AS THE ELECTRICITY FREQUENTLY FAILS DURING A SEVERE STORM.



Secure everything that might be blown around or torn loose – indoors and outdoors. Flying objects such as garbage cans and lawn furniture can injure people and

damage property. If hail is forecast, you may want to protect your car by putting it in the garage.

Never venture out in a boat. If you are on the water and you see bad weather approaching, head for shore immediately. Always check the marine forecast first before leaving for a day of boating and listen to weather reports during your cruise.

If you are advised by officials to evacuate, do so. Take your emergency kit with you.

If you are outdoors when a storm hits, take shelter immediately.

Stay calm. You will be able to cope better with emergencies.

THINGS to do AFTER the STORM

LISTEN TO YOUR RADIO FOR INFORMATION AND FOLLOW INSTRUCTIONS.

Give first aid to people who are injured or trapped.
Get help if necessary.

Unless you are asked to help or are qualified to give assistance, please stay away from damaged areas.

Do not go near loose or dangling power lines. Report them and any broken sewer and water mains to the authorities.

Report fires to the fire department. Be alert to prevent fires, as broken water mains may cause a reduction in water pressure. Lightning and downed power lines can cause fires. Know how to fight small fires.

Water supplies may be contaminated so purify your water by boiling it for 10 minutes, or by adding water purification tablets, or by adding one drop of unscented chlorine bleach to one litre of water (or three drops for cloudy water).

If you use chlorine bleach to purify the water, stir the bleach in and wait 30 minutes before drinking. The water should have a slight chlorine smell.

Please leave the telephone lines free for official use. Do not use the telephone, except in real emergencies.

Drive cautiously and only if necessary. Debris, broken power lines and washed out or icy roads and bridges will make driving dangerous after a severe storm. Please give way to emergency vehicles at all times.

Finally, if the power has been off for several hours, check the food in the refrigerator and freezer to check if it has spoiled.

SEVERE STORMS

Tornadoes

TORNADOES FORM SUDDENLY, ARE OFTEN PRECEDED BY WARM HUMID WEATHER AND ALWAYS PRODUCED BY THUNDERSTORMS — ALTHOUGH NOT EVERY THUNDERSTORM PRODUCES A TORNADO. THERE ARE WARNING SIGNS, INCLUDING:

- severe thunderstorms with frequent thunder and lightning;
- an extremely dark sky sometimes highlighted by green or yellow clouds;
- a rumbling sound, such as a freight train might make or a whistling sound such as a jet aircraft might make; and
- a funnel cloud at the rear base of a thunder cloud often behind a curtain of heavy rain or hail.



Tornadoes are violent windstorms characterized by a twisting funnel-shaped cloud which forms at the base of cloud banks and points towards the ground. Tornadoes usually move over the ground at anywhere from 20 to 90

km/h and often travel

from the southwest to the northeast. They are erratic and can change course suddenly.

It is not a good idea to chase tornadoes.

Generally speaking, May to September are prime tornado months. Tornadoes usually hit in the afternoon and early evening but they have been known to strike at night too.

Canada has several high risk areas including Alberta, southern Ontario, southern Quebec and a band of land

which stretches from southern Saskatchewan and Manitoba through to Thunder Bay, Ontario. There are also tornado zones in the interior of British Columbia and in western New Brunswick.

THINGS TO DO IN CASE OF A TORNADO

If you live in one of Canada's high-risk areas, you should listen to your radio during severe thunderstorms. As a rule, when Environment Canada issues a tornado warning, radio stations broadcast it immediately. If you hear that a tornado warning has been issued for your area, take cover immediately. If you are at home, go to the basement or take shelter in a small interior ground floor room such as a bathroom, closet or hallway. Failing that, protect yourself by taking shelter under a heavy table or desk. In all cases, stay away from windows and outside walls and doors.

If you are at the office or in an apartment building, take shelter in an inner hallway or room, ideally in the basement or the ground floor. Do not use the elevator and stay away from windows. Avoid buildings such as gymnasiums, churches and auditoriums with wide-span roofs. These roofs do not have supports in the middle and may collapse if a tornado hits them. If you are in one of these buildings take cover under a sturdy structure.

Do not get caught in a car or mobile home. More than 50 per cent of all deaths from tornadoes happen in mobile homes. Take shelter elsewhere – such as a building with a strong foundation. If no shelter is available, then lie down in a ditch away from the automobile or mobile home. However, beware of flooding from downpours and be prepared to move.

If you are driving and spot a tornado in the distance, try to get to a nearby shelter. If the tornado is close by, get out of your car and take cover in a low-lying area. If a tornado seems to be standing still then it is either travelling away from you or heading right for you.

In all cases, get as close to the ground as possible, protect your head and watch out for flying debris. Small objects such as sticks and straws can become lethal weapons when driven by a tornado's winds.

SEVERE THUNDERSTORMS — LIGHTNING, HEAVY RAIN and HAIL

A THUNDERSTORM

DEVELOPS IN

AN UNSTABLE

ATMOSPHERE

WHEN WARM

MOIST AIR NEAR

THE EARTH'S

SURFACE RISES

QUICKLY AND COOLS. THE

MOISTURE CONDENSES TO FORM RAIN DROPLETS

AND DARK THUNDER CLOUDS CALLED

CUMULONIMBUS CLOUDS. THESE STORMS ARE

OFTEN ACCOMPANIED BY HAIL, LIGHTNING, HIGH

WINDS, HEAVY RAIN AND TORNADOES.

THUNDERSTORMS ARE USUALLY OVER IN AN

HOUR, ALTHOUGH A SERIES OF THUNDERSTORMS

CAN LAST FOR SEVERAL HOURS.



LIGHTNING

The air is charged with electricity during a thunderstorm.

The most striking sign of this is lightning. Bolts of lightning

hit the ground at about 40,000 kilometres per second —

so fast that the lightning appears to be a single main bolt

with a few forks when actually the opposite is true. The

main bolt is a whole series of lightning strikes all taking

the same path but at such a pace that the eye cannot

distinguish between them.

To estimate how far away the lightning is, count the seconds between the flash of lightning and the thunder-clap. Each second is about 300 metres. If you count fewer than 30 seconds, look around for shelter; if fewer than five seconds, take shelter urgently. Lightning is near and you do not want to be the tallest object in the area. It is recommended to wait 30 minutes after the last lightning stroke in a severe storm before venturing outside again.

At the office or house

- If indoors, stay there but away from windows, doors, fireplaces, radiators, stoves, sinks, bathtubs, appliances, metal pipes, telephones and other materials which conduct electricity. (You can use a cellular telephone.)
- Unplug radios and televisions.
- Do not go out to rescue the laundry on the clothesline as it conducts electricity.

Outside

- Take shelter, preferably in a building; failing this, in a depressed area such as a ditch or a culvert but never under a tree.
- Do not ride bicycles, motorcycles or golf carts or use metal shovels or golf clubs as they conduct electricity.
- If swimming or in a boat, get back to shore immediately.
- If caught in the open, do not lie flat but crouch in the leap frog position and lower your head.
- If you are in a car, stay there but pull away from trees where heavy branches might fall on you.

HEAVY RAIN

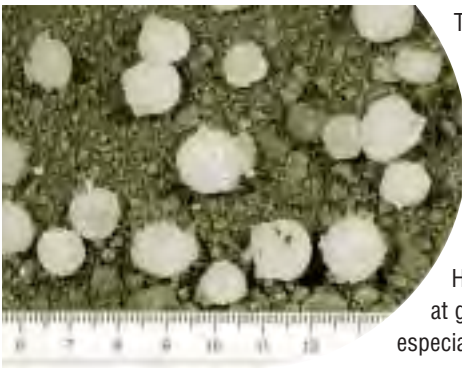
A heavy rain fall can result in flooding. This is particularly true when the ground is still frozen or already saturated from previous storms. Floods may also result if a heavy rain coincides with the spring thaw.

- If you know there is flooding or the possibility of flooding in your area, keep your radio on to find out what areas are flooded, what areas are likely to be flooded as well as what roads are safe, where to go and what to do if the local emergency team asks you to leave your home.

- Generally speaking, it is a good idea to avoid driving through flooded roads and underpasses. The water may be a great deal deeper than it looks and you could get stuck. You may also want to avoid crossing bridges if the water is high and flowing quickly.

HAIL

Hail forms when updrafts in thunderclouds carry raindrops upwards into extremely cold areas of the atmosphere. The raindrops freeze and are bounced around in the powerful winds within thunderclouds while new layers of ice are added. Eventually, the hailstones grow too heavy to be supported by the updrafts and fall to the ground. Some hailstones are the size of peas while others can be as big as grapefruits.



Take cover when hail begins to fall. Do not go out to cover plants, cars or garden furniture or to rescue animals. Hail comes down

at great speed, especially when accompanied by high

winds. Although no-one in Canada has ever been killed by hail, people have been seriously injured by it.

WINTER STORMS: FREEZING RAIN, HEAVY SNOW, BLOWING SNOW and BLIZZARDS

BLIZZARDS COME IN ON A WAVE OF COLD ARCTIC AIR, BRINGING SNOW, BITTER COLD, HIGH WINDS AND POOR VISIBILITY IN BLOWING SNOW. WHILE THESE CONDITIONS MUST LAST FOR AT LEAST SIX HOURS TO BE DESIGNATED A BLIZZARD, THEY MAY LAST FOR SEVERAL DAYS. THE SNOWFALL MAY NOT BE HEAVY, BUT THE POOR VISIBILITY, LOW TEMPERATURES AND HIGH WINDS CONSTITUTE A SIGNIFICANT HAZARD.

Freezing rain occurs when the air in an upper-air layer has an above-freezing temperature while the temperature at the surface is below freezing. The snow that falls melts in the warmer layer; as a result, it is rain – not snow – that lands on the surface. But since the temperature is below 0°C, rain drops freeze on contact and turn into a smooth layer of ice spreading on the ground or any other object like trees or power lines. More slippery than snow, freezing rain is tough and clings to everything it touches. A little of it is dangerous, a lot can be catastrophic.

In Canada, blizzards are most common in the Prairies, and the eastern Arctic. Heavy snowfalls are most common in British Columbia, areas around the Great Lakes, southern and eastern Quebec and the Atlantic Provinces. Freezing rain can occur pretty much anywhere in the country, but is particularly common from Ontario to Newfoundland.

On average, the storms and cold of winter kill more than 100 people every year. That is more than the total number of people killed by hurricanes, tornadoes, floods, lightning, and extreme heat.

AT HOME

If you live in a community located in one of the areas where blizzards or heavy snows are frequent, you may want to consider stocking up on heating fuel, ready-to-eat food as well as battery-powered flashlights and radios – and extra batteries.



- When freezing rain, heavy snow, blowing snow or a blizzard is forecast, leave your radio on to stay informed of the situation and hear updated forecasts.
- If a blizzard or heavy blowing snow is forecast and if you are on a farm with livestock, bring the animals into the barn. Make sure they have plenty of water and food. You may also want to string a lifeline between your house and any outbuildings which you may have to go to during the storm.
- When a winter storm hits, stay indoors. If you must go to the outbuildings, dress for the weather. Outer clothing should be tightly woven and water-repellent. The jacket should have a hood. Wear mittens – they are warmer than gloves – and a hat, as most body heat is lost through the head.
- In wide open areas, visibility can be virtually zero during heavy blowing snow or a blizzard. You may easily lose your way. If a blizzard strikes, do not try to walk to another building unless there is a rope to guide you or something you can follow.
- Ice from freezing rain accumulates on branches, power lines and buildings. If you must go outside when an important accumulation of ice has already occurred, pay attention to branches or wires that

could break due to the weight of the ice and fall on you. Ice sheets could also do the same. Above all, do not touch power lines: a hanging power line could be charged (live) and you would run the risk of electrocution. Remember also that ice, branches or power lines can continue to break and fall for several hours after the end of the precipitation, so be vigilant.

Finally, if the power has been off for several hours, check the food in the refrigerator and freezer to check if it has spoiled. For other advice and tricks to prepare for power failures, consult our mini-guide for dealing with winter power outages (prepared in cooperation with Hydro-Québec), also available on the Web at <http://www.safeguard.ca/english/publications/winpower.html>

IN YOUR CAR

As a rule, it is a good idea to keep your gas tank almost full during the winter and to have extra windshield washer fluid and anti-freeze on hand. You may want to put together two small emergency kits – one to put in the trunk of your car and the other in the cab of the car. The trunk kit should include:

- shovel, sand, or salt, kitty litter or other traction aids;
- tow chain and booster cables;
- fire extinguisher, warning light or flares; and
- extra clothing, including mittens, hats and boots.

The kit in the cab of the car should include:

- flashlight;
- blanket;
- first-aid kit; and
- matches, candles (in a deep can to warm hands or heat a drink) and emergency food pack.



If you do not already have a cellular telephone and if the cellular network works in your area, you may want to consider having one in your car for emergencies.

Remember that freezing rain, even just a little freezing rain, can make roads extremely slippery. It is therefore not recommended to drive when freezing rain is forecast, as well as for several hours after freezing rain ends, so that road maintenance crews have enough time to spread sand or salt on icy roads.

If you must travel during a winter storm, do so during the day and let someone know your route and arrival time.



If your car gets stuck in a blizzard or snow storm, remain calm and stay in your car. Keep fresh air in your car by opening the window slightly on the sheltered side – away from the wind. You can run the car engine about 10 minutes every half hour if the exhaust system is working well. Beware of exhaust fumes and check the exhaust pipe periodically to make sure it is not blocked with snow. (Remember – you can't smell potentially fatal carbon monoxide fumes.)

Finally, to keep your hands and feet warm exercise them periodically. In general, it is a good idea to keep moving to avoid falling asleep. If you do try to shovel the snow from around your car avoid over-exerting yourself as shovelling and bitter cold can kill. Keep watch for traffic or searchers.

HURRICANES

HURRICANES ARE VIOLENT TROPICAL STORMS WHICH BLOW UP FROM THE CARIBBEAN AND OCCASIONALLY HIT EASTERN CANADA USUALLY BETWEEN JUNE AND NOVEMBER WITH SEPTEMBER BEING THE PEAK MONTH. THE EAST AND WEST COASTS, HOWEVER, DO GET FALL AND WINTER STORMS WHICH HAVE HURRICANE FORCE WINDS. HURRICANES CAUSE MORE WIDESPREAD DAMAGE THAN TORNADOES BECAUSE THEY ARE BIGGER. SOME ARE AS LARGE AS 1,000 KILOMETRES ACROSS.

In Canada, heavy rain and flooding are usually greater hazards than strong winds – although the winds are still strong and potentially dangerous. If a hurricane warning has been issued, and you live on the coast or in a low-lying area near the coast, you are advised to move inland and to higher ground. The high winds create huge waves at sea which, when they reach the shore, may become tidal waves or storm surges.

Do not go down to the water to watch the storm. Most people who are killed during hurricanes are caught in large waves, storm surges or floodwaters.

As a rule hurricanes move slowly and batter communities for several hours. If the eye of the hurricane passes over, there will be a lull in the wind lasting from two or three minutes to half an hour. Stay in a safe place. Make emergency repairs only, but remember that once the eye has passed over the winds will return from the opposite direction and with possibly even greater force.

A NOTE for OWNERS and RESIDENTS of MOBILE HOMES

OWNERS AND RESIDENTS OF MOBILE HOMES MUST TAKE SPECIAL CARE TO PROTECT THEMSELVES AND THEIR PROPERTY IN THE EVENT OF STORMS.



Position your trailer near a natural wind-break such as a hill or clump of trees. As severe storms usually come in from the southwest, west or northwest, the narrow end of the trailer should face in a westerly direction to make a smaller target.

Make sure your trailer is securely anchored. Consult the manufacturer for information on secure tiedown systems.

Finally, when a severe storm approaches you should still seek shelter in a more secure building. Trailers are the exception to the stay indoors rule.

ADDITIONAL INFORMATION

For more information about severe weather or weather in general, contact:

ENQUIRY CENTRE ENVIRONMENT CANADA

Ottawa, Ontario, Canada K1A 0H3

Telephone: 1-800-668-6767 or (819) 997-2800

Fax: (819) 953-0966

E-mail: enviroinfo@ec.gc.ca

Internet: <http://www.msc-smc.ec.gc.ca/>

WEATHER MENU

A menu of recorded specialized weather forecasts

1-900-565-5000 (English)

1-900-545-4000 (French)

There is a fee per minute for this service.

WEATHER ONE-ON-ONE

To consult an Environment Canada weather expert

1-900-565-5555 (English)

1-900-565-4455 (French)

There is also a per-minute fee for this service

(\$2.99 a minute at press time).

For additional information on emergency preparedness, contact the Office of Critical Infrastructure Protection and Emergency Preparedness or your provincial or territorial emergency measures organization.

OFFICE OF CRITICAL INFRASTRUCTURE PROTECTION AND EMERGENCY PREPAREDNESS

Communications

122 Bank St., 2nd Floor, Ottawa, ON K1A 0W6

Telephone: (613) 991-7035

1-800-830-3118

Fax: (613) 998-9589

E-mail: communications@ociepc-bpiepc.gc.ca

Internet: <http://www.ociepc-bpiepc.gc.ca>

PROVINCIAL/TERRITORIAL EMERGENCY MEASURES ORGANIZATIONS

Newfoundland and Labrador

Emergency Measures Organization

Telephone: (709) 729-3703

Fax: (709) 729-3857

Prince Edward Island

Emergency Measures Organization

Telephone: (902) 888-8050

Fax: (902) 888-8054

Nova Scotia

Emergency Measures Organization

Telephone: (902) 424-5620

Fax: (902) 424-5376

New Brunswick

Emergency Measures Organization

Telephone: (506) 453-2133

Toll free: (800) 561-4034

Fax: (506) 453-5513

Québec

Direction générale de la sécurité civile et de la
sécurité incendie

Telephone: (418) 646-7950

Fax: (418) 646-5427

Toll Free Emergency Number: 1 866 776-8345

Emergency Number: (418) 643-3256

Or one of the Direction générale de la sécurité civile
regional offices:

Bas-Saint-Laurent–Gaspésie–

Îles-de-la-Madeleine: (418) 727-3589

Saguenay–Lac-St-Jean–Côte-Nord: (418) 695-7872

Capitale Nationale–Chaudière–

Appalaches–Nunavik: (418) 643-3244

Mauricie–Centre-du-Québec: (819) 371-6703

Montréal–Laval–Laurentides–

Lanaudière: (514) 873-1300

Montérégie–Estrie: (514) 873-1324

Outaouais–Abitibi-Témiscamingue–

Nord-du-Québec: (819) 772-3737

Ontario

Emergency Measures Ontario

Telephone: (416) 314-8615

Fax: (416) 314-3758

Manitoba

Emergency Measures Organization

Telephone: (204) 945-4772

Fax: (204) 945-4620

Saskatchewan

Saskatchewan Emergency Planning

Telephone: (306) 787-9563

Fax: (306) 787-1694

Alberta

Disaster Services Branch

Telephone: (780) 422-9000

Toll free in Alberta, dial 310-0000-780-422-9000

Fax: (780) 422-1549

British Columbia

Provincial Emergency Program (PEP)

Telephone: (250) 952-4913

Fax: (250) 952-4888

Northwest Territories

Emergency Measures Organization

Telephone: (867) 920-6133

Fax: (867) 873-8193

Yukon

Emergency Measures Organization

Telephone : (867) 667-3594

Fax: (867) 393-6266

Nunavut

Nunavut Emergency Management

Telephone : (867) 979-5822

Fax: (867) 979-4211

OTHER PUBLICATIONS IN THE SELF-HELP ADVICE SERIES:


- Be Prepared Not Scared
- Floods – What to do before and after
- Prepared for the Woods
- Prepare to Survive a Major Earthquake
- Storm Surges
- Winter Power Failures
- Winter Driving –
You, your car and winter storms
- Preparing for the Unexpected

SAFE GUARD

SAFE GUARD is a national information program based on partnerships and aimed at increasing public awareness of emergency preparedness in Canada.

The SAFE GUARD program brings together government, private organizations and voluntary agencies that are part of the emergency preparedness, response, recovery and mitigation community.

The triangle depicted in the program logo is the international symbol of emergency preparedness. The jagged line evokes the maple leaf, Canada's internationally recognized symbol.

SAFE  GUARD is a program of the Office of Critical Infrastructure Protection and Emergency Preparedness.

APPENDIX 'E'

FLOOD-PRONE SITE ASSESSMENT