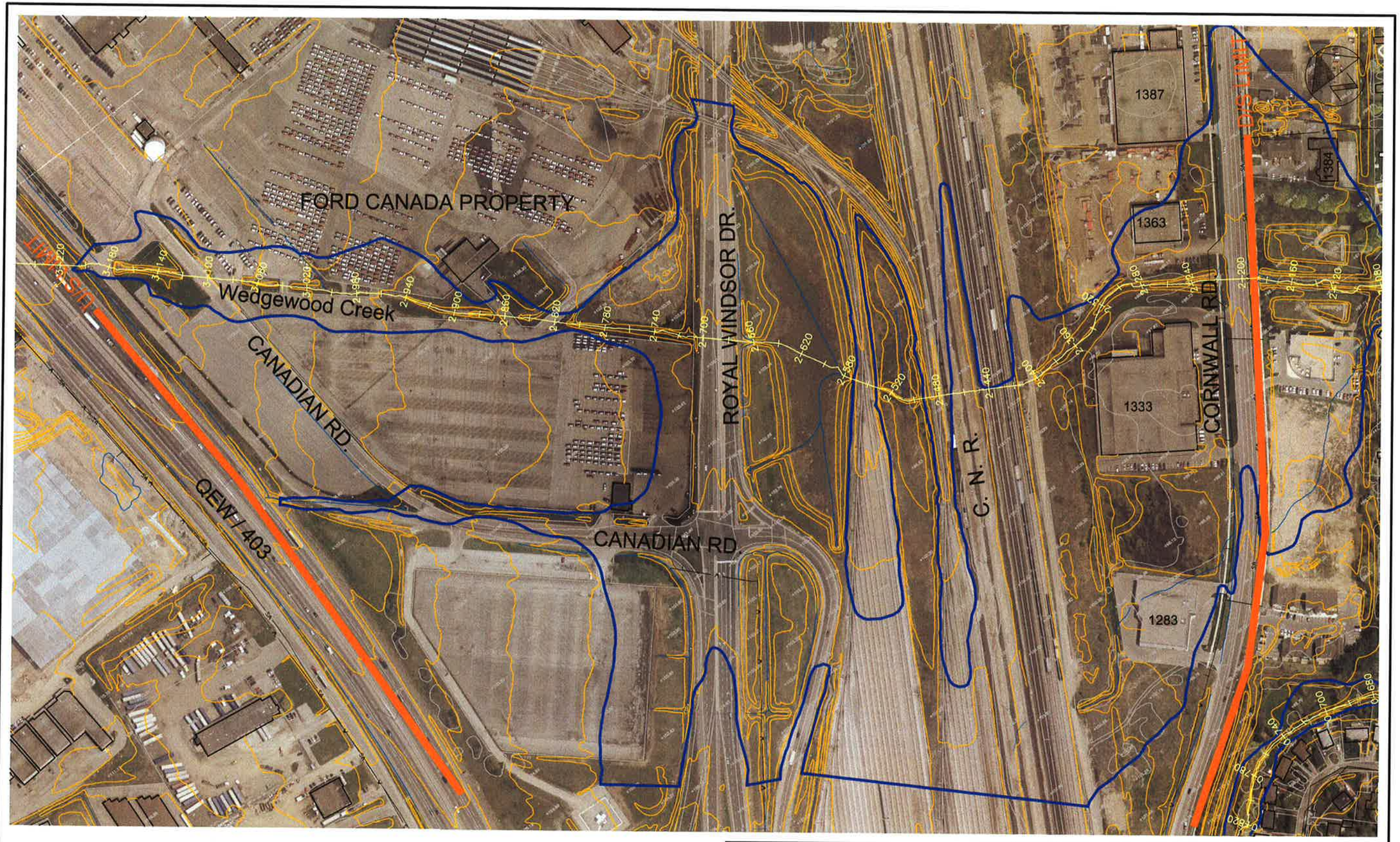
Appendix B

Information Tracking Sheet, Field Reconnaissance, and Terrestrial and Aquatic Background Review

SITE #22 – WEDG2190M



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LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 22 - WEDG2190M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:3,000
Figure No.	22

Feb 11/08 – avogt

Site #22 (WEDG2190M) Implementation Program
Recommended Management Approach/Project Scope: • Further assessment of CNR and Royal Windsor Crossings. Assessment would require updated topographic survey of crossings to update the existing HEC-2 modeling. Assessment would determine potential culvert upgrades and possible road profile improvements. Detail design would follow the assessment completion.
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations at Morrison Road (Site 23) • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of area • Vegetation assessment • Hydraulic modeling refinement • Approval process with CNR
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • CNR consent to proposed culvert upgrades
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #22 (WEDG2190M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Various CNR culverts creating high tail water conditions downstream of Royal Windsor Drive. • Royal Windsor Culvert size and channel inverts creating flooding conditions on roadway. Flooding conditions allow both private and emergency vehicle access as flow depths are always below 0.3m with low flow velocities. The roadway floods for all storms, 2 year through to the Regional Storm. Minimum flooding depth is 0.10 m. The crossing does not meet the road classification flood requirements, but does prevent vehicle ingress/egress.
Screened Alternatives: • Crossing upgrades of CNR and Royal Windsor, or just Royal Windsor • Road profile improvement • Floodplain/channel upgrades • Regulate TBD
Preferred Management Approach: • The preferred approach would require further assessment of the CNR and Royal Windsor crossings, as the original HEC-2 floodplain model appears to have coding issues and elevations used in the modeling require checking. There is approximately just under a 2 m drop through the Royal Windsor crossing. Therefore, further hydraulic assessment and topographic survey data would be required.
Potential Linkage to Adjacent Sites: • Linkage to Site 26

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
22	20.0	0.0	0.0	0.0	0.0	0.0	9.0	16.0	8.0	**53.0**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
22	Design Flood Criteria	Arterial	10	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	2-yr - Arterial	1.0	2	20
22	Private Vehicle	EMS Route	10	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.0	5	0.0
22	Emergency Vehicle	EMS Route	10	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
22	Private Vehicle Acess to Facilities	Yes	10	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	2-yr - Arterial	0.0	3	0
22	Emergency Vehicle Access to Facilities	Yes	10	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.0	7	0
22	Private Vehicle Driveway Access (Multiuser)	Med-High Usage	8	102.40	102.6	102.6	102.6	102.7	102.7	102.7	102.6	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5	0.5	0.6	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	2-yr	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
22	105.12	105.14	105.17	105.25	105.29	105.34	105.16	0	0	0	0	0	0	0

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
22	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (9 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
22	3	125	90	40	0.0	0.3	0.0	0.0	0.0	0.0	0.0	50	20	10	4	2	1	0.4	5	1	9	9

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endagerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)/m^2	First Floor Flooding (Yes/ No)	Floor Area (m^2)	Damage Costs ($)
Ford Canada Out E	105.6	105.6	105.16	105.63	30	16	105.41	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.34	105.75	30	16	105.56	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.29	105.72	30	16	105.52	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.25	105.68	30	16	105.48	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.17	105.63	30	16	105.42	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.14	105.59	30	16	105.38	-100.00	$0.00	0	0	0
Ford Canada Out E	105.6	105.6	105.12	105.52	30	16	105.33	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.06	107.04	55	24	106.49	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.2	107.12	55	24	106.60	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.16	107.1	55	24	106.57	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.12	107.08	55	24	106.54	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.07	107.05	55	24	106.50	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	106.03	107.02	55	24	106.46	-100.00	$0.00	0	0	0
Ford Canada Plant	109	109.0	105.98	106.99	55	24	106.42	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1283 Cornwall Rd	99.28	99.3	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1333 Cornwall Rd	98.82	98.8	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.66	98.66	20	10	98.66	0.06	$3.18	1	900	2865
1363Cornwall Rd	98.6	98.6	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1363Cornwall Rd	98.6	98.6	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1387 Cornwall Rd	98.89	98.9	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
									Reg	0	0	area (ha)
									100	1	900	0
									50	0	0	0.09
									25	0	0	0
									10	0	0	0
									5	0	0	0
									2	0	0	0
											900	0.09

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$2,864.81
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerment

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
22	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$29	$523	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	0	$0	0	0	0	0	0	0	$0					
	25	93.64	0	0	0	$0	0	0	0	0	0	0	$0					
	50	93.69	0	0	0	$0	0	0	0	0	0	0	$0					
	100	93.74	0	0	0	$0	0.09	$2,865	0	0	0	0	$2,865					
	Reg	93.61	0	0	0	$0	0	0	0	0	0	0	$0					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$4	$78	2	4	8
$0					
$0					
$0					
$0					
$430					
$0					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

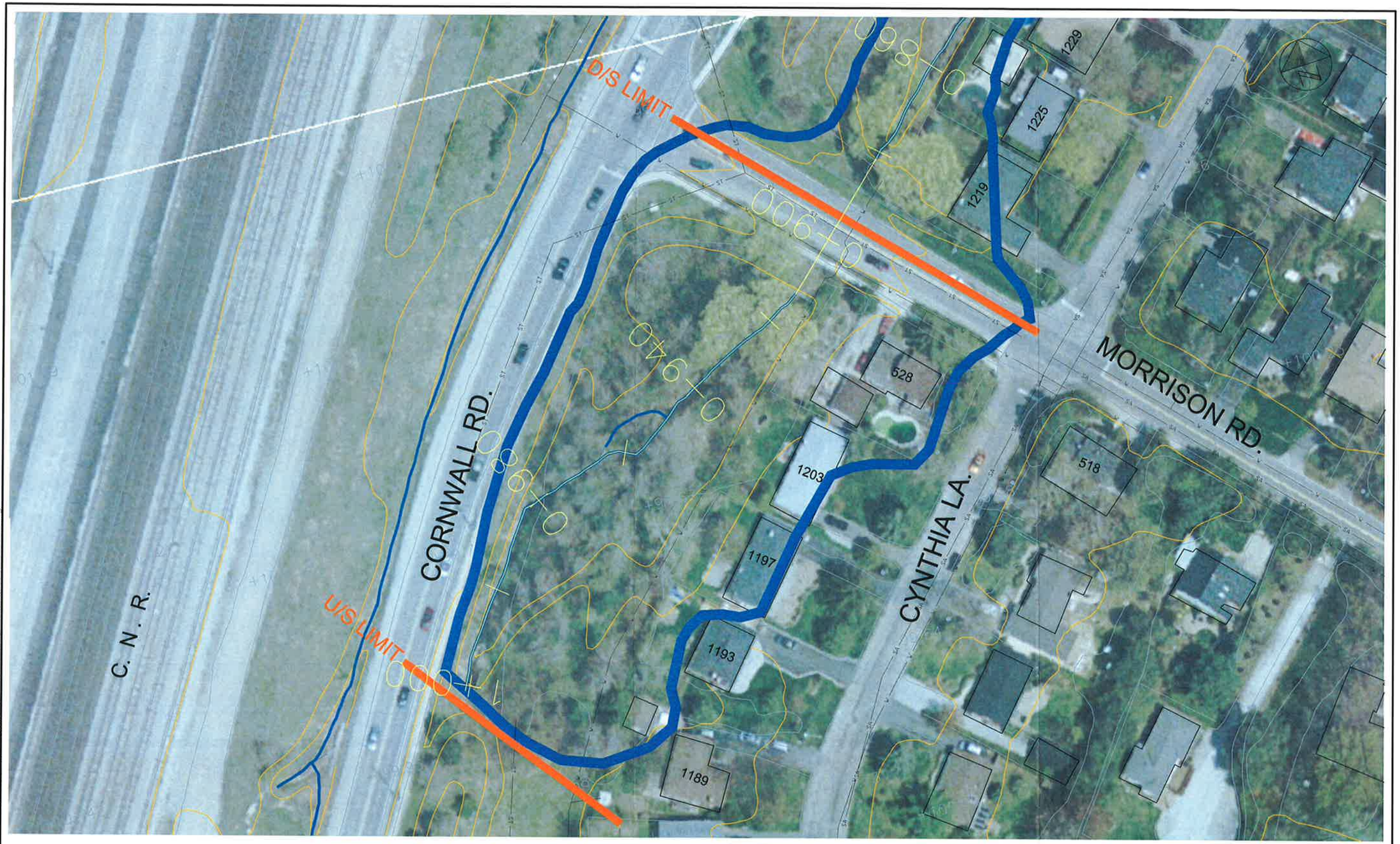
Building No.	Finished Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)/m²	First Floor Flooding (Yes/ No)	Floor Area (m²)	Damage Costs ($)
Ford Canal	105.6	105.6	105.16	105.63	30	16	105.41	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.34	105.75	30	16	105.56	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.29	105.72	30	16	105.52	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.25	105.68	30	16	105.48	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.17	105.63	30	16	105.42	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.14	105.59	30	16	105.38	-100.00	$0.00	0	0	0
Ford Canal	105.6	105.6	105.12	105.52	30	16	105.33	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.66	107.04	55	24	106.49	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.3	107.12	55	24	106.60	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.16	107.1	55	24	106.57	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.12	107.08	55	24	106.54	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.07	107.05	55	24	106.50	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	106.03	107.02	55	24	106.46	-100.00	$0.00	0	0	0
Ford Canal	109	109.0	105.98	106.99	55	24	106.42	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1283 Corn	99.28	99.3	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1333 Corn	98.82	98.8	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.66	98.66	20	10	98.66	0.06	$3.18	1	900	2865
1363Corn	98.6	98.6	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1363Corn	98.6	98.6	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.66	98.66	20	10	98.66	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.57	98.57	20	10	98.57	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.47	98.47	20	10	98.47	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.34	98.34	20	10	98.34	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.2	98.2	20	10	98.20	-100.00	$0.00	0	0	0
1387 Corn	98.89	98.9	98.12	98.12	20	10	98.12	-100.00	$0.00	0	0	0
									Reg	0	0	$0
									100	1	900	$2,865
									50	0	0	$0
									25	0	0	$0
									10	0	0	$0
									5	0	0	$0
									2	0	0	$0
											900	$2,865

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$2,864.81
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

	area (ha)
	0
	0.09
	0
	0
	0
	0
	0.09

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #23 – WEDG0895T



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 23 - WEDG0895T
WEDEGWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:750
Figure No.	23

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Feb 11/08 – avogt

Site #23 (WEDG0895T) Implementation Program
Recommended Management Approach/Project Scope: • Morrison Road culvert upgrade from 1.88 m by 1.26 m CSP arch culvert to 6 m by 1.2 m box culvert
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of culvert and upstream and downstream creek • Vegetation assessment • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program. • Project should be conducted in conjunction with Site 23 works if possible
Possible Implementation Issues: • Private land owners consent to proposed grading (watercourse not owned by Town of Oakville) • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation • Wetland area upstream of Morrison Road
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund (Morrison Road culvert works for Site 23) • Others

Site #23 (WEDG0895T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Morrison Road 1.88 m by 1.26 m CSP arch culvert crossing • Floodplain capacity of approximately the 2 year storm 3.0 m^3/s in vicinity of 1197 Cynthia La. • Encroachment
Screened Alternatives: • Morrison Road culvert upgrade using 6m by 1.2 m box culvert • Floodplain/ channel improvements not practical due to marsh area and limited hydraulic improvements • Roadway profile could not be improved much based on existing grades • Flood proofing homes that are not flooded on all sides. There are homes flooded on all sides; therefore flood proofing would not protect all homes. • Acquisition of 3 homes would be expensive • Regulate
Preferred Management Approach: • Upgrade Morrison Road culvert
Potential Linkage to Adjacent Sites: • Linkage to Site 24, spill across Morrison Road eliminated with upgraded culvert. 1219 Baldwin Dr. would be removed from the Regional floodplain.

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
23	8.0	0.0	0.0	0.0	0.0	0.0	50.0	48.0	24.0	**130.0**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
			(4,6,8,10)	(m)	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	(2-100, Reg)	(0.4-50)	(1-10)	
23	Design Flood Criteria	Arterial	10	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	5-yr / 1:100 - Reg	0.4	2	8
23	Private Vehicle	Level 3 Road/ 100-Regional	6	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	5	0
23	Emergency Vehicle	Level 3 Road/ 100-Regional	6	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
23	Private Vehicle Acess to Facilities	Partial	5	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
23	Emergency Vehicle Access to Facilities	Partial	5	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
23	Private Vehicle Driveway Access (Multiuser)	Medium Vehicle Usage	6	98.74	98.9	99.0	99.0	99.1	99.1	99.1	99.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.0	0.5	0.6	0.6	0.7	0.7	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
23	98.86	98.95	99	99.05	99.09	99.12	99.08	3	3	3	3	3	3	3

Site No	Industrial Area (ha)							Commercial Area (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
23	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
23	9	9	9	9	9	9	9	50	20	10	4	2	1	0.4	786.6	5	10	50

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endagerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endagered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endagered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
528 Morrison	99.2	96.8	98.6	99.08	99.08	10	9	99.08	0.49	$20,740.54	1	0
528 Morrison	99.2	96.8	98.6	99.12	99.12	10	9	99.12	0.53	$21,363.37	1	0
528 Morrison	99.2	96.8	98.6	99.09	99.09	10	9	99.09	0.50	$20,894.52	1	0
528 Morrison	99.2	96.8	98.6	99.05	99.05	10	9	99.05	0.46	$20,285.35	1	0
528 Morrison	99.2	96.8	98.6	99	99	10	9	99.00	0.41	$19,548.80	1	0
528 Morrison	99.2	96.8	98.6	98.95	98.95	10	9	98.95	0.36	$18,839.00	1	0
528 Morrison	99.2	96.8	98.6	98.86	98.86	10	9	98.86	0.27	$17,625.66	1	0
1197 Cynthia	99.15	96.7	98.5	99.08	99.09	40	29	99.09	0.55	$21,637.71	1	0
1197 Cynthia	99.15	96.7	98.5	99.12	99.13	40	29	99.13	0.59	$22,287.50	1	0
1197 Cynthia	99.15	96.7	98.5	99.09	99.09	40	29	99.09	0.55	$21,681.77	1	0
1197 Cynthia	99.15	96.7	98.5	99.05	99.06	40	29	99.06	0.52	$21,162.84	1	0
1197 Cynthia	99.15	96.7	98.5	99	99	40	29	99.00	0.46	$20,285.35	1	0
1197 Cynthia	99.15	96.7	98.5	98.95	98.95	40	29	98.95	0.41	$19,548.80	1	0
1197 Cynthia	99.15	96.7	98.5	98.86	98.87	40	29	98.87	0.33	$18,388.10	1	0
1203 Cynthia	99.15	96.7	98.5	99.09	99.09	50	9	99.09	0.55	$21,681.77	1	0
1203 Cynthia	99.15	96.7	98.5	99.13	99.13	50	9	99.13	0.59	$22,332.88	1	0
1203 Cynthia	99.15	96.7	98.5	99.09	99.09	50	9	99.09	0.55	$21,681.77	1	0
1203 Cynthia	99.15	96.7	98.5	99.06	99.06	50	9	99.06	0.52	$21,205.93	1	0
1203 Cynthia	99.15	96.7	98.5	99	99	50	9	99.00	0.46	$20,285.35	1	0
1203 Cynthia	99.15	96.7	98.5	98.95	98.95	50	9	98.95	0.41	$19,548.80	1	0
1203 Cynthia	99.15	96.7	98.5	98.87	98.87	50	9	98.87	0.33	$18,425.54	1	0
										Reg	3	0
											3	0
											3	0
											3	0
											3	0
											3	0
											3	0

Frequency	Summarized Damage Costs ($)
Reg	$64,060.02
100	$65,983.75
50	$64,258.07
25	$62,654.12
10	$60,119.50
5	$57,936.60
2	$54,439.31

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangermer

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
23	2	92.69	3	3	3	$80,570	0	0	0	0	0	0	$80,570	$42,986	$784,749	6	8	48
	5	93.00	3	3	3	$85,746	0	0	0	0	0	0	$85,746					
	10	93.51	3	3	3	$88,977	0	0	0	0	0	0	$88,977					
	25	93.64	3	3	3	$92,728	0	0	0	0	0	0	$92,728					
	50	93.69	3	3	3	$95,102	0	0	0	0	0	0	$95,102					
	100	93.74	3	3	3	$97,656	0	0	0	0	0	0	$97,656					
	Reg	93.61	3	3	3	$94,809	0	0	0	0	0	0	$94,809					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$12,086	$6,448	$117,712	6	4	24
$12,862					
$13,347					
$13,909					
$14,265					
$14,648					
$14,221					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream Reg Elevations	2-100/ Flood (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Elevations	Flood (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
528 Morris	98.67	96.2	98.1	99.08		99.08	10	9	99.08		1.02	$30,695.96	1	1
528 Morris	98.67	96.2	98.1	99.12		99.12	10	9	99.12		1.06	$31,617.76	1	1
528 Morris	98.67	96.2	98.1	99.09		99.09	10	9	99.09		1.03	$30,923.86	1	1
528 Morris	98.67	96.2	98.1	99.05		99.05	10	9	99.05		0.99	$30,022.29	1	1
528 Morris	98.67	96.2	98.1	99		99	10	9	99.00		0.94	$28,932.20	1	1
528 Morris	98.67	96.2	98.1	98.95		98.95	10	9	98.95		0.89	$27,881.68	1	1
528 Morris	98.67	96.2	98.1	98.86		98.86	10	9	98.86		0.80	$26,085.95	1	1
1197 Cynth	98.62	96.2	98.0	99.08		99.09	40	29	99.09		1.08	$32,023.78	1	1
1197 Cynth	98.62	96.2	98.0	99.12		99.13	40	29	99.13		1.12	$32,985.46	1	1
1197 Cynth	98.62	96.2	98.0	99.09		99.09	40	29	99.09		1.08	$32,088.99	1	1
1197 Cynth	98.62	96.2	98.0	99.05		99.06	40	29	99.06		1.05	$31,320.97	1	1
1197 Cynth	98.62	96.2	98.0	99		99	40	29	99.00		0.99	$30,022.29	1	1
1197 Cynth	98.62	96.2	98.0	98.95		98.95	40	29	98.95		0.94	$28,932.20	1	1
1197 Cynth	98.62	96.2	98.0	98.86		98.87	40	29	98.87		0.86	$27,214.36	1	1
1203 Cynth	98.62	96.2	98.0	99.09		99.09	50	9	99.09		1.08	$32,088.99	1	1
1203 Cynth	98.62	96.2	98.0	99.13		99.13	50	9	99.13		1.12	$33,052.63	1	1
1203 Cynth	98.62	96.2	98.0	99.09		99.09	50	9	99.09		1.08	$32,088.99	1	1
1203 Cynth	98.62	96.2	98.0	99.06		99.06	50	9	99.06		1.05	$31,384.75	1	1
1203 Cynth	98.62	96.2	98.0	99		99	50	9	99.00		0.99	$30,022.29	1	1
1203 Cynth	98.62	96.2	98.0	98.95		98.95	50	9	98.95		0.94	$28,932.20	1	1
1203 Cynth	98.62	96.2	98.0	98.87		98.87	50	9	98.87		0.86	$27,269.78	1	1
												Reg	3	3
													3	3
													3	3
													3	3
													3	3
													3	3

Frequency	Summarized Damage Costs ($)
Reg	$94,808.73
100	$97,655.84
50	$95,101.84
25	$92,728.00
10	$88,976.77
5	$85,746.07
2	$80,570.09

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #24 – WEDG0622T

U/S LIMIT

MORRISON RD.

CORNWALL RD.

Wedgewood Creek Tributary N.

BALDWIN DR.

0+940

0+980

0+820

0+740

0+700

0+680

0+660

D/S LIMIT

528

1219

1225

1229

1235

1239

1245

1249

1253

1257

1261

1263

1277

1281

N

LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 24 - WEDG0622T
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	24

Feb 11/08 – avogt

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Site #24 (WEDG0622T) Implementation Program
Recommended Management Approach/Project Scope: • Floodplain grading improvements • Morrison Road culvert upgrades (Site 23)
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Land owners approval for grading • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations at Morrison Road (Site 23) • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of area • Vegetation assessment • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program. • Project should be conducted in conjunction with Site 23 works if possible
Possible Implementation Issues: • Private land owners consent to proposed grading • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation • Wetland area upstream of Morrison Road
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund (Morrison Road culvert works for Site 23) • Others

Site #24 (WEDG0622T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Floodplain capacity is approximately 2year at 5.2 m^3/s in vicinity of 1239 Baldwin Dr. • Spill from Morrison Road flooding (Site 23) • Encroachment
Screened Alternatives: • Floodplain grading improvements are possible in vicinity of 1253 to 1239 Baldwin Dr. • Morrison Road culvert upgrades (Site 23) • Floodproofing of 1219 Baldwin Dr. This would not resolve the property flooding occurring on neighbouring lots. • Regulate
Preferred Management Approach: • Floodplain grading improvements • Morrison Road culvert upgrades (Site 23)
Potential Linkage to Adjacent Sites: • Linkage to Site 23

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	**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**	**Combined Products**
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	8.0	**24**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
24	Design Flood Criteria	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	2	0
24	Private Vehicle	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	5	0
24	Emergency Vehicle	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	6	0
24	Private Vehicle Acess to Facilities	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	3	0
24	Emergency Vehicle Access to Facilities	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	7	0
24	Private Vehicle Driveway Access (Multiuser)	N ot Applicable	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
24	96.38	96.52	96.63	96.75	96.84	96.95	96.83	0	0	0	0	0	0	0

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
24	0	0	0	0	0	0	0	50	20	10	4	2	1	0.4	0	0	10	0

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1245 Baldwin	98.1	95.7	97.5	96.83	97.25	40	31	97.16	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.95	97.33	40	31	97.24	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.84	97.26	40	31	97.17	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.75	97.17	40	31	97.08	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.63	97.05	40	31	96.96	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.52	96.95	40	31	96.85	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.38	96.82	40	31	96.72	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.83	97.25	40	38	97.23	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.95	97.33	40	38	97.31	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.84	97.26	40	38	97.24	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.75	97.17	40	38	97.15	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.63	97.05	40	38	97.03	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.52	96.95	40	38	96.93	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.38	96.82	40	38	96.80	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
										Reg	0	0
											0	0
											0	0
											0	0
											0	0
											0	0
											0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$0.00
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerment

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1245 Baldwin	98.1	95.7	97.5	96.83	97.25	40	31	97.16	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.95	97.33	40	31	97.24	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.84	97.26	40	31	97.17	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.75	97.17	40	31	97.08	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.63	97.05	40	31	96.96	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.52	96.95	40	31	96.85	-100.00	$0.00	0	0
1245 Baldwin	98.1	95.7	97.5	96.38	96.82	40	31	96.72	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.83	97.25	40	38	97.23	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.95	97.33	40	38	97.31	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.84	97.26	40	38	97.24	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.75	97.17	40	38	97.15	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.63	97.05	40	38	97.03	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.52	96.95	40	38	96.93	-100.00	$0.00	0	0
1239 Baldwin	98.15	95.7	97.5	96.38	96.82	40	38	96.80	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldwin	99.1	96.7	98.5	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
										Reg	0	0
											0	0
											0	0
											0	0
											0	0
											0	0
											0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$0.00
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerment

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
24	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$2,257	$41,209	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	0	$0	0	0	0	0	0	0	$0					
	25	93.64	2	2	0	$31,024	0	0	0	0	0	0	$31,024					
	50	93.69	2	2	0	$33,160	0	0	0	0	0	0	$33,160					
	100	93.74	2	2	0	$35,063	0	0	0	0	0	0	$35,063					
	Reg	93.61	2	2	0	$32,915	0	0	0	0	0	0	$32,915					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$339	$6,181	2	4	8
$0					
$0					
$4,654					
$4,974					
$5,260					
$4,937					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages)
related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5%
for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1245 Baldv	97.6	95.2	97.0	96.83	97.25	40	31	97.16	0.17	$16,314.55	1	0
1245 Baldv	97.6	95.2	97.0	96.95	97.33	40	31	97.24	0.25	$17,424.73	1	0
1245 Baldv	97.6	95.2	97.0	96.84	97.26	40	31	97.17	0.18	$16,435.68	1	0
1245 Baldv	97.6	95.2	97.0	96.75	97.17	40	31	97.08	0.09	$15,377.13	1	0
1245 Baldv	97.6	95.2	97.0	96.63	97.05	40	31	96.96	-100.00	$0.00	0	0
1245 Baldv	97.6	95.2	97.0	96.52	96.95	40	31	96.85	-100.00	$0.00	0	0
1245 Baldv	97.6	95.2	97.0	96.38	96.82	40	31	96.72	-100.00	$0.00	0	0
1239 Baldv	97.65	95.2	97.0	96.83	97.25	40	38	97.23	0.19	$16,600.62	1	0
1239 Baldv	97.65	95.2	97.0	96.95	97.33	40	38	97.31	0.27	$17,638.71	1	0
1239 Baldv	97.65	95.2	97.0	96.84	97.26	40	38	97.24	0.20	$16,723.87	1	0
1239 Baldv	97.65	95.2	97.0	96.75	97.17	40	38	97.15	0.11	$15,646.77	1	0
1239 Baldv	97.65	95.2	97.0	96.63	97.05	40	38	97.03	-100.00	$0.00	0	0
1239 Baldv	97.65	95.2	97.0	96.52	96.95	40	38	96.93	-100.00	$0.00	0	0
1239 Baldv	97.65	95.2	97.0	96.38	96.82	40	38	96.80	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.68	97.68	1	1	97.68	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.69	97.69	1	1	97.69	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
1219 Baldv	98.6	96.2	98.0	97.7	97.7	1	1	97.70	-100.00	$0.00	0	0
										Reg	2	0
											2	0
											2	0
											2	0
											0	0
											0	0
											0	0

Frequency	Summarized Damage Costs ($)
Reg	$32,915.17
100	$35,063.44
50	$33,159.55
25	$31,023.90
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #25 – WEDG0145T

LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 25 - WEDG0145T
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1000
Figure No.	25

Feb 11/08 – avogt

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Site #25 (WEDG0145T) Implementation Program
Recommended Management Approach/Project Scope: • Flood proof homes on Drummond Road: 410, 420, 426, 432, 438, 444, 448 to a height of 0.33m • Drummond Road culvert upgrade from existing 1. m by 1.2 m box culvert to 6 m by 1.8 m box culvert
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations at Morrison Road (Site 23) • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of creek, crossing and homes requiring flood proofing • Vegetation assessment • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners for flood proofing
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed flood proofing • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintencance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #25 (WEDG0145T) Specific Flood Management Alternative Assessment

Data/ Information:

Flooding mechanisms:

- Drummond Road culvert crossing 1.2m by 1.2 m box with 1m +/- Regional storm backwater affect.
- Flood plain capacity of less than the 2 year storm 5.20 m^3/s
- Encroachment

Screened Alternatives:

- Culvert upgrade to 6m by 1.8 m concrete box.
- Road Profile improvements would be limited due to site constraints and existing road elevation
- Floodplain/ channel improvements not practical based on extent of flooding
- Flood proofing homes not flooded on all sides
- Acquisition of 8 homes would be prohibitive
- Regulate

Preferred Management Approach:

- Upgrade culvert crossing on Drummond Road
- Flood proof homes on Drummond Road –Nos. 410,420, 426, 432, 438, 444, and 448 to an height of 0.33m. Topographic survey required to verify building elevations and flood proofing required.
- Regulate

Potential Linkage to Adjacent Sites:

- Site 27, spill across Drummond Road eliminated due to culvert upgrade

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	**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**	**Combined Products**
25	0.6	0.0	0.0	0.0	0.0	0.0	60.0	80.0	40.0	**180.6**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
			(4,6,8,10)	(m)	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	(2-100, Reg)	(0.4-50)	(1-10)	
25	Design Flood Criteria	Collector	8	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	Collector / 1:50-yr	0.04	2	0.64
25	Private Vehicle	Level 4 Road/ 100-Regional	4	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0	5	0
25	Emergency Vehicle	Level 4 Road/ 100-Regional	4	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
25	Private Vehicle Acess to Facilities	No	0	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
25	Emergency Vehicle Access to Facilities	No	0	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
25	Private Vehicle Driveway Access (Multiuser)	NA	0	93.50	93.6	93.7	93.7	93.8	93.8	93.8	93.8	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
25	90.27	90.36	90.44	90.63	90.77	90.91	90.86	4	7	7	7	7	7	7

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
25	12	21	21	21	21	21	21	50	20	10	4	2	1	0.4	1385.4	6	10	60

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
448 Drummon	94.2	91.8	93.6	93.81	94.24	40	4	93.85	0.26	$17,534.64	1	0
448 Drummon	94.2	91.8	93.6	93.86	94.31	40	4	93.91	0.31	$18,222.23	1	0
448 Drummon	94.2	91.8	93.6	93.81	94.25	40	4	93.85	0.26	$17,547.61	1	0
448 Drummon	94.2	91.8	93.6	93.74	94.21	40	4	93.79	0.20	$16,699.15	1	0
448 Drummon	94.2	91.8	93.6	93.67	94.11	40	4	93.71	0.12	$15,821.34	1	0
448 Drummon	94.2	91.8	93.6	93.62	94.04	40	4	93.66	0.07	$15,224.34	1	0
448 Drummon	94.2	91.8	93.6	93.54	93.95	40	4	93.58	-100.00	$0.00	0	0
444 Drummon	94.2	91.8	93.6	93.79	93.81	40	31	93.81	0.22	$16,929.24	1	0
444 Drummon	94.2	91.8	93.6	93.82	93.86	40	31	93.85	0.26	$17,508.71	1	0
444 Drummon	94.2	91.8	93.6	93.79	93.81	40	31	93.81	0.22	$16,929.24	1	0
444 Drummon	94.2	91.8	93.6	93.77	93.74	40	31	93.75	0.16	$16,209.30	1	0
444 Drummon	94.2	91.8	93.6	93.73	93.67	40	31	93.68	0.09	$15,468.40	1	0
444 Drummon	94.2	91.8	93.6	93.69	93.62	40	31	93.64	0.05	$14,931.58	1	0
444 Drummon	94.2	91.8	93.6	93.64	93.54	40	31	93.56	-100.00	$0.00	0	0
438 Drummon	94.2	91.8	93.6	93.81	93.81	1	1	93.81	0.22	$16,985.69	1	0
438 Drummon	94.2	91.8	93.6	93.86	93.86	1	1	93.86	0.27	$17,625.66	1	0
438 Drummon	94.2	91.8	93.6	93.81	93.81	1	1	93.81	0.22	$16,985.69	1	0
438 Drummon	94.2	91.8	93.6	93.74	93.74	1	1	93.74	0.15	$16,128.57	1	0
438 Drummon	94.2	91.8	93.6	93.67	93.67	1	1	93.67	0.08	$15,314.70	1	0
438 Drummon	94.2	91.8	93.6	93.62	93.62	1	1	93.62	0.03	$14,758.63	1	0
438 Drummon	94.2	91.8	93.6	93.54	93.54	1	1	93.54	-100.00	$0.00	0	0
432 Drummon	93.1	90.7	92.5	93.79	93.79	29	9	93.79	1.30	$37,759.87	1	1
432 Drummon	93.1	90.7	92.5	93.82	93.82	29	9	93.82	1.33	$38,607.17	1	1
432 Drummon	93.1	90.7	92.5	93.8	93.79	29	9	93.80	1.31	$37,952.99	1	1
432 Drummon	93.1	90.7	92.5	93.77	93.77	29	9	93.77	1.28	$37,205.37	1	1
432 Drummon	93.1	90.7	92.5	93.73	93.73	29	9	93.73	1.24	$36,120.66	1	1
432 Drummon	93.1	90.7	92.5	93.69	93.69	29	9	93.69	1.20	$35,067.58	1	1
432 Drummon	93.1	90.7	92.5	93.64	93.64	29	9	93.64	1.15	$33,794.29	1	1
426 Drummon	93.6	91.2	93.0	93.79	93.79	31	20	93.79	0.80	$26,085.95	1	1
426 Drummon	93.6	91.2	93.0	93.82	93.82	31	20	93.82	0.83	$26,671.30	1	1
426 Drummon	93.6	91.2	93.0	93.8	93.8	31	20	93.80	0.81	$26,279.63	1	1
426 Drummon	93.6	91.2	93.0	93.77	93.77	31	20	93.77	0.78	$25,702.88	1	1
426 Drummon	93.6	91.2	93.0	93.73	93.73	31	20	93.73	0.74	$24,953.52	1	1
426 Drummon	93.6	91.2	93.0	93.69	93.69	31	20	93.69	0.70	$24,226.01	1	1
426 Drummon	93.6	91.2	93.0	93.64	93.64	31	20	93.64	0.65	$23,346.38	1	1
420 Drummon	93.2	90.8	92.6	93.79	93.79	1	1	93.79	1.20	$35,067.58	1	1
420 Drummon	93.2	90.8	92.6	93.82	93.82	1	1	93.82	1.23	$35,854.46	1	1
420 Drummon	93.2	90.8	92.6	93.8	93.8	1	1	93.80	1.21	$35,327.93	1	1
420 Drummon	93.2	90.8	92.6	93.77	93.77	1	1	93.77	1.18	$34,552.61	1	1
420 Drummon	93.2	90.8	92.6	93.73	93.73	1	1	93.73	1.14	$33,545.24	1	1
420 Drummon	93.2	90.8	92.6	93.69	93.69	1	1	93.69	1.10	$32,567.24	1	1
420 Drummon	93.2	90.8	92.6	93.64	93.64	1	1	93.64	1.05	$31,384.75	1	1
410 Drummon	93.1	90.7	92.5	93.79	93.79	30	7	93.79	1.30	$37,759.87	1	1
410 Drummon	93.1	90.7	92.5	93.82	93.82	30	7	93.82	1.33	$38,607.17	1	1
410 Drummon	93.1	90.7	92.5	93.79	93.8	30	7	93.79	1.30	$37,825.10	1	1
410 Drummon	93.1	90.7	92.5	93.77	93.77	30	7	93.77	1.28	$37,205.37	1	1
410 Drummon	93.1	90.7	92.5	93.73	93.73	30	7	93.73	1.24	$36,120.66	1	1
410 Drummon	93.1	90.7	92.5	93.69	93.69	30	7	93.69	1.20	$35,067.58	1	1
410 Drummon	93.1	90.7	92.5	93.64	93.64	30	7	93.64	1.15	$33,794.29	1	1
1300 Amber C	93.2	90.8	92.6	92.43	92.43	1	1	92.43	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.47	92.47	1	1	92.47	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.43	92.43	1	1	92.43	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.47	92.47	1	1	92.47	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1300 Amber C	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.86	91.46	30	22	91.30	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.91	91.53	30	22	91.36	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.77	91.46	30	22	91.28	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.63	91.4	30	22	91.19	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.44	91.16	30	22	90.97	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.36	91.04	30	22	90.86	-100.00	$0.00	0	0
1306 Amber C	93.3	90.9	92.7	90.27	90.91	30	22	90.74	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.79	93.79	1	1	93.79	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.82	93.82	1	1	93.82	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.8	93.8	1	1	93.80	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.77	93.77	1	1	93.77	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.73	93.73	1	1	93.73	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.69	93.69	1	1	93.69	-100.00	$0.00	0	0
1286 Cumnoc	95	92.6	94.4	93.64	93.64	1	1	93.64	-100.00	$0.00	0	0
										Reg	7	4
										100	7	4
										50	7	4
										25	7	4
										10	7	4
										5	7	4
										2	4	4

Frequency	Summarized Damage Costs ($)
Reg	**$188,122.84**
100	$193,096.71
50	$188,848.19
25	$183,703.23
10	$177,344.52
5	$171,842.96
2	$122,319.72

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangermer

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
25	2	92.69	4	4	4	$122,320	0	0	0	0	0	0	$122,320	$80,044	$1,461,281	10	8	80
	5	93.00	7	7	4	$171,843	0	0	0	0	0	0	$171,843					
	10	93.51	7	7	4	$177,345	0	0	0	0	0	0	$177,345					
	25	93.64	7	7	4	$183,703	0	0	0	0	0	0	$183,703					
	50	93.69	7	7	4	$188,848	0	0	0	0	0	0	$188,848					
	100	93.74	7	7	4	$193,097	0	0	0	0	0	0	$193,097					
	Reg	93.61	7	7	4	$188,123	0	0	0	0	0	0	$188,123					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$18,348	$12,007	$219,192	10	4	40
$25,776					
$26,602					
$27,555					
$28,327					
$28,965					
$28,218					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream Reg Elevations	2-100/ Flood (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Elevations	Flood (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
448 Drumr	94.2	91.8	93.6	93.81		94.24	40	4	93.85		0.26	$17,534.64	1	0
448 Drumr	94.2	91.8	93.6	93.86		94.31	40	4	93.91		0.31	$18,222.23	1	0
448 Drumr	94.2	91.8	93.6	93.81		94.25	40	4	93.85		0.26	$17,547.61	1	0
448 Drumr	94.2	91.8	93.6	93.74		94.21	40	4	93.79		0.20	$16,699.15	1	0
448 Drumr	94.2	91.8	93.6	93.67		94.11	40	4	93.71		0.12	$15,821.34	1	0
448 Drumr	94.2	91.8	93.6	93.62		94.04	40	4	93.66		0.07	$15,224.34	1	0
448 Drumr	94.2	91.8	93.6	93.54		93.95	40	4	93.58		-100.00	$0.00	0	0
444 Drumr	94.2	91.8	93.6	93.79		93.81	40	31	93.81		0.22	$16,929.24	1	0
444 Drumr	94.2	91.8	93.6	93.82		93.86	40	31	93.85		0.26	$17,508.71	1	0
444 Drumr	94.2	91.8	93.6	93.79		93.81	40	31	93.81		0.22	$16,929.24	1	0
444 Drumr	94.2	91.8	93.6	93.77		93.74	40	31	93.75		0.16	$16,209.30	1	0
444 Drumr	94.2	91.8	93.6	93.73		93.67	40	31	93.68		0.09	$15,468.40	1	0
444 Drumr	94.2	91.8	93.6	93.69		93.62	40	31	93.64		0.05	$14,931.58	1	0
444 Drumr	94.2	91.8	93.6	93.64		93.54	40	31	93.56		-100.00	$0.00	0	0
438 Drumr	94.2	91.8	93.6	93.81		93.81	1	1	93.81		0.22	$16,985.69	1	0
438 Drumr	94.2	91.8	93.6	93.86		93.86	1	1	93.86		0.27	$17,625.66	1	0
438 Drumr	94.2	91.8	93.6	93.81		93.81	1	1	93.81		0.22	$16,985.69	1	0
438 Drumr	94.2	91.8	93.6	93.74		93.74	1	1	93.74		0.15	$16,128.57	1	0
438 Drumr	94.2	91.8	93.6	93.67		93.67	1	1	93.67		0.08	$15,314.70	1	0
438 Drumr	94.2	91.8	93.6	93.62		93.62	1	1	93.62		0.03	$14,758.63	1	0
438 Drumr	94.2	91.8	93.6	93.54		93.54	1	1	93.54		-100.00	$0.00	0	0
432 Drumr	93.1	90.7	92.5	93.79		93.79	29	9	93.79		1.30	$37,759.87	1	1
432 Drumr	93.1	90.7	92.5	93.82		93.82	29	9	93.82		1.33	$38,607.17	1	1
432 Drumr	93.1	90.7	92.5	93.8		93.79	29	9	93.80		1.31	$37,952.99	1	1
432 Drumr	93.1	90.7	92.5	93.77		93.77	29	9	93.77		1.28	$37,205.37	1	1
432 Drumr	93.1	90.7	92.5	93.73		93.73	29	9	93.73		1.24	$36,120.66	1	1
432 Drumr	93.1	90.7	92.5	93.69		93.69	29	9	93.69		1.20	$35,067.58	1	1
432 Drumr	93.1	90.7	92.5	93.64		93.64	29	9	93.64		1.15	$33,794.29	1	1
426 Drumr	93.6	91.2	93.0	93.79		93.79	31	20	93.79		0.80	$26,085.95	1	1
426 Drumr	93.6	91.2	93.0	93.82		93.82	31	20	93.82		0.83	$26,671.30	1	1
426 Drumr	93.6	91.2	93.0	93.8		93.8	31	20	93.80		0.81	$26,279.63	1	1
426 Drumr	93.6	91.2	93.0	93.77		93.77	31	20	93.77		0.78	$25,702.88	1	1
426 Drumr	93.6	91.2	93.0	93.73		93.73	31	20	93.73		0.74	$24,953.52	1	1

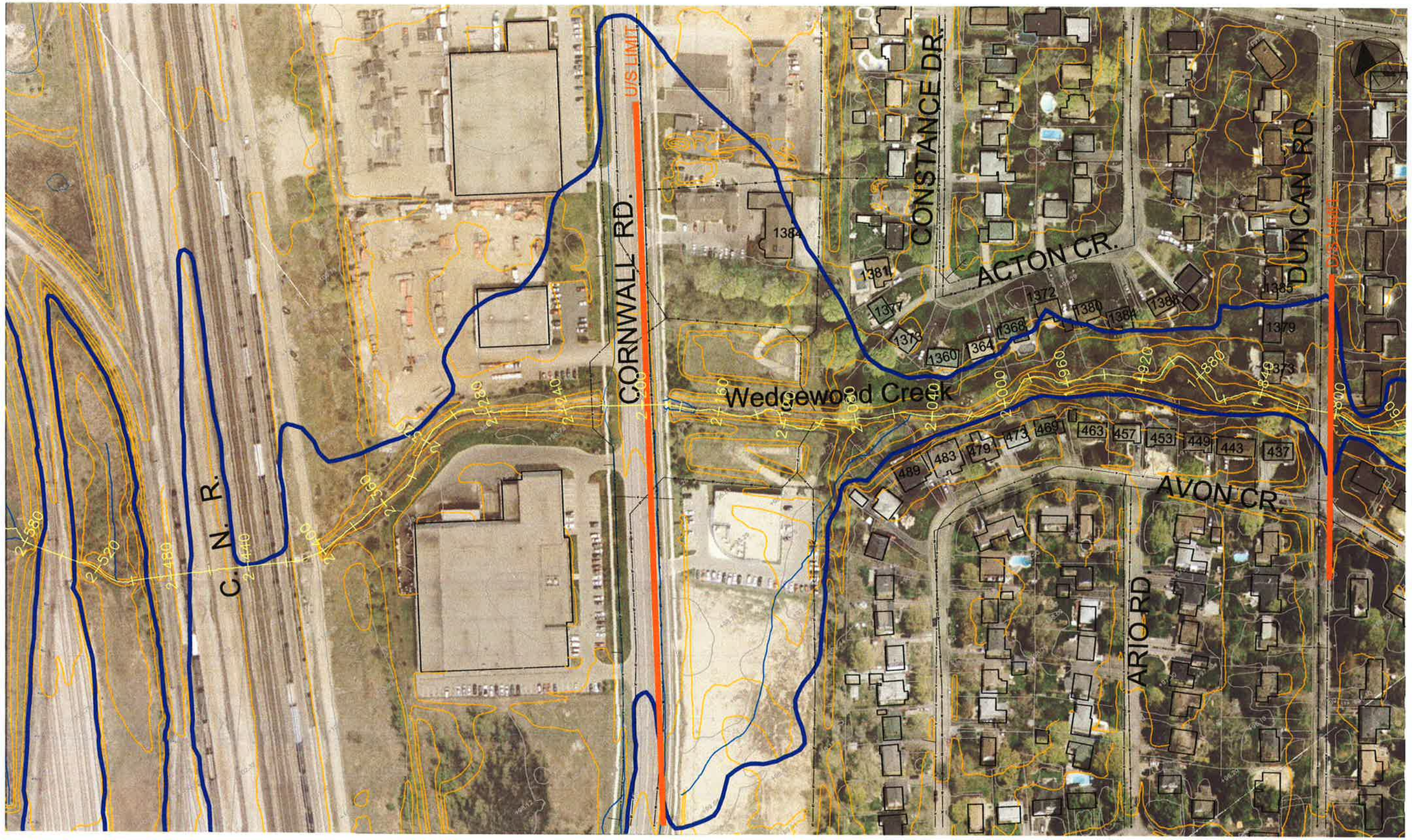
Frequency	Cost
Reg	$188,122.84
100	$193,096.71
50	$188,848.19
25	$183,703.23
10	$177,344.52
5	$171,842.96
2	$122,319.72

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
426 Drumr	93.6	91.2	93.0	93.69	93.69	31	20	93.69	0.70	$24,226.01	1	1
426 Drumr	93.6	91.2	93.0	93.64	93.64	31	20	93.64	0.65	$23,346.38	1	1
420 Drumr	93.2	90.8	92.6	93.79	93.79	1	1	93.79	1.20	$35,067.58	1	1
420 Drumr	93.2	90.8	92.6	93.82	93.82	1	1	93.82	1.23	$35,854.46	1	1
420 Drumr	93.2	90.8	92.6	93.8	93.8	1	1	93.80	1.21	$35,327.93	1	1
420 Drumr	93.2	90.8	92.6	93.77	93.77	1	1	93.77	1.18	$34,552.61	1	1
420 Drumr	93.2	90.8	92.6	93.73	93.73	1	1	93.73	1.14	$33,545.24	1	1
420 Drumr	93.2	90.8	92.6	93.69	93.69	1	1	93.69	1.10	$32,567.24	1	1
420 Drumr	93.2	90.8	92.6	93.64	93.64	1	1	93.64	1.05	$31,384.75	1	1
410 Drumr	93.1	90.7	92.5	93.79	93.79	30	7	93.79	1.30	$37,759.87	1	1
410 Drumr	93.1	90.7	92.5	93.82	93.82	30	7	93.82	1.33	$38,607.17	1	1
410 Drumr	93.1	90.7	92.5	93.79	93.8	30	7	93.79	1.30	$37,825.10	1	1
410 Drumr	93.1	90.7	92.5	93.77	93.77	30	7	93.77	1.28	$37,205.37	1	1
410 Drumr	93.1	90.7	92.5	93.73	93.73	30	7	93.73	1.24	$36,120.66	1	1
410 Drumr	93.1	90.7	92.5	93.69	93.69	30	7	93.69	1.20	$35,067.58	1	1
410 Drumr	93.1	90.7	92.5	93.64	93.64	30	7	93.64	1.15	$33,794.29	1	1
1300 Amb	93.2	90.8	92.6	92.43	92.43	1	1	92.43	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.47	92.47	1	1	92.47	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.43	92.43	1	1	92.43	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.47	92.47	1	1	92.47	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1300 Amb	93.2	90.8	92.6	92.42	92.42	1	1	92.42	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.86	91.46	30	22	91.30	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.91	91.53	30	22	91.36	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.77	91.46	30	22	91.28	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.63	91.4	30	22	91.19	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.44	91.16	30	22	90.97	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.36	91.04	30	22	90.86	-100.00	$0.00	0	0
1306 Amb	93.3	90.9	92.7	90.27	90.91	30	22	90.74	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.79	93.79	1	1	93.79	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.82	93.82	1	1	93.82	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.8	93.8	1	1	93.80	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.77	93.77	1	1	93.77	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.73	93.73	1	1	93.73	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.69	93.69	1	1	93.69	-100.00	$0.00	0	0
1286 Cum	95	92.6	94.4	93.64	93.64	1	1	93.64	-100.00	$0.00	0	0
										Reg	7	4
										100	7	4
										50	7	4
										25	7	4
										10	7	4
										5	7	4
										2	4	4

Frequency	Cost

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #26 – WEDG1810M



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 26 - WEDG1810M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:2,000
Figure No.	26

Site #26 (WEDG1810M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Duncan Road crossing 2.3 m by 1.8 m elliptical CSP with Regional storm backwater of 1.2 m +/- • Floodplain capacity of 2-5 year storm 16.2 m^3/s to 20.7 m^3/s • Encroachment
Screened Alternatives: • Crossing upgrades – 6 m by 2.1 m box culvert at Duncan Road • Road profile improvement – not practical due to existing driveways, lot grading and culvert configuration • Floodplain/channel upgrades – not practical due to natural vegetation and resulting limited hydraulic improvement • Flood-proofing not a stand alone alternative • Acquisition • Regulate
Preferred Management Approach: • Culvert upgrades • Flood-proofing of 1373 and 1379, by 0.15 m and 0.25 m respectively. Topographic survey required to verify building elevations and flood proofing required after culvert upgrades complete. • Regulate
Potential Linkage to Adjacent Sites: • Site 22

Site #26 (WEDG1810M) Implementation Program
Recommended Management Approach/Project Scope: • Flood proofing of 1373 and 1379 Duncan Road by 0.15m and 0.25 m respectively • Duncan Road crossing upgrade from 2.3 m by 1.8 m elliptical CSP to 6 m by 2.1 m box culvert
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of creek, crossing and homes to be flood proofed • Vegetation assessment at crossing • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed flood proofing • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
26	0.6	30.0	0.0	0.0	0.0	0.0	50.0	32.0	16.0	**128.6**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
			(4,6,8,10)	(m)	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	(2-100, Reg)	(0.4-50)	(1-10)	
26	Design Flood Criteria	Collector	8	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Collector / 1:50	0.04	2	0.64
26	Private Vehicle	Level 3 Road/ 100-Regional	6	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	2-yr	1.0	5	30
26	Emergency Vehicle	Level 3 Road/ 100-Regional	6	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
26	Private Vehicle Acess to Facilities	No	0	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
26	Emergency Vehicle Access to Facilities	No	0	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
26	Private Vehicle Driveway Access (Multiuser)	NA	0	93.85	94.2	94.3	94.4	94.5	94.6	94.7	94.4	0.4	0.4	0.5	0.7	0.7	0.8	0.6	0.6	0.8	0.9	1.1	1.2	1.3	1.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
26	93.24	94.34	94.38	94.31	94.24	94.18	94.02	2	2	2	2	2	2	2

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
26	3	125	90	40	6	6	6	6	6	3	0	50	20	10	4	2	1	0.4	519	5	10	50

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endagered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1373 Duncan	94.6	92.2	94.0	94.39	94.53	50	8	94.41	0.42	$19,728.93	1	0
1373 Duncan	94.6	92.2	94.0	94.6	94.84	50	8	94.64	0.65	$23,318.77	1	1
1373 Duncan	94.6	92.2	94.0	94.53	94.73	50	8	94.56	0.57	$22,037.50	1	0
1373 Duncan	94.6	92.2	94.0	94.45	94.61	50	8	94.48	0.49	$20,673.14	1	0
1373 Duncan	94.6	92.2	94.0	94.34	94.46	50	8	94.36	0.37	$18,967.64	1	0
1373 Duncan	94.6	92.2	94.0	94.25	94.35	50	8	94.27	0.28	$17,704.06	1	0
1373 Duncan	94.6	92.2	94.0	94.19	94.25	50	8	94.20	0.21	$16,855.52	1	0
1379 Duncan	94.7	92.3	94.1	94.39	94.53	50	8	94.41	0.32	$18,322.25	1	0
1379 Duncan	94.7	92.3	94.1	94.6	94.84	50	8	94.64	0.55	$21,656.13	1	0
1379 Duncan	94.7	92.3	94.1	94.53	94.73	50	8	94.56	0.47	$20,466.21	1	0
1379 Duncan	94.7	92.3	94.1	94.45	94.61	50	8	94.48	0.39	$19,199.14	1	0
1379 Duncan	94.7	92.3	94.1	94.34	94.46	50	8	94.36	0.27	$17,615.24	1	0
1379 Duncan	94.7	92.3	94.1	94.25	94.35	50	8	94.27	0.18	$16,441.76	1	0
1379 Duncan	94.7	92.3	94.1	94.19	94.25	50	8	94.20	0.11	$15,653.71	1	0
1380 Acton Ct	96.1	93.7	95.5	94.54	94.44	40	3	94.53	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.84	94.75	40	3	94.83	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.73	94.64	40	3	94.72	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.62	94.52	40	3	94.61	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.47	94.37	40	3	94.46	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.35	94.25	40	3	94.34	-100.00	$0.00	0	0
1380 Acton Ct	96.1	93.7	95.5	94.25	94.17	40	3	94.24	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.54	94.44	40	11	94.51	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.84	94.75	40	11	94.82	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.73	94.64	40	11	94.71	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.62	94.52	40	11	94.59	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.47	94.37	40	11	94.44	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.35	94.25	40	11	94.32	-100.00	$0.00	0	0
1372 Acton Ct	96.1	93.7	95.5	94.25	94.17	40	11	94.23	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.54	94.44	40	22	94.49	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.84	94.75	40	22	94.79	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.73	94.64	40	22	94.68	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.62	94.52	40	22	94.57	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.47	94.37	40	22	94.42	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.35	94.25	40	22	94.30	-100.00	$0.00	0	0
1368 Acton Ct	96.2	93.8	95.6	94.25	94.17	40	22	94.21	-100.00	$0.00	0	0

Frequency	Summarized Damage Costs ($)
Reg	$38,051.19
100	$44,974.90
50	$42,503.71
25	$39,872.28
10	$36,582.87
5	$34,145.82
2	$32,509.23

Reg	2	0
100	2	1
50	2	0
25	2	0
10	2	0
5	2	0
2	2	0

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerment

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
26	2	92.69	2	2	0	$32,509	0	0	0	0	0	0	$32,509	$17,524	$319,914	4	8	32
	5	93.00	2	2	0	$34,146	0	0	0	0	0	0	$34,146					
	10	93.51	2	2	0	$36,583	0	0	0	0	0	0	$36,583					
	25	93.64	2	2	0	$39,872	0	0	0	0	0	0	$39,872					
	50	93.69	2	2	0	$42,504	0	0	0	0	0	0	$42,504					
	100	93.74	2	2	1	$44,975	0	0	0	0	0	0	$44,975					
	Reg	93.61	2	2	0	$38,051	0	0	0	0	0	0	$38,051					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$4,876	$2,629	$47,987	4	4	16
$5,122					
$5,487					
$5,981					
$6,376					
$6,746					
$5,708					

Evaluation Process

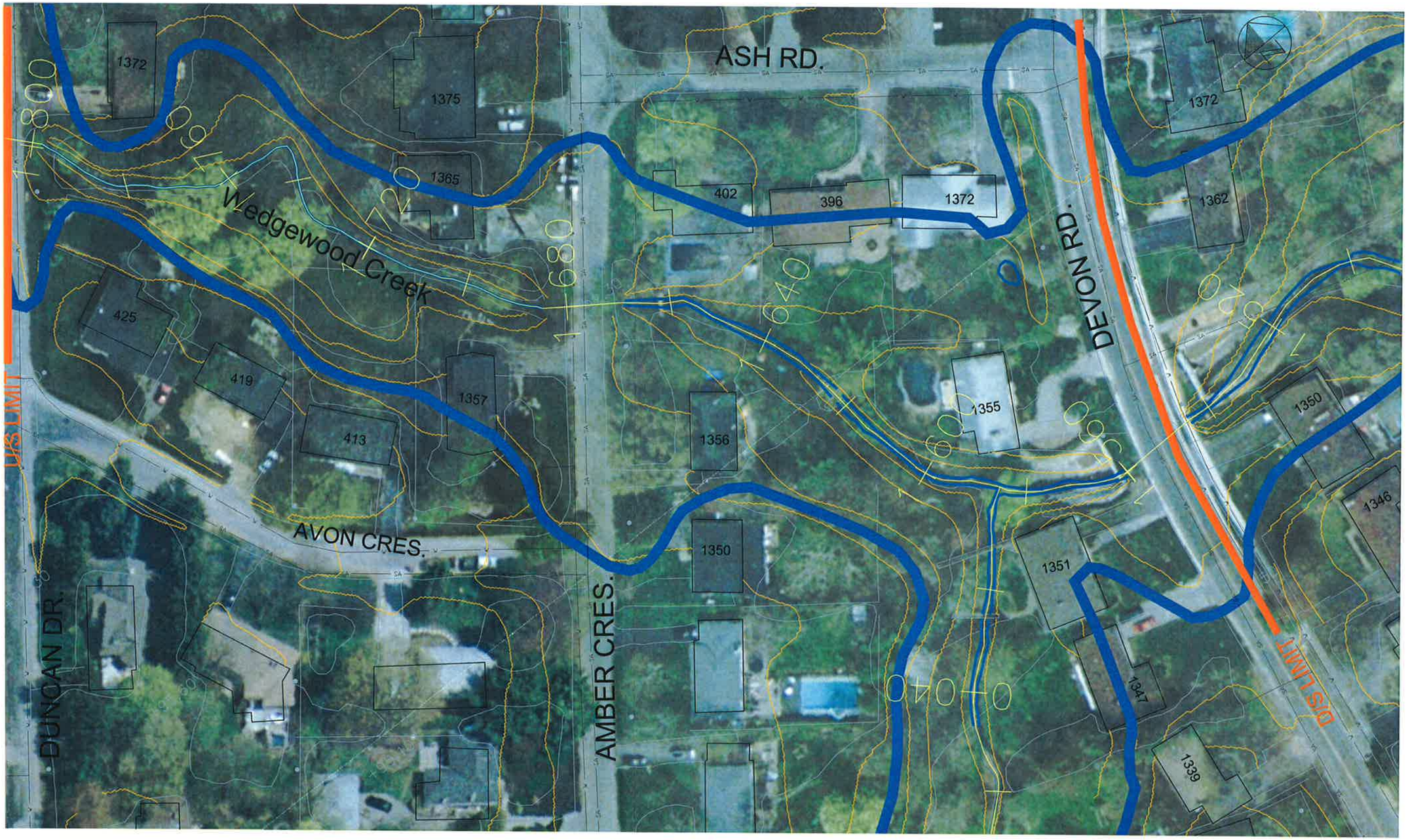
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1373 Dunc	94.6	92.2	94.0	94.39	94.53	50	8	94.41	0.42	$19,728.93	1	0
1373 Dunc	94.6	92.2	94.0	94.6	94.84	50	8	94.64	0.65	$23,318.77	1	1
1373 Dunc	94.6	92.2	94.0	94.53	94.73	50	8	94.56	0.57	$22,037.50	1	0
1373 Dunc	94.6	92.2	94.0	94.45	94.61	50	8	94.48	0.49	$20,673.14	1	0
1373 Dunc	94.6	92.2	94.0	94.34	94.46	50	8	94.36	0.37	$18,967.64	1	0
1373 Dunc	94.6	92.2	94.0	94.25	94.35	50	8	94.27	0.28	$17,704.06	1	0
1373 Dunc	94.6	92.2	94.0	94.19	94.25	50	8	94.20	0.21	$16,855.52	1	0
1379 Dunc	94.7	92.3	94.1	94.39	94.53	50	8	94.41	0.32	$18,322.25	1	0
1379 Dunc	94.7	92.3	94.1	94.6	94.84	50	8	94.64	0.55	$21,656.13	1	0
1379 Dunc	94.7	92.3	94.1	94.53	94.73	50	8	94.56	0.47	$20,466.21	1	0
1379 Dunc	94.7	92.3	94.1	94.45	94.61	50	8	94.48	0.39	$19,199.14	1	0
1379 Dunc	94.7	92.3	94.1	94.34	94.46	50	8	94.36	0.27	$17,615.24	1	0
1379 Dunc	94.7	92.3	94.1	94.25	94.35	50	8	94.27	0.18	$16,441.76	1	0
1379 Dunc	94.7	92.3	94.1	94.19	94.25	50	8	94.20	0.11	$15,653.71	1	0
1380 Acto	96.1	93.7	95.5	94.54	94.44	40	3	94.53	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.84	94.75	40	3	94.83	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.73	94.64	40	3	94.72	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.62	94.52	40	3	94.61	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.47	94.37	40	3	94.46	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.35	94.25	40	3	94.34	-100.00	$0.00	0	0
1380 Acto	96.1	93.7	95.5	94.25	94.17	40	3	94.24	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.54	94.44	40	11	94.51	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.84	94.75	40	11	94.82	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.73	94.64	40	11	94.71	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.62	94.52	40	11	94.59	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.47	94.37	40	11	94.44	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.35	94.25	40	11	94.32	-100.00	$0.00	0	0
1372 Acto	96.1	93.7	95.5	94.25	94.17	40	11	94.23	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.54	94.44	40	22	94.49	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.84	94.75	40	22	94.79	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.73	94.64	40	22	94.68	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.62	94.52	40	22	94.57	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.47	94.37	40	22	94.42	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.35	94.25	40	22	94.30	-100.00	$0.00	0	0
1368 Acto	96.2	93.8	95.6	94.25	94.17	40	22	94.21	-100.00	$0.00	0	0
										Reg	2	0
										100	2	1
										50	2	0
										25	2	0
										10	2	0
										5	2	0
										2	2	0

Frequency	Summarized Damage Costs ($)
Reg	$38,051.19
100	$44,974.90
50	$42,503.71
25	$39,872.28
10	$36,582.87
5	$34,145.82
2	$32,509.23

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #27 – WEDG1549M



LEGEND :

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 27 - WEDG1549M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:750
Figure No.	27

Feb 11/08 – avogt

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Site #27 (WEDG1549M) Implementation Program
Recommended Management Approach/Project Scope: • Amber Crescent crossing upgrade from 2.7 m by 2.2 m CSP arch to 6 m by 1.2 m concrete box • Flood proofing of homes still flooded after crossing upgrade • Implement Devon Road Culvert Improvements – separate Town of Oakville Project
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for water and wastewater servicing alterations at Morrison Road (Site 23) • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of creek, Amber Road and Devon Road culverts and homes within Regulatory floodplain • Vegetation assessment • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners for flood proofing
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed grading of creek adjacent to culvert upgrade • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing(s) maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #27 (WEDG1549M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Devon Road to Amber Cres. floodplain capacity and culvert capacity • Amber Cres. and upstream floodplain capacity and culvert capacity • Encroachment
Screened Alternatives: • Floodplain improvements – not very practical based on private property and existing natural vegetation • Devon Road culvert improvements – being undertaken by the Town of Oakville under separate study – twin 4.27 m span Conspan culverts • Culvert improvement on Amber Cres. from 2.7 m by 2.2 m CSP arch to 6 m by 1.2 m concrete box • Flood-proofing • Regulate
Preferred Management Approach: • Amber Cres. culvert improvement • Flood-proof homes to extent possible, would require topographic survey to verify building elevations and flood proofing possible. • Consider acquisition of 1355 Devon Road • Regulate
Potential Linkage to Adjacent Sites: • No linkage

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Direct Damages	Combined Products
27	0.0	0.0	0.0	0.0	0.0	0.0	50.0	32.0	16.0	**98.0**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
27	Design Flood Criteria	Collector	8	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	2	0
27	Private Vehicle	Level 3 Road/ 100-Regional	6	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	5	0
27	Emergency Vehicle	Level 3 Road/ 100-Regional	6	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
27	Private Vehicle Acess to Facilities	No	0	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
27	Emergency Vehicle Access to Facilities	No	0	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
27	Private Vehicle Driveway Access (Multiuser)	NA	0	90.80	89.0	89.1	89.3	89.4	89.8	90.1	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
27	89.32	89.45	89.65	89.85	90	90.13	90.09	3	2	3	4	6	7	6

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
27	3	125	90	40	9	6	9	12	18	21	18	50	20	10	4	2	1	0.4	772.2	5	10	50

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1347 Devon R	91.2	88.8	90.6	90.01	90.78	60	30	90.40	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	90.09	90.86	60	30	90.48	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	89.78	90.51	60	30	90.15	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	90.13	90.91	60	30	90.52	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	89.64	90.36	60	30	90.00	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	90	90.76	60	30	90.38	-100.00	$0.00	0	0
1347 Devon R	91.2	88.8	90.6	89.48	90.22	60	30	89.85	-100.00	$0.00	0	0
1351 Devon R	90.7	88.3	90.1	90.09	90.9	50	10	90.25	0.16	$16,272.37	1	0
1351 Devon R	90.7	88.3	90.1	90.13	90.94	50	10	90.29	0.20	$16,761.03	1	0
1351 Devon R	90.7	88.3	90.1	90	90.78	50	10	90.16	0.07	$15,156.92	1	0
1351 Devon R	90.7	88.3	90.1	89.85	90.61	50	10	90.00	-100.00	$0.00	0	0
1351 Devon R	90.7	88.3	90.1	89.65	90.36	50	10	89.79	-100.00	$0.00	0	0
1351 Devon R	90.7	88.3	90.1	89.45	90.19	50	10	89.60	-100.00	$0.00	0	0
1351 Devon R	90.7	88.3	90.1	89.32	90.01	50	10	89.46	-100.00	$0.00	0	0
1355 Devon R	90.2	87.8	89.6	90.09	90.9	50	25	90.50	0.90	$28,192.77	1	1
1355 Devon R	90.2	87.8	89.6	90.13	90.94	50	25	90.54	0.94	$29,039.40	1	1
1355 Devon R	90.2	87.8	89.6	90	90.78	50	25	90.39	0.80	$26,085.95	1	1
1355 Devon R	90.2	87.8	89.6	89.85	90.61	50	25	90.23	0.64	$23,174.33	1	1
1355 Devon R	90.2	87.8	89.6	89.65	90.36	50	25	90.01	0.41	$19,621.24	1	0
1355 Devon R	90.2	87.8	89.6	89.45	90.19	50	25	89.82	0.23	$17,111.80	1	0
1355 Devon R	90.2	87.8	89.6	89.32	90.01	50	25	89.67	0.07	$15,258.16	1	0
1372 Devon R	91.4	89.0	90.8	90.09	90.9	50	31	90.59	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	90.13	90.94	50	31	90.63	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	90	90.78	50	31	90.48	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	89.85	90.61	50	31	90.32	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	89.65	90.36	50	31	90.09	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	89.45	90.19	50	31	89.91	-100.00	$0.00	0	0
1372 Devon R	91.4	89.0	90.8	89.32	90.01	50	31	89.75	-100.00	$0.00	0	0
396 Ash Rd	91.5	89.1	90.9	90.9	91.18	30	12	91.01	0.12	$15,797.95	1	0
396 Ash Rd	91.5	89.1	90.9	90.94	91.43	30	12	91.14	0.25	$17,315.52	1	0
396 Ash Rd	91.5	89.1	90.9	90.78	91.36	30	12	91.01	0.12	$15,797.95	1	0
396 Ash Rd	91.5	89.1	90.9	90.61	91.26	30	12	90.87	-100.00	$0.00	0	0
396 Ash Rd	91.5	89.1	90.9	90.36	91.08	30	12	90.65	-100.00	$0.00	0	0
396 Ash Rd	91.5	89.1	90.9	90.19	90.85	30	12	90.45	-100.00	$0.00	0	0
396 Ash Rd	91.5	89.1	90.9	90.01	90.7	30	12	90.29	-100.00	$0.00	0	0
402 Ash Rd	91.5	89.1	90.9	91.18	91.18	1	1	91.18	0.29	$17,888.36	1	0
402 Ash Rd	91.5	89.1	90.9	91.43	91.43	1	1	91.43	0.54	$21,521.99	1	0
402 Ash Rd	91.5	89.1	90.9	91.36	91.36	1	1	91.36	0.47	$20,435.96	1	0
402 Ash Rd	91.5	89.1	90.9	91.26	91.26	1	1	91.26	0.37	$18,978.87	1	0
402 Ash Rd	91.5	89.1	90.9	91.08	91.08	1	1	91.08	0.19	$16,612.91	1	0
402 Ash Rd	91.5	89.1	90.9	90.85	90.85	1	1	90.85	-100.00	$0.00	0	0
402 Ash Rd	91.5	89.1	90.9	90.7	90.7	1	1	90.70	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	91.18	91.18	1	1	91.18	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	91.43	91.43	1	1	91.43	0.04	$14,868.20	1	0
1356 Amber C	92	89.6	91.4	91.36	91.36	1	1	91.36	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	91.26	91.26	1	1	91.26	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	91.08	91.08	1	1	91.08	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	90.85	90.85	1	1	90.85	-100.00	$0.00	0	0
1356 Amber C	92	89.6	91.4	90.7	90.7	1	1	90.70	-100.00	$0.00	0	0
1357 Amber C	93.3	90.9	92.7	92.88	92.95	30	4	92.89	0.20	$16,728.00	1	0
1357 Amber C	93.3	90.9	92.7	93.13	93.23	30	4	93.14	0.45	$20,185.56	1	0
1357 Amber C	93.3	90.9	92.7	93.04	93.13	30	4	93.05	0.36	$18,866.89	1	0
1357 Amber C	93.3	90.9	92.7	92.95	93.03	30	4	92.96	0.27	$17,634.36	1	0
1357 Amber C	93.3	90.9	92.7	92.83	92.89	30	4	92.84	0.15	$16,104.72	1	0
1357 Amber C	93.3	90.9	92.7	92.71	92.77	30	4	92.72	0.03	$14,736.81	1	0
1357 Amber C	93.3	90.9	92.7	93.01	93.03	30	4	93.01	0.32	$18,325.87	1	0
1365 Amber C	93.5	91.1	92.9	92.88	92.95	30	17	92.92	0.03	$14,754.99	1	0
1365 Amber C	93.5	91.1	92.9	93.13	93.23	30	17	93.19	0.30	$17,976.79	1	0
1365 Amber C	93.5	91.1	92.9	93.04	93.13	30	17	93.09	0.20	$16,748.63	1	0
1365 Amber C	93.5	91.1	92.9	92.95	93.03	30	17	93.00	0.10	$15,604.39	1	0
1365 Amber C	93.5	91.1	92.9	92.83	92.89	30	17	92.86	-100.00	$0.00	0	0
1365 Amber C	93.5	91.1	92.9	92.71	92.77	30	17	92.74	-100.00	$0.00	0	0
1365 Amber C	93.5	91.1	92.9	93.01	93.03	30	17	93.02	0.13	$15,907.40	1	0
										Reg	6	1
										100	7	1
										50	6	1
										25	4	1
										10	3	0
										5	2	0
										2	3	0

Frequency	Summarized Damage Costs ($)
Reg	$109,634.43
100	$137,668.49
50	$113,092.31
25	$75,391.93
10	$52,338.87
5	$31,848.61
2	$49,491.43

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerment

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
27	2	92.69	3	3	0	$49,491	0	0	0	0	0	0	$49,491	$24,645	$449,918	4	8	32
	5	93.00	2	2	0	$31,849	0	0	0	0	0	0	$31,849					
	10	93.51	3	3	0	$52,339	0	0	0	0	0	0	$52,339					
	25	93.64	4	4	1	$75,392	0	0	0	0	0	0	$75,392					
	50	93.69	6	6	1	$113,092	0	0	0	0	0	0	$113,092					
	100	93.74	7	7	1	$137,668	0	0	0	0	0	0	$137,668					
	Reg	93.61	6	6	1	$109,634	0	0	0	0	0	0	$109,634					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$7,424	$3,697	$67,488	4	4	16
$4,777					
$7,851					
$11,309					
$16,964					
$20,650					
$16,445					

Evaluation Process

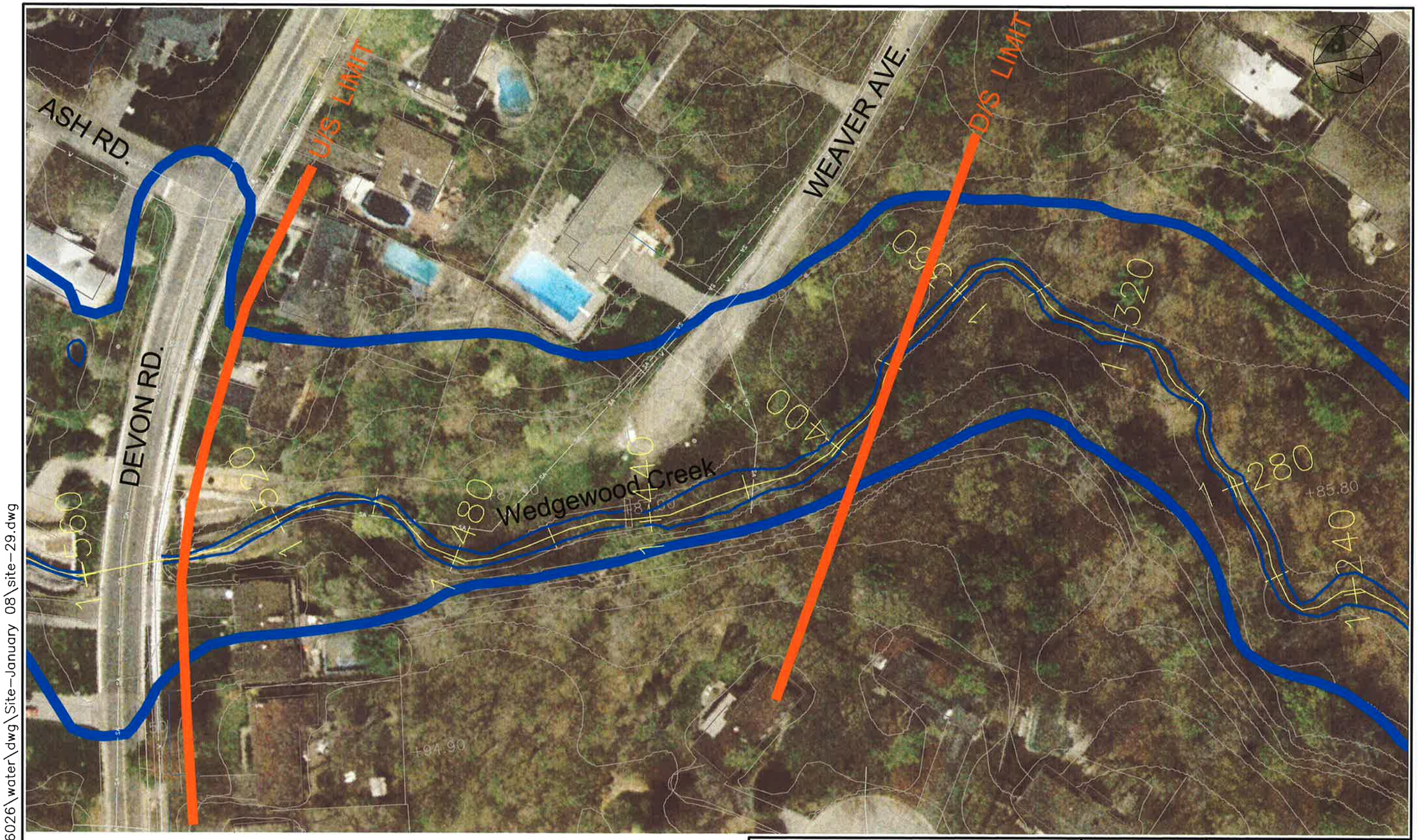
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream Reg 2-100/ Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
1347 Devo	91.2	88.8	90.6	90.01	90.78	60	30	90.40	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	90.09	90.86	60	30	90.48	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	89.78	90.51	60	30	90.15	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	90.13	90.91	60	30	90.52	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	89.64	90.36	60	30	90.00	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	90	90.76	60	30	90.38	-100.00	$0.00	0	0
1347 Devo	91.2	88.8	90.6	89.48	90.22	60	30	89.85	-100.00	$0.00	0	0
1351 Devo	90.7	88.3	90.1	90.09	90.9	50	10	90.25	0.16	$16,272.37	1	0
1351 Devo	90.7	88.3	90.1	90.13	90.94	50	10	90.29	0.20	$16,761.03	1	0
1351 Devo	90.7	88.3	90.1	90	90.78	50	10	90.16	0.07	$15,156.92	1	0
1351 Devo	90.7	88.3	90.1	89.85	90.61	50	10	90.00	-100.00	$0.00	0	0
1351 Devo	90.7	88.3	90.1	89.65	90.36	50	10	89.79	-100.00	$0.00	0	0
1351 Devo	90.7	88.3	90.1	89.45	90.19	50	10	89.60	-100.00	$0.00	0	0
1351 Devo	90.7	88.3	90.1	89.32	90.01	50	10	89.46	-100.00	$0.00	0	0
1355 Devo	90.2	87.8	89.6	90.09	90.9	50	25	90.50	0.90	$28,192.77	1	1
1355 Devo	90.2	87.8	89.6	90.13	90.94	50	25	90.54	0.94	$29,039.40	1	1
1355 Devo	90.2	87.8	89.6	90	90.78	50	25	90.39	0.80	$26,085.95	1	1
1355 Devo	90.2	87.8	89.6	89.85	90.61	50	25	90.23	0.64	$23,174.33	1	1
1355 Devo	90.2	87.8	89.6	89.65	90.36	50	25	90.01	0.41	$19,621.24	1	0
1355 Devo	90.2	87.8	89.6	89.45	90.19	50	25	89.82	0.23	$17,111.80	1	0
1355 Devo	90.2	87.8	89.6	89.32	90.01	50	25	89.67	0.07	$15,258.16	1	0
1372 Devo	91.4	89.0	90.8	90.09	90.9	50	31	90.59	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	90.13	90.94	50	31	90.63	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	90	90.78	50	31	90.48	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	89.85	90.61	50	31	90.32	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	89.65	90.36	50	31	90.09	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	89.45	90.19	50	31	89.91	-100.00	$0.00	0	0
1372 Devo	91.4	89.0	90.8	89.32	90.01	50	31	89.75	-100.00	$0.00	0	0
396 Ash R	91.5	89.1	90.9	90.9	91.18	30	12	91.01	0.12	$15,797.95	1	0
396 Ash R	91.5	89.1	90.9	90.94	91.43	30	12	91.14	0.25	$17,315.52	1	0
396 Ash R	91.5	89.1	90.9	90.78	91.36	30	12	91.01	0.12	$15,797.95	1	0
396 Ash R	91.5	89.1	90.9	90.61	91.26	30	12	90.87	-100.00	$0.00	0	0
396 Ash R	91.5	89.1	90.9	90.36	91.08	30	12	90.65	-100.00	$0.00	0	0
396 Ash R	91.5	89.1	90.9	90.19	90.85	30	12	90.45	-100.00	$0.00	0	0
396 Ash R	91.5	89.1	90.9	90.01	90.7	30	12	90.29	-100.00	$0.00	0	0
402 Ash R	91.5	89.1	90.9	91.18	91.18	1	1	91.18	0.29	$17,888.36	1	0
402 Ash R	91.5	89.1	90.9	91.43	91.43	1	1	91.43	0.54	$21,521.99	1	0
402 Ash R	91.5	89.1	90.9	91.36	91.36	1	1	91.36	0.47	$20,435.96	1	0
402 Ash R	91.5	89.1	90.9	91.26	91.26	1	1	91.26	0.37	$18,978.87	1	0
402 Ash R	91.5	89.1	90.9	91.08	91.08	1	1	91.08	0.19	$16,612.91	1	0
402 Ash R	91.5	89.1	90.9	90.85	90.85	1	1	90.85	-100.00	$0.00	0	0
402 Ash R	91.5	89.1	90.9	90.7	90.7	1	1	90.70	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	91.18	91.18	1	1	91.18	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	91.43	91.43	1	1	91.43	0.04	$14,868.20	1	0
1356 Amb	92	89.6	91.4	91.36	91.36	1	1	91.36	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	91.26	91.26	1	1	91.26	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	91.08	91.08	1	1	91.08	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	90.85	90.85	1	1	90.85	-100.00	$0.00	0	0
1356 Amb	92	89.6	91.4	90.7	90.7	1	1	90.70	-100.00	$0.00	0	0
1357 Amb	93.3	90.9	92.7	92.88	92.95	30	4	92.89	0.20	$16,728.00	1	0
1357 Amb	93.3	90.9	92.7	93.13	93.23	30	4	93.14	0.45	$20,185.56	1	0
1357 Amb	93.3	90.9	92.7	93.04	93.13	30	4	93.05	0.36	$18,866.89	1	0
1357 Amb	93.3	90.9	92.7	92.95	93.03	30	4	92.96	0.27	$17,634.36	1	0
1357 Amb	93.3	90.9	92.7	92.83	92.89	30	4	92.84	0.15	$16,104.72	1	0
1357 Amb	93.3	90.9	92.7	92.71	92.77	30	4	92.72	0.03	$14,736.81	1	0
1357 Amb	93.3	90.9	92.7	93.01	93.03	30	4	93.01	0.32	$18,325.87	1	0
1365 Amb	93.5	91.1	92.9	92.88	92.95	30	17	92.92	0.03	$14,754.99	1	0
1365 Amb	93.5	91.1	92.9	93.13	93.23	30	17	93.19	0.30	$17,976.79	1	0
1365 Amb	93.5	91.1	92.9	93.04	93.13	30	17	93.09	0.20	$16,748.63	1	0
1365 Amb	93.5	91.1	92.9	92.95	93.03	30	17	93.00	0.10	$15,604.39	1	0
1365 Amb	93.5	91.1	92.9	92.83	92.89	30	17	92.86	-100.00	$0.00	0	0
1365 Amb	93.5	91.1	92.9	92.71	92.77	30	17	92.74	-100.00	$0.00	0	0
1365 Amb	93.5	91.1	92.9	93.01	93.03	30	17	93.02	0.13	$15,907.40	1	0
										Reg	6	1
										100	7	1
										50	6	1
										25	4	1
										10	3	0
										5	2	0
										2	3	0

Frequency	Summarized Damage Costs ($)
Reg	$109,634.43
100	$137,668.49
50	$113,092.31
25	$75,391.93
10	$52,338.87
5	$31,848.61
2	$49,491.43

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential la
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #29 – WEDG1380M



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 29 - WEDG1380M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:750
Figure No.	29

Feb 11/08 – avogt

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SITE #30 – WEDG0634M

LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 30 - WEDG0634M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	30

Feb 11/08 – avogt

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Site #30 (WEDG0634M) Implementation Program
Recommended Management Approach/Project Scope: • Flood proofing of homes not flooded on all sides
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of area • Hydraulic modeling refinement • Approval process with private land owners
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed flood proofing
Possible Monitoring Requirements: • N/A
Need for Maintenance: • N/A
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Others

Site #30 (WEDG0634M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Wedgewood Drive crossing 4.0 m by 1.7 m arch • Floodplain capacity is less than the 5 year storm @ 7.70 m^3/s. Regional is 47.90 m^3/s
Screened Alternatives: • Crossing upgrades based on land availability do not result in significant hydraulic improvements • Floodplain/channel upgrades – not practical due to private property issues and natural vegetation • Flood-proofing – practical for 3 out of 5 homes • Acquisition – 4 homes (costly) • Regulate
Preferred Management Approach: • Flood-proof for homes not flooded on all sides; topographic survey required to verify building elevations and flood proofing possible. • Regulate
Potential Linkage to Adjacent Sites: • Site 31

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	**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**	**Combined Products**
30	0.2	4.0	1.3	0.1	2.8	1.3	40.0	64.0	32.0	**145.6**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
30	Design Flood Criteria	Arterial	10	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.01	2	0.16
30	Private Vehicle	EMS Route	10	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.1	5	4
30	Emergency Vehicle	EMS Route	10	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
30	Private Vehicle Acess to Facilities	Partial	5	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.01	3	0.12
30	Emergency Vehicle Access to Facilities	No	5	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.1	7	2.8
30	Private Vehicle Driveway Access (Multiuser)	Low Vehicle Usage	4	82.40	82.6	82.7	82.8	82.8	82.9	82.9	83.0	0.0	0.3	0.4	0.4	0.5	0.5	0.6	0.0	0.7	0.8	0.9	1.0	1.0	1.1	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.1	4	1.28

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
30	82.57	82.63	82.66	82.76	82.92	83.03	83.11	1	2	3	4	6	6	7

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
30	3	125	90	40	3	6	9	12	18	18	21	50	20	10	4	2	1	0.4	470.4	4	10	40

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
200 Wedgewo	83.4	81.0	82.8	83.11	83.69	50	6	83.18	0.39	$19,256.03	1	0
200 Wedgewo	83.4	81.0	82.8	83.03	83.61	50	6	83.10	0.31	$18,149.59	1	0
200 Wedgewo	83.4	81.0	82.8	82.92	83.49	50	6	82.99	0.20	$16,716.45	1	0
200 Wedgewo	83.4	81.0	82.8	82.76	83.35	50	6	82.83	0.04	$14,877.01	1	0
200 Wedgewo	83.4	81.0	82.8	82.66	83.11	50	6	82.71	-100.00	$0.00	0	0
200 Wedgewo	83.4	81.0	82.8	82.63	82.96	50	6	82.67	-100.00	$0.00	0	0
200 Wedgewo	83.4	81.0	82.8	82.57	82.81	50	6	82.60	-100.00	$0.00	0	0
208 Wedgewo	83.3	80.9	82.7	83.11	83.69	50	5	83.17	0.48	$20,557.25	1	0
208 Wedgewo	83.3	80.9	82.7	83.03	83.61	50	5	83.09	0.40	$19,376.05	1	0
208 Wedgewo	83.3	80.9	82.7	82.92	83.49	50	5	82.98	0.29	$17,848.70	1	0
208 Wedgewo	83.3	80.9	82.7	82.76	83.35	50	5	82.82	0.13	$15,879.97	1	0
208 Wedgewo	83.3	80.9	82.7	82.66	83.11	50	5	82.71	0.01	$14,595.78	1	0
208 Wedgewo	83.3	80.9	82.7	82.63	82.96	50	5	82.66	-100.00	$0.00	0	0
208 Wedgewo	83.3	80.9	82.7	82.57	82.81	50	5	82.59	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	83.69	83.76	50	8	83.70	0.01	$14,554.81	1	0
216 Wedgewo	84.3	81.9	83.7	83.61	83.68	50	8	83.62	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	83.49	83.56	50	8	83.50	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	83.35	83.43	50	8	83.36	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	83.11	83.2	50	8	83.12	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	82.96	83.05	50	8	82.97	-100.00	$0.00	0	0
216 Wedgewo	84.3	81.9	83.7	82.81	82.9	50	8	82.82	-100.00	$0.00	0	0
230 Alscot Dr	83.2	80.8	82.6	83.76	83.76	1	1	83.76	1.17	$34,297.96	1	1
230 Alscot Dr	83.2	80.8	82.6	83.68	83.68	1	1	83.68	1.09	$32,327.23	1	1
230 Alscot Dr	83.2	80.8	82.6	83.56	83.56	1	1	83.56	0.97	$29,581.41	1	1
230 Alscot Dr	83.2	80.8	82.6	83.43	83.43	1	1	83.43	0.84	$26,869.32	1	1
230 Alscot Dr	83.2	80.8	82.6	83.2	83.2	1	1	83.20	0.61	$22,665.73	1	1
230 Alscot Dr	83.2	80.8	82.6	83.05	83.05	1	1	83.05	0.46	$20,285.35	1	0
230 Alscot Dr	83.2	80.8	82.6	82.9	82.9	1	1	82.90	0.31	$18,154.96	1	0
236 Alscot Dr	84.1	81.7	83.5	83.7	83.7	1	1	83.70	0.21	$16,860.51	1	0
236 Alscot Dr	84.1	81.7	83.5	83.62	83.62	1	1	83.62	0.13	$15,891.72	1	0
236 Alscot Dr	84.1	81.7	83.5	83.51	83.51	1	1	83.51	0.02	$14,649.86	1	0
236 Alscot Dr	84.1	81.7	83.5	83.38	83.38	1	1	83.38	-100.00	$0.00	0	0
236 Alscot Dr	84.1	81.7	83.5	83.15	83.15	1	1	83.15	-100.00	$0.00	0	0
236 Alscot Dr	84.1	81.7	83.5	83.02	83.02	1	1	83.02	-100.00	$0.00	0	0
236 Alscot Dr	84.1	81.7	83.5	82.86	82.86	1	1	82.86	-100.00	$0.00	0	0
244 Alscot Dr	84.3	81.9	83.7	84.36	84.36	1	1	84.36	0.67	$23,694.34	1	1
244 Alscot Dr	84.3	81.9	83.7	84.35	84.35	1	1	84.35	0.66	$23,519.71	1	1
244 Alscot Dr	84.3	81.9	83.7	84.22	84.22	1	1	84.22	0.53	$21,363.37	1	0
244 Alscot Dr	84.3	81.9	83.7	84.1	84.1	1	1	84.10	0.41	$19,548.80	1	0
244 Alscot Dr	84.3	81.9	83.7	83.94	83.94	1	1	83.94	0.25	$17,366.83	1	0
244 Alscot Dr	84.3	81.9	83.7	83.82	83.82	1	1	83.82	0.13	$15,891.72	1	0
244 Alscot Dr	84.3	81.9	83.7	83.67	83.67	1	1	83.67	-100.00	$0.00	0	0
241 Trelawn A	85.3	82.9	84.7	84.93	84.93	1	1	84.93	0.24	$17,238.84	1	0
241 Trelawn A	85.3	82.9	84.7	84.84	84.84	1	1	84.84	0.15	$16,128.57	1	0
241 Trelawn A	85.3	82.9	84.7	84.74	84.74	1	1	84.74	0.05	$14,978.59	1	0
241 Trelawn A	85.3	82.9	84.7	84.62	84.62	1	1	84.62	-100.00	$0.00	0	0
241 Trelawn A	85.3	82.9	84.7	84.44	84.44	1	1	84.44	-100.00	$0.00	0	0
241 Trelawn A	85.3	82.9	84.7	84.3	84.3	1	1	84.30	-100.00	$0.00	0	0
241 Trelawn A	85.3	82.9	84.7	84.14	84.14	1	1	84.14	-100.00	$0.00	0	0
										Reg	7	2
										100	6	2
										50	6	1
										25	4	1
										10	3	1
										5	2	0
										2	1	0

Frequency	Summarized Damage Costs ($)
Reg	$146,459.73
100	$125,392.87
50	$115,138.39
25	$77,175.09
10	$54,628.34
5	$36,177.07
2	$18,154.96
TOTAL=	$573,126.46

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
30	2	92.69	7	7	1	$83,228	0	0	0	0	0	0	$83,228	$59,457	$1,085,451	8	8	64
	5	93.00	7	7	2	$120,582	0	0	0	0	0	0	$120,582					
	10	93.51	7	7	2	$130,498	0	0	0	0	0	0	$130,498					
	25	93.64	7	7	2	$164,761	0	0	0	0	0	0	$164,761					
	50	93.69	6	6	4	$182,122	0	0	0	0	0	0	$182,122					
	100	93.74	6	6	6	$198,409	0	0	0	0	0	0	$198,409					
	Reg	93.61	4	4	6	$208,890	0	0	0	0	0	0	$208,890					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$12,484	$8,919	$162,818	8	4	32
$18,087					
$19,575					
$24,714					
$27,318					
$29,761					
$31,333					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

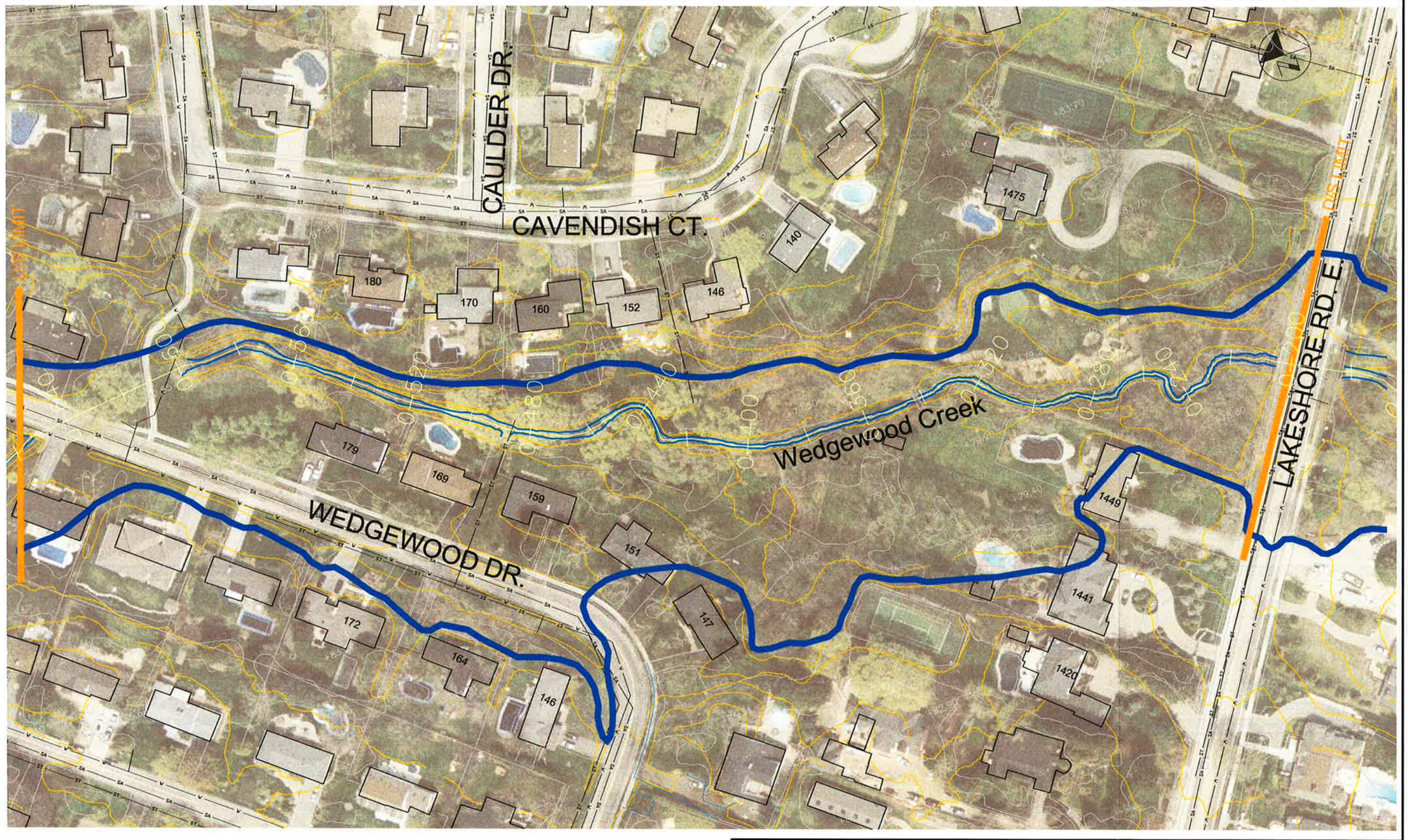
Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Elevations	Flood (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Elevations	Flood (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
200 Wedg	82.92	80.5	82.3	83.11		83.69	50	6	83.18		0.67	$27,464.11	1	1
200 Wedg	82.92	80.5	82.3	83.03		83.61	50	6	83.10		0.79	$25,886.05	1	1
200 Wedg	82.92	80.5	82.3	82.92		83.49	50	6	82.99		0.68	$23,842.02	1	1
200 Wedg	82.92	80.5	82.3	82.76		83.35	50	6	82.83		0.52	$21,218.49	1	0
200 Wedg	82.92	80.5	82.3	82.66		83.11	50	6	82.71		0.40	$19,462.23	1	0
200 Wedg	82.92	80.5	82.3	82.63		82.96	50	6	82.67		0.36	$18,833.42	1	0
200 Wedg	82.92	80.5	82.3	82.57		82.81	50	6	82.60		0.29	$17,872.48	1	0
208 Wedg	82.82	80.4	82.2	83.11		83.69	50	5	83.17		0.96	$29,319.99	1	1
208 Wedg	82.82	80.4	82.2	83.03		83.61	50	5	83.09		0.88	$27,635.29	1	1
208 Wedg	82.82	80.4	82.2	82.92		83.49	50	5	82.98		0.77	$25,456.90	1	1
208 Wedg	82.82	80.4	82.2	82.76		83.35	50	5	82.82		0.61	$22,648.97	1	0
208 Wedg	82.82	80.4	82.2	82.66		83.11	50	5	82.71		0.49	$20,817.39	1	0
208 Wedg	82.82	80.4	82.2	82.63		82.96	50	5	82.66		0.45	$20,180.59	1	0
208 Wedg	82.82	80.4	82.2	82.57		82.81	50	5	82.59		0.38	$19,176.43	1	0
216 Wedg	83.82	81.4	83.2	83.69		83.76	50	8	83.70		0.49	$20,758.55	1	0
216 Wedg	83.82	81.4	83.2	83.61		83.68	50	8	83.62		0.41	$19,566.16	1	0
216 Wedg	83.82	81.4	83.2	83.49		83.56	50	8	83.50		0.29	$17,904.24	1	0
216 Wedg	83.82	81.4	83.2	83.35		83.43	50	8	83.36		0.15	$16,162.01	1	0
216 Wedg	83.82	81.4	83.2	83.11		83.2	50	8	83.12		-100.00	$0.00	0	0
216 Wedg	83.82	81.4	83.2	82.96		83.05	50	8	82.97		-100.00	$0.00	0	0
216 Wedg	83.82	81.4	83.2	82.81		82.9	50	8	82.82		-100.00	$0.00	0	0
230 Alscot	82.72	80.3	82.1	83.76		83.76	1	1	83.76		1.65	$48,917.53	1	1
230 Alscot	82.72	80.3	82.1	83.68		83.68	1	1	83.68		1.57	$46,107.06	1	1
230 Alscot	82.72	80.3	82.1	83.56		83.56	1	1	83.56		1.45	$42,190.79	1	1
230 Alscot	82.72	80.3	82.1	83.43		83.43	1	1	83.43		1.32	$38,322.65	1	1
230 Alscot	82.72	80.3	82.1	83.2		83.2	1	1	83.20		1.09	$32,327.23	1	1
230 Alscot	82.72	80.3	82.1	83.05		83.05	1	1	83.05		0.94	$28,932.20	1	1
230 Alscot	82.72	80.3	82.1	82.9		82.9	1	1	82.90		0.79	$25,893.71	1	1
236 Alscot	83.62	81.2	83.0	83.7		83.7	1	1	83.70		0.69	$24,047.47	1	1
236 Alscot	83.62	81.2	83.0	83.62		83.62	1	1	83.62		0.61	$22,665.73	1	1
236 Alscot	83.62	81.2	83.0	83.51		83.51	1	1	83.51		0.50	$20,694.52	1	0
236 Alscot	83.62	81.2	83.0	83.38		83.38	1	1	83.38		0.37	$18,978.87	1	0
236 Alscot	83.62	81.2	83.0	83.15		83.15	1	1	83.15		0.14	$16,009.70	1	0
236 Alscot	83.62	81.2	83.0	83.02		83.02	1	1	83.02		0.01	$14,541.90	1	0
236 Alscot	83.62	81.2	83.0	82.86		82.86	1	1	82.86		-100.00	$0.00	0	0
244 Alscot	83.82	81.4	83.2	84.36		84.36	1	1	84.36		1.15	$33,794.29	1	1
244 Alscot	83.82	81.4	83.2	84.35		84.35	1	1	84.35		1.14	$33,545.24	1	1
244 Alscot	83.82	81.4	83.2	84.22		84.22	1	1	84.22		1.01	$30,469.74	1	1
244 Alscot	83.82	81.4	83.2	84.1		84.1	1	1	84.10		0.89	$27,881.68	1	1
244 Alscot	83.82	81.4	83.2	83.94		83.94	1	1	83.94		0.73	$24,769.62	1	1
244 Alscot	83.82	81.4	83.2	83.82		83.82	1	1	83.82		0.61	$22,665.73	1	1
244 Alscot	83.82	81.4	83.2	83.67		83.67	1	1	83.67		0.46	$20,285.35	1	0
241 Trelaw	84.82	82.4	84.2	84.93		84.93	1	1	84.93		0.72	$24,587.08	1	1
241 Trelaw	84.82	82.4	84.2	84.84		84.84	1	1	84.84		0.63	$23,003.54	1	1
241 Trelaw	84.82	82.4	84.2	84.74		84.74	1	1	84.74		0.53	$21,363.37	1	0
241 Trelaw	84.82	82.4	84.2	84.62		84.62	1	1	84.62		0.41	$19,548.80	1	0
241 Trelaw	84.82	82.4	84.2	84.44		84.44	1	1	84.44		0.23	$17,111.80	1	0
241 Trelaw	84.82	82.4	84.2	84.3		84.3	1	1	84.30		0.09	$15,428.40	1	0
241 Trelaw	84.82	82.4	84.2	84.14		84.14	1	1	84.14		-100.00	$0.00	0	0

Frequency	Summarized Damage Costs ($)
Reg	$208,889.74
100	$198,409.06
50	$182,121.59
25	$164,761.46
10	$130,497.97
5	$120,582.23
2	$83,227.97
TOTAL=	$1,088,490.02

Reg	7	6
100	7	6
50	7	4
25	7	2
10	6	2
5	6	2
2	4	1

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #31 – WEDG0200M



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 31 - WEDG0200M
WEDGEWOOD CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,250
Figure No.	31

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Site #31 (WEDG0200M) Implementation Program
Recommended Management Approach/Project Scope: • Regulate – maintain existing conditions •
Appropriate Lead for Undertaking: • N/A
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act
Approval Requirements: • N/A
Need for, and Scope of Follow-Up Assessment/Analysis: • N/A
Suggested Timing, Need for Phasing: • N/A
Possible Implementation Issues: • N/A
Possible Monitoring Requirements: • N/A
Need for Maintenance: • Typical creek and crossing maintenance
Potential Interface with Other Town/Agency Programs: • N/A
Other Funding Opportunities: • N/A

Site #31 (WEDG0200M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Lakeshore Road East crossing 3.9 m by 1.2 m box culvert • Channel capacity at Lakeshore Road both upstream and downstream • Channel floodplain capacity near Wedgewood Drive • Encroachment • Spill from Wedgewood Drive crossing (Site 30)
Screened Alternatives: • Upgrades to Lakeshore Road East crossing – no affect on flooding of homes located on Wedgewood Drive • Site 30 potential improvements • Channel/floodplain improvements – not practical due to private property, existing vegetation and limited hydraulic improvements. • Flood-proofing – not practical as homes are flooded on all sides • Acquisition – 4 homes (costly) • Regulate
Preferred Management Approach: • Regulate
Potential Linkage to Adjacent Sites: • Site 30

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	**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**	**Combined Products**
31	0.2	1.0	0.5	0.3	1.4	0.5	40.0	16.0	8.0	**67.8**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
			(4,6,8,10)	(m)	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	(2-100, Reg)	(0.4-50)	(1-10)	
31	Design Flood Criteria	Arterial	10	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.01	2	0.2
31	Private Vehicle	EMS Route	10	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	5	1
31	Emergency Vehicle	EMS Route	10	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
31	Private Vehicle Acess to Facilities	Yes	10	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.01	3	0.3
31	Emergency Vehicle Access to Facilities	Yes	10	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	7	1.4
31	Private Vehicle Driveway Access (Multiuser)	Medium Vehicle Usage	6	79.90	78.4	79.2	80.1	80.2	80.3	80.3	80.4	0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	4	0.5

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
31	79 15	79.62	80 14	80.28	80.35	80 41	80 45	0	0	2	2	2	3	3

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
31	3	125	90	40	0	0	6	6	6	9	9	50	20	10	4	2	1	0.4	108.6	4	10	40

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
180 Lakeshor	81.2	78.8	80.6	80.45	80.45	1	1	80.45	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	80.41	80.41	1	1	80.41	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	80.35	80.35	1	1	80.35	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	80.28	80.28	1	1	80.28	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	80.14	80.14	1	1	80.14	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	79.62	79.62	1	1	79.62	-100.00	$0.00	0	0
180 Lakeshor	81.2	78.8	80.6	79.15	79.15	1	1	79.15	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	80.45	80.5	40	10	80.46	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	80.41	80.46	40	10	80.42	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	80.35	80.4	40	10	80.36	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	80.28	80.32	40	10	80.29	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	80.14	80.17	40	10	80.15	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	79.62	79.67	40	10	79.63	-100.00	$0.00	0	0
180 Lakeshor	81.3	78.9	80.7	79.15	79.38	40	10	79.21	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	80.5	80.61	50	8	80.52	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	80.46	80.57	50	8	80.48	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	80.39	80.5	50	8	80.41	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	80.31	80.43	50	8	80.33	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	80.16	80.3	50	8	80.18	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	79.72	80.22	50	8	79.80	-100.00	$0.00	0	0
147 Wedgewo	82.5	80.1	81.9	79.64	80.12	50	8	79.72	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.61	81.4	40	7	80.75	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.57	81.35	40	7	80.71	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.5	81.29	40	7	80.64	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.43	81.23	40	7	80.57	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.3	81.12	40	7	80.44	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.22	81.04	40	7	80.36	-100.00	$0.00	0	0
151 Wedgewo	82.4	80.0	81.8	80.12	80.95	40	7	80.27	-100.00	$0.00	0	0
159 Wedgewo	81.9	79.5	81.3	81.4	81.4	1	1	81.40	0.11	$15,658.34	1	0
159 Wedgewo	81.9	79.5	81.3	81.35	81.35	1	1	81.35	0.06	$15,089.80	1	0
159 Wedgewo	81.9	79.5	81.3	81.29	81.29	1	1	81.29	-100.00	$0.00	0	0
159 Wedgewo	81.9	79.5	81.3	81.23	81.23	1	1	81.23	-100.00	$0.00	0	0
159 Wedgewo	81.9	79.5	81.3	81.12	81.12	1	1	81.12	-100.00	$0.00	0	0
159 Wedgewo	81.9	79.5	81.3	81.04	81.04	1	1	81.04	-100.00	$0.00	0	0
159 Wedgewo	81.9	79.5	81.3	80.95	80.95	1	1	80.95	-100.00	$0.00	0	0
169 Wedgewo	82.2	79.8	81.6	81.4	82.18	50	40	82.02	0.43	$19,895.95	1	0
169 Wedgewo	82.2	79.8	81.6	81.35	82.12	50	40	81.97	0.38	$19,063.28	1	0
169 Wedgewo	82.2	79.8	81.6	81.29	82.04	50	40	81.89	0.30	$18,021.17	1	0
169 Wedgewo	82.2	79.8	81.6	81.23	81.95	50	40	81.81	0.22	$16,935.50	1	0
169 Wedgewo	82.2	79.8	81.6	81.12	81.83	50	40	81.69	0.10	$15,519.97	1	0
169 Wedgewo	82.2	79.8	81.6	81.04	81.72	50	40	81.58	-100.00	$0.00	0	0
169 Wedgewo	82.2	79.8	81.6	80.95	81.6	50	40	81.47	-100.00	$0.00	0	0
179 Wedgewo	82.4	80.0	81.8	82.18	82.18	1	1	82.18	0.39	$19,261.73	1	0
179 Wedgewo	82.4	80.0	81.8	82.12	82.12	1	1	82.12	0.33	$18,425.54	1	0
179 Wedgewo	82.4	80.0	81.8	82.04	82.04	1	1	82.04	0.25	$17,366.83	1	0
179 Wedgewo	82.4	80.0	81.8	81.95	81.95	1	1	81.95	0.16	$16,248.31	1	0
179 Wedgewo	82.4	80.0	81.8	81.83	81.83	1	1	81.83	0.04	$14,868.20	1	0
179 Wedgewo	82.4	80.0	81.8	81.72	81.72	1	1	81.72	-100.00	$0.00	0	0
179 Wedgewo	82.4	80.0	81.8	81.6	81.6	1	1	81.60	-100.00	$0.00	0	0

Frequency	Summarized Damage Costs ($)
Reg	$54,819.02
100	$52,578.63
50	$35,388.00
25	$33,183.81
10	$30,388.17
5	$0.00
2	$0.00
TOTAL=	$206,357.63

Reg	3
100-yr	3
50-yr	2
25-yr	2
10-yr	2
5-yr	0
2-yr	0

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
31	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$5,097	$93,046	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	2	2	0	$30,388	0	0	0	0	0	0	$30,388					
	25	93.64	2	2	0	$33,184	0	0	0	0	0	0	$33,184					
	50	93.69	2	2	0	$35,388	0	0	0	0	0	0	$35,388					
	100	93.74	3	3	0	$52,579	0	0	0	0	0	0	$52,579					
	Reg	93.61	3	3	0	$54,819	0	0	0	0	0	0	$54,819					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$765	$13,957	2	4	8
$0					
$4,558					
$4,978					
$5,308					
$7,887					
$8,223					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

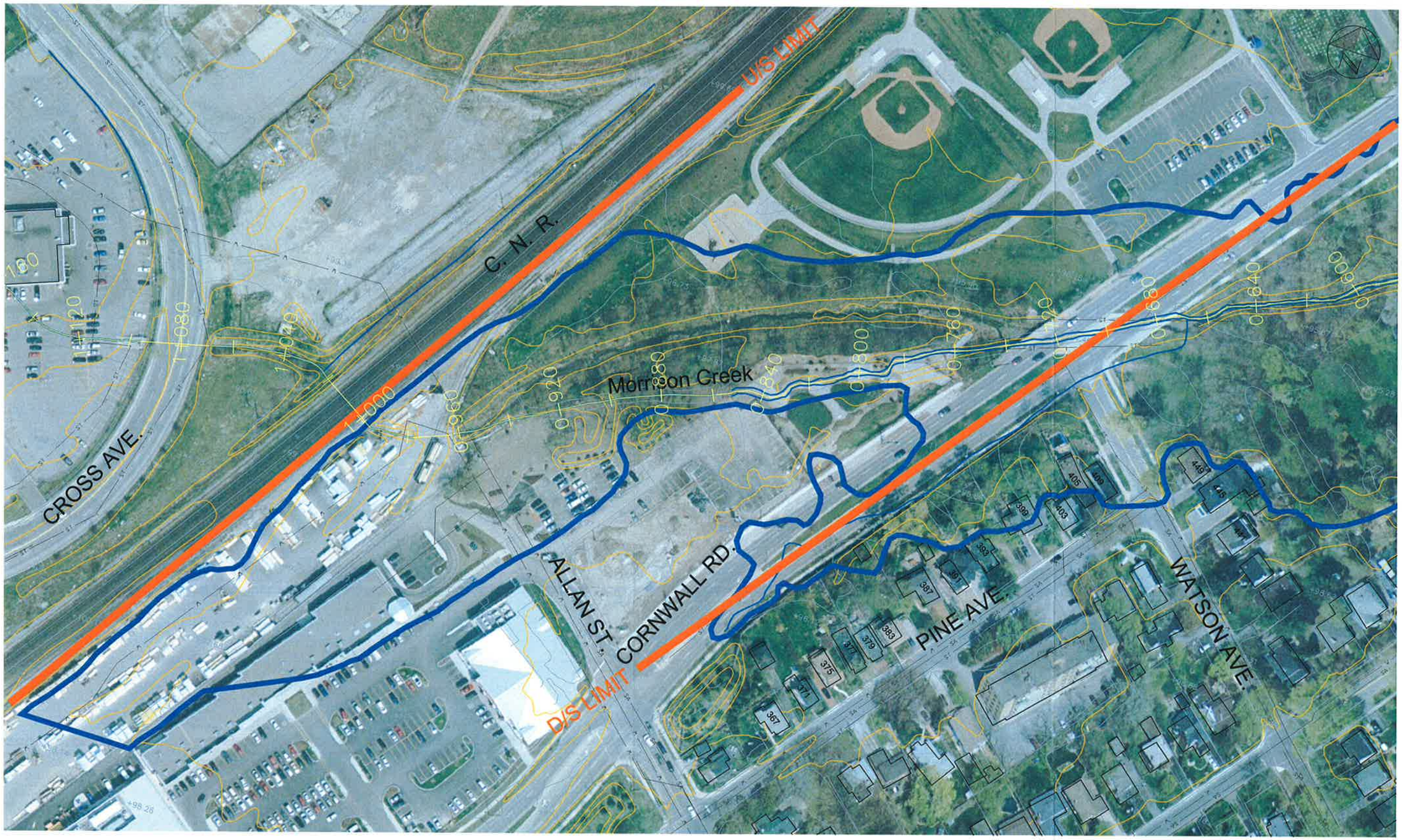
Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
180 Lakes	81.2	78.8	80.6	80.45	80.45	1	1	80.45	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	80.41	80.41	1	1	80.41	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	80.35	80.35	1	1	80.35	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	80.28	80.28	1	1	80.28	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	80.14	80.14	1	1	80.14	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	79.62	79.62	1	1	79.62	-100.00	$0.00	0	0
180 Lakes	81.2	78.8	80.6	79.15	79.15	1	1	79.15	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	80.45	80.5	40	10	80.46	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	80.41	80.46	40	10	80.42	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	80.35	80.4	40	10	80.36	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	80.28	80.32	40	10	80.29	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	80.14	80.17	40	10	80.15	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	79.62	79.67	40	10	79.63	-100.00	$0.00	0	0
180 Lakes	81.3	78.9	80.7	79.15	79.38	40	10	79.21	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	80.5	80.61	50	8	80.52	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	80.46	80.57	50	8	80.48	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	80.39	80.5	50	8	80.41	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	80.31	80.43	50	8	80.33	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	80.16	80.3	50	8	80.18	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	79.72	80.22	50	8	79.80	-100.00	$0.00	0	0
147 Wedg	82.5	80.1	81.9	79.64	80.12	50	8	79.72	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.61	81.4	40	7	80.75	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.57	81.35	40	7	80.71	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.5	81.29	40	7	80.64	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.43	81.23	40	7	80.57	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.3	81.12	40	7	80.44	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.22	81.04	40	7	80.36	-100.00	$0.00	0	0
151 Wedg	82.4	80.0	81.8	80.12	80.95	40	7	80.27	-100.00	$0.00	0	0
159 Wedg	81.9	79.5	81.3	81.4	81.4	1	1	81.40	0.11	$15,658.34	1	0
159 Wedg	81.9	79.5	81.3	81.35	81.35	1	1	81.35	0.06	$15,089.80	1	0
159 Wedg	81.9	79.5	81.3	81.29	81.29	1	1	81.29	-100.00	$0.00	0	0
159 Wedg	81.9	79.5	81.3	81.23	81.23	1	1	81.23	-100.00	$0.00	0	0
159 Wedg	81.9	79.5	81.3	81.12	81.12	1	1	81.12	-100.00	$0.00	0	0
159 Wedg	81.9	79.5	81.3	81.04	81.04	1	1	81.04	-100.00	$0.00	0	0
159 Wedg	81.9	79.5	81.3	80.95	80.95	1	1	80.95	-100.00	$0.00	0	0
169 Wedg	82.2	79.8	81.6	81.4	82.18	50	40	82.02	0.43	$19,898.95	1	0
169 Wedg	82.2	79.8	81.6	81.35	82.12	50	40	81.97	0.38	$19,063.28	1	0
169 Wedg	82.2	79.8	81.6	81.29	82.04	50	40	81.89	0.30	$18,021.17	1	0
169 Wedg	82.2	79.8	81.6	81.23	81.95	50	40	81.81	0.22	$16,935.50	1	0
169 Wedg	82.2	79.8	81.6	81.12	81.83	50	40	81.69	0.10	$15,519.97	1	0
169 Wedg	82.2	79.8	81.6	81.04	81.72	50	40	81.58	-100.00	$0.00	0	0
169 Wedg	82.2	79.8	81.6	80.95	81.6	50	40	81.47	-100.00	$0.00	0	0
179 Wedg	82.4	80.0	81.8	82.18	82.18	1	1	82.18	0.39	$19,261.73	1	0
179 Wedg	82.4	80.0	81.8	82.12	82.12	1	1	82.12	0.33	$18,425.54	1	0
179 Wedg	82.4	80.0	81.8	82.04	82.04	1	1	82.04	0.25	$17,366.83	1	0
179 Wedg	82.4	80.0	81.8	81.95	81.95	1	1	81.95	0.16	$16,248.31	1	0
179 Wedg	82.4	80.0	81.8	81.83	81.83	1	1	81.83	0.04	$14,868.20	1	0
179 Wedg	82.4	80.0	81.8	81.72	81.72	1	1	81.72	-100.00	$0.00	0	0
179 Wedg	82.4	80.0	81.8	81.6	81.6	1	1	81.60	-100.00	$0.00	0	0

Reg	3
100-yr	3
50-yr	2
25-yr	2
10-yr	2
5-yr	0
2-yr	0

Frequency	Summarized Damage Costs ($)
Reg	$54,819.02
100	$52,578.63
50	$35,388.00
25	$33,183.81
10	$30,388.17
5	$0.00
2	$0.00
TOTAL=	$206,357.63

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #32 – MORRO700T



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LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE

SITE # 32 - MORR0700T
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,500
Figure No.	32

Feb 11/08 – avogt

Site #32 (MORR0700T) Implementation Program
Recommended Management Approach/Project Scope: • No management approach recommended due to
Appropriate Lead for Undertaking: • N/A
Governing Protocol Legislation: • N/A
Approval Requirements: • N/A
Need for, and Scope of Follow-Up Assessment/Analysis: • NA/
Suggested Timing, Need for Phasing: • N/A
Possible Implementation Issues: • N/A
Possible Monitoring Requirements: • N/A
Need for Maintenance: • N/A
Potential Interface with Other Town/Agency Programs: • N/A
Other Funding Opportunities: • N/A

Site #32 (MORR0700T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Based on discussions with Conservation Halton there would be no Threat to Life due to a reduction in flood levels upstream of Cornwall Road to the CNR track. Based on information provided by Conservation Halton Cornwall Road would not be overtopped during the Regional storm event.
Screened Alternatives: • N/A
Preferred Management Approach: • N/A
Potential Linkage to Adjacent Sites: • At Site 33

Table 7
Summary of Site Evaluation Results

Site	Catergory Evaluation Products									Combined Products
	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	
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

The combined product of 34 is conservative, as based on discussions with Conservation Halton, actual flood depths would not result in Threat to Life or Flood Damages

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
			(4,6,8,10)	(m)	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	(2-100, Reg)	(0.4-50)	(1-10)	
32	Design Flood Criteria	Arterial	10	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.00	2	0.0
32	Private Vehicle	Level 1 Road/ 100-Regional	10	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.00	5	0
32	Emergency Vehicle	Level 1 Road/ 100-Regional	10	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
32	Private Vehicle Acess to Facilities	Partial	5	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.00	3	0
32	Emergency Vehicle Access to Facilities	Partial	5	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.00	7	0
32	Private Vehicle Driveway Access (Multiuser)	High-Med Vehicle Usage	8	96.46	95.6	95.7	95.9	96.2	96.3	96.3	95.9	-0.9	-0.7	-0.6	-0.3	-0.2	-0.6	-0.6	0.0	0.5	0.7	0.8	0.8	0.9	0.9	1	0.4	0.2	0.08	0.04	0.02	0.01	25-yr	0.00	4	0.0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
32	95.89	96.33	96.29	96.21	95.87	95.78	95.71	0	0	0	0	0	0	0

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
32	3	125	90	40	0	0	0	0	0	0	0	50	20	10	4	2	1	0.4	0	0	10	0

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Finished Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2 100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)/m2	Damage Costs ($)	First Floor Flooding (Yes/ No)	Floor Area (m2)
97.87	97.9	97.4	97.39	50	10	97.40	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.81	97.78	10	10	97.78	-100.00	$0.00	$0.00	0	1,800
97.87	97.9	97.69	97.66	10	97.78	97.40	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.55	97.53	97.78	97.39666	97.53	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.34	97.34	97.39666	97.53007841	97.34	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.17	97.2	97.53007841	97.34	97.20	-100.00	$0.00	$0.00	0	0
97.87	97.9	96.96	97.01	97.34	97.19994153	97.01	-100.00	$0.00	$0.00	0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$0.00
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
32	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$0	$0	0	8	0
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	0	$0	0	0	0	0	0	0	$0					
	25	93.64	0	0	0	$0	0	0	0	0	0	0	$0					
	50	93.69	0	0	0	$0	0	0	0	0	0	0	$0					
	100	93.74	0	0	1	$0	0	0	0	0	0	0	$0					
	Reg	93.61	0	0	0	$0	0	0	0	0	0	0	$0					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$0	$0	0	4	0
$0					
$0					
$0					
$0					
$0					
$0					

Evaluation Process

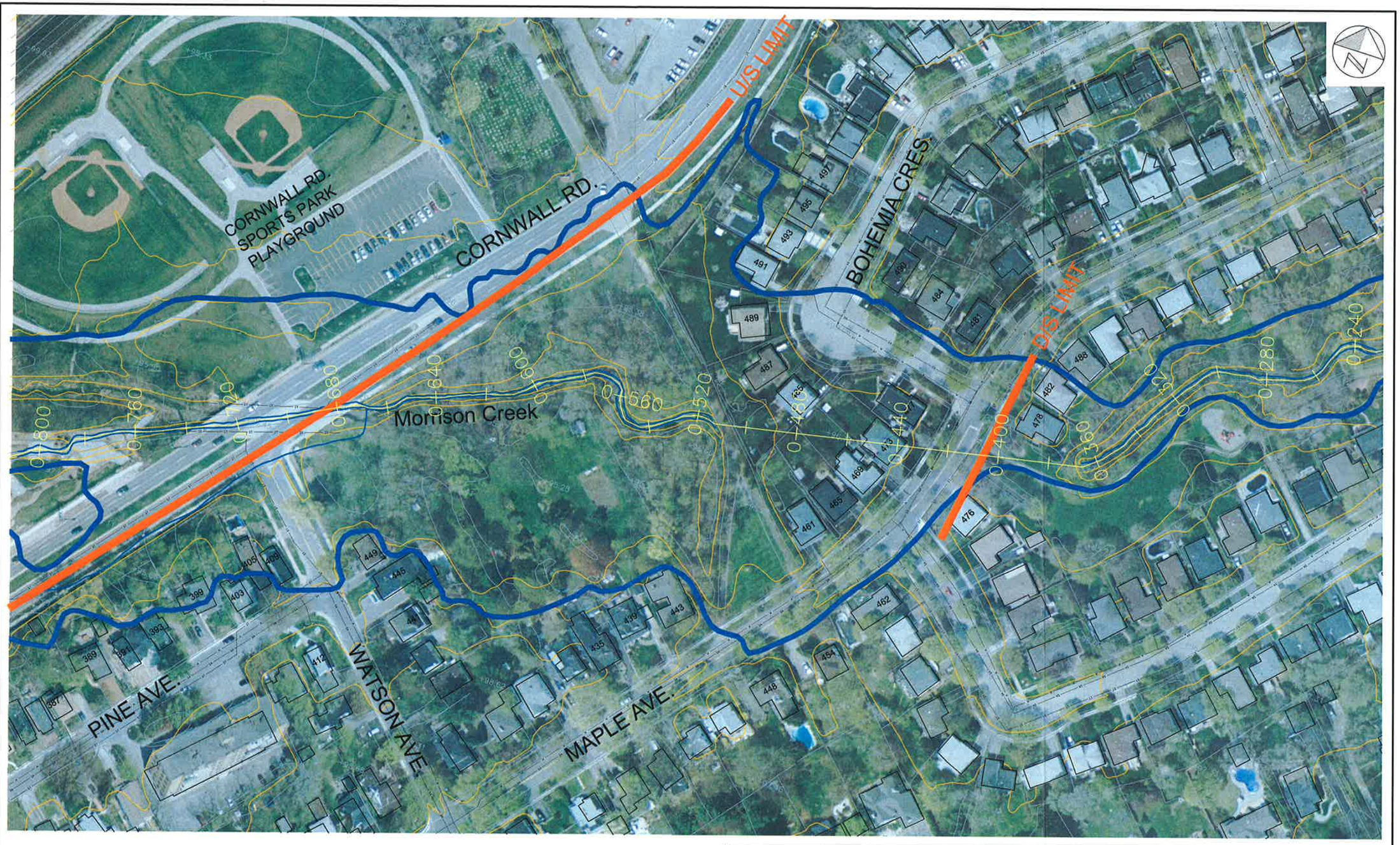
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Finished Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)/m2	Damage Costs ($)	First Floor Flooding (Yes/ No)	Floor Area (m2)
97.87	97.9	97.4	97.39	50	10	97.40	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.81	97.78	10	10	97.78	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.69	97.66	10	97.78	97.40	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.55	97.53	97.78	97.39666	97.53	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.34	97.34	97.39666	97.53007841	97.34	-100.00	$0.00	$0.00	0	0
97.87	97.9	97.17	97.2	97.53007841	97.34	97.20	-100.00	$0.00	$0.00	0	0
97.87	97.9	96.96	97.01	97.34	97.19994153	97.01	-100.00	$0.00	$0.00	0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$0.00
50	$0.00
25	$0.00
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #33 – MORR0405T



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 33 - MORR0405T
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,500
Figure No.	33

Feb 11/08 – avogt

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Site #33 (MORR0405T) Implementation Program

Recommended Management Approach/Project Scope:

- Upstream flood storage required to reduce flows, potentially located upstream of Maple Avenue within open space lands
- Flood proofing of homes not flooded on all sides

Appropriate Lead for Undertaking:

- Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein. This project would require an Environmental Assessment to determine the feasibility of a flood storage area upstream.

Governing Protocol Legislation:

- Town of Oakville's Policies and protocols
- Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations
- Regional Municipality of Halton (EEAC) if flood control located within an ESA
- Ministry of Natural Resources Lakes and Rivers Act
- Department of Fisheries and Oceans Fisheries Act
- Ministry of Environment Certification of Approval
- Others

Approval Requirements: (Would require both Class EA approval and detail design approval)

- Town of Oakville
- Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit
- Regional Municipality of Halton – potentially EEAC
- Regional Municipality for potential water and wastewater servicing alterations
- Ministry of Environment approval of flood control facility design
- Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required)
- Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works)
- Input from Utility companies for utility locations
- Private ownership approval for flood proofing

Need for, and Scope of Follow-Up Assessment/Analysis:

- Class Environmental Assessment for assessing feasibility of upstream flood control controls
- As part of the EA
    - Hydrologic modeling refinement
    - Hydraulic modeling refinement
    - Vegetation assessment
    - Fisheries assessment
    - Natural channel design assessment
- Approval process with private land owners
- Detail design of flood control facility based on Class EA
- Revision to hydraulic modeling at Site 33 and assessment of reduced flows on flood impacts
- Assessment of homes still flooded with revised hydraulics, topographic survey of homes; flood proofing to follow assessment

Suggested Timing, Need for Phasing:

- Timing of project dependant on Capital Works Program budget and priority of project within the Program.

Possible Implementation Issues:

- Lack of feasibility to implement upstream flood controls, or flood controls not effective in reducing downstream flows as required
- Land ownership
- Fisheries constraints
- Approval from home owner(s) for flood proofing

Possible Monitoring Requirements:

- Potentially Department of Fisheries and Oceans monitoring requirements\

Site #33 (MORR0405T) Implementation Program
Need for Maintenance:
• Would have to be determined within the Class EA
Potential Interface with Other Town/Agency Programs:
• To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study • Potential projects already identified by Conservation Halton
Other Funding Opportunities:
• To be discussed/ determined with the Town of Oakville and Conservation Halton • Others

Site #33 (MORR0405T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Maple Avenue crossing 161 m by 3.1 m by 1.22 m box culvert • Encroachment
Screened Alternatives: • Culvert upgrades – 2 (2.4 m by 1.2 m box culverts) would be expensive due to 161 m length of culvert and location of culvert within private property. • Flood storage at site and north of Cornwall Road • Floodplain and channel improvements would not provide flood protection as the Maple Avenue crossing is the hydraulic constraint. • Flood-proofing • Acquisition • Regulate
Preferred Management Approach: • Flood storage at site and potentially north of Cornwall road, details to be determined. • Flood-proof to extent possible of homes not flooded on all sides. • Regulate
Potential Linkage to Adjacent Sites: • Site 32 and 35

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
33	0.6	0.4	0.5	0.6	0.7	0.5	40.0	32.0	16.0	**91.3**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
33	Design Flood Criteria	Collector	8	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	Collector / 1:50	0.04	2	0.6
33	Private Vehicle	Level 4 Road/ 100-Regional	4	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	5	0.4
33	Emergency Vehicle	Level 4 Road/ 100-Regional	4	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
33	Private Vehicle Acess to Facilities	Partial	5	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	Collector / 1:50	0.04	3	0.6
33	Emergency Vehicle Access to Facilities	Partial	5	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	7	0.7
33	Private Vehicle Driveway Access (Multiuser)	Medium Vehicle Usage	6	95.40	94.8	95.6	95.6	95.7	95.7	95.8	95.7	0.0	0.2	0.2	0.3	0.3	0.4	0.3	0.0	0.5	0.6	0.7	0.8	0.8	0.7	1	0.4	0.2	0.08	0.04	0.02	0.01	100-yr	0.02	4	0.5

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
33	94.79	95.56	95.63	95.67	69.68	95.8	95.67	0	2	3	7	12	12	3

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered						
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg
33	3	125	90	40	0	6	9	21	36	36	9

Site No	Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg				
33	50	20	10	4	2	1	0.4	405.6	4	10	40

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
477 Maple Av	95.9	93.5	95.3	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
477 Maple Av	95.9	93.5	95.3	95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
477 Maple Av	95.9	93.5	95.3	95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
477 Maple Av	95.9	93.5	95.3	95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
477 Maple Av	95.9	93.5	95.3	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
477 Maple Av	95.9	93.5	95.3	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
477 Maple Av	95.9	93.5	95.3	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
473 Maple Av	95.9	93.5	95.3	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
473 Maple Av	95.9	93.5	95.3	95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
473 Maple Av	95.9	93.5	95.3	95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
473 Maple Av	95.9	93.5	95.3	95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
473 Maple Av	95.9	93.5	95.3	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
473 Maple Av	95.9	93.5	95.3	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
473 Maple Av	95.9	93.5	95.3	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
469 Maple Av	95.9	93.5	95.3	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
469 Maple Av	95.9	93.5	95.3	95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
469 Maple Av	95.9	93.5	95.3	95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
469 Maple Av	95.9	93.5	95.3	95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
469 Maple Av	95.9	93.5	95.3	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
469 Maple Av	95.9	93.5	95.3	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
469 Maple Av	95.9	93.5	95.3	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
465 Maple Av	96	93.6	95.4	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
465 Maple Av	96	93.6	95.4	95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
465 Maple Av	96	93.6	95.4	95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
465 Maple Av	96	93.6	95.4	95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
465 Maple Av	96	93.6	95.4	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
465 Maple Av	96	93.6	95.4	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
465 Maple Av	96	93.6	95.4	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
461 Maple Av	96.1	93.7	95.5	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
461 Maple Av	96.1	93.7	95.5	95.67	95.67	1	1	95.67	0.19	$16,490.48	1	0
461 Maple Av	96.1	93.7	95.5	95.56	95.56	1	1	95.56	0.07	$15,201.83	1	0
461 Maple Av	96.1	93.7	95.5	95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
461 Maple Av	96.1	93.7	95.5	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
461 Maple Av	96.1	93.7	95.5	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
461 Maple Av	96.1	93.7	95.5	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
485 Bohemia	96	93.6	95.4	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
485 Bohemia	96	93.6	95.4	95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
485 Bohemia	96	93.6	95.4	95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
485 Bohemia	96	93.6	95.4	95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
485 Bohemia	96	93.6	95.4	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
485 Bohemia	96	93.6	95.4	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
485 Bohemia	96	93.6	95.4	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
487 Bohemia	96	93.6	95.4	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
487 Bohemia	96	93.6	95.4	95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
487 Bohemia	96	93.6	95.4	95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
487 Bohemia	96	93.6	95.4	95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
487 Bohemia	96	93.6	95.4	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
487 Bohemia	96	93.6	95.4	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
487 Bohemia	96	93.6	95.4	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
489 Bohemia	96	93.6	95.4	95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
489 Bohemia	96	93.6	95.4	95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
489 Bohemia	96	93.6	95.4	95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
489 Bohemia	96	93.6	95.4	95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
489 Bohemia	96	93.6	95.4	94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
489 Bohemia	96	93.6	95.4	94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
489 Bohemia	96	93.6	95.4	94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.35	95.35	1	1	95.35	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.78	95.78	1	1	95.78	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.69	95.69	1	1	95.69	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.53	95.53	1	1	95.53	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.28	95.28	1	1	95.28	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	95.16	95.16	1	1	95.16	-100.00	$0.00	0	0
445 Watson A	96.9	94.5	96.3	94.97	94.97	1	1	94.97	-100.00	$0.00	0	0
409 Pine Ave	96	93.6	95.4	95.69	95.69	1	1	95.69	0.30	$18,021.17	1	0
409 Pine Ave	96	93.6	95.4	95.9	95.9	1	1	95.90	0.51	$21,049.65	1	0
409 Pine Ave	96	93.6	95.4	95.84	95.84	1	1	95.84	0.45	$20,135.85	1	0
409 Pine Ave	96	93.6	95.4	95.76	95.76	1	1	95.76	0.37	$18,978.67	1	0
409 Pine Ave	96	93.6	95.4	95.66	95.66	1	1	95.66	0.27	$17,625.66	1	0
409 Pine Ave	96	93.6	95.4	95.55	95.55	1	1	95.55	0.16	$16,248.31	1	0
408 Pine Ave	96	93.6	95.4	95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
405 Pine Ave	96.1	93.7	95.5	95.69	95.69	1	1	95.69	0.20	$16,736.25	1	0
405 Pine Ave	96.1	93.7	95.5	95.9	95.9	1	1	95.90	0.41	$19,548.80	1	0
405 Pine Ave	96.1	93.7	95.5	95.84	95.84	1	1	95.84	0.35	$18,700.16	1	0
405 Pine Ave	96.1	93.7	95.5	95.76	95.76	1	1	95.76	0.27	$17,625.66	1	0
405 Pine Ave	96.1	93.7	95.5	95.66	95.66	1	1	95.66	0.17	$16,368.95	1	0
405 Pine Ave	96.1	93.7	95.5	95.55	95.55	1	1	95.55	0.06	$15,089.60	1	0
405 Pine Ave	96.1	93.7	95.5	95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
403 Pine Ave	96.2	93.8	95.6	95.69	95.69	1	1	95.69	0.10	$15,542.55	1	0
403 Pine Ave	96.2	93.8	95.6	95.9	95.9	1	1	95.90	0.31	$18,154.96	1	0
403 Pine Ave	96.2	93.8	95.6	95.84	95.84	1	1	95.84	0.25	$17,366.83	1	0
403 Pine Ave	96.2	93.8	95.6	95.76	95.76	1	1	95.76	0.17	$16,368.95	1	0
403 Pine Ave	96.2	93.8	95.6	95.66	95.66	1	1	95.66	0.07	$15,201.83	1	0
403 Pine Ave	96.2	93.8	95.6	95.55	95.55	1	1	95.55	-100.00	$0.00	0	0
403 Pine Ave	96.2	93.8	95.6	95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
399 Pine Ave	96.3	93.9	95.7	95.69	95.69	1	1	95.69	-100.00	$0.00	0	0
399 Pine Ave	96.3	93.9	95.7	95.9	95.9	1	1	95.90	0.21	$16,860.51	1	0
399 Pine Ave	96.3	93.9	95.7	95.84	95.84	1	1	95.84	0.15	$16,128.57	1	0
399 Pine Ave	96.3	93.9	95.7	95.76	95.76	1	1	95.76	0.07	$15,201.83	1	0
399 Pine Ave	96.3	93.9	95.7	95.66	95.66	1	1	95.66	-100.00	$0.00	0	0
399 Pine Ave	96.3	93.9	95.7	95.55	95.55	1	1	95.55	-100.00	$0.00	0	0
399 Pine Ave	96.3	93.9	95.7	95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
										Reg	3	0
										100	12	0
										50	12	0
										25	7	0
										10	3	0
										5	2	0
										2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$50,300.36
100	$220,493.61
50	$205,986.01
25	$113,111.08
10	$49,196.44
5	$31,338.11
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endangerme

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
33	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$20,297	$370,536	4	8	32
	5	93.00	2	2	0	$31,338	0	0	0	0	0	0	$31,338					
	10	93.51	3	3	0	$49,196	0	0	0	0	0	0	$49,196					
	25	93.64	7	7	0	$113,111	0	0	0	0	0	0	$113,111					
	50	93.69	12	12	0	$205,886	0	0	0	0	0	0	$205,886					
	100	93.74	12	12	0	$220,490	0	0	0	0	0	0	$220,490					
	Reg	93.61	3	3	0	$50,300	0	0	0	0	0	0	$50,300					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$3,045	$55,580	4	4	16
$4,701					
$7,379					
$16,967					
$30,883					
$33,073					
$7,545					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.38	$19,119.77	1	0
95.56	95.56	1	1	95.56	0.27	$17,625.66	1	0
95.34	95.34	1	1	95.34	0.05	$14,978.59	1	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.18	$16,490.48	1	0
95.56	95.56	1	1	95.56	0.07	$15,201.83	1	0
95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.19	95.19	1	1	95.19	-100.00	$0.00	0	0
95.67	95.67	1	1	95.67	0.28	$17,756.52	1	0
95.56	95.56	1	1	95.56	0.17	$16,368.95	1	0
95.34	95.34	1	1	95.34	-100.00	$0.00	0	0
94.89	94.89	1	1	94.89	-100.00	$0.00	0	0
94.4	94.4	1	1	94.40	-100.00	$0.00	0	0
94.28	94.28	1	1	94.28	-100.00	$0.00	0	0
95.35	95.35	1	1	95.35	-100.00	$0.00	0	0
95.78	95.78	1	1	95.78	-100.00	$0.00	0	0
95.69	95.69	1	1	95.69	-100.00	$0.00	0	0
95.53	95.53	1	1	95.53	-100.00	$0.00	0	0
95.28	95.28	1	1	95.28	-100.00	$0.00	0	0
95.16	95.16	1	1	95.16	-100.00	$0.00	0	0
94.97	94.97	1	1	94.97	-100.00	$0.00	0	0
95.69	95.69	1	1	95.69	0.30	$18,021.17	1	0
95.9	95.9	1	1	95.90	0.51	$21,049.65	1	0
95.84	95.84	1	1	95.84	0.45	$20,135.85	1	0
95.76	95.76	1	1	95.76	0.37	$18,978.87	1	0
95.66	95.66	1	1	95.66	0.27	$17,625.66	1	0
95.55	95.55	1	1	95.55	0.16	$16,248.31	1	0
95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
95.69	95.69	1	1	95.69	0.20	$16,736.25	1	0
95.9	95.9	1	1	95.90	0.41	$19,548.80	1	0
95.84	95.84	1	1	95.84	0.35	$18,700.16	1	0
95.76	95.76	1	1	95.76	0.27	$17,625.66	1	0
95.66	95.66	1	1	95.66	0.17	$16,368.95	1	0
95.55	95.55	1	1	95.55	0.06	$15,089.80	1	0
95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
95.69	95.69	1	1	95.69	0.10	$15,542.95	1	0
95.9	95.9	1	1	95.90	0.31	$18,154.96	1	0
95.84	95.84	1	1	95.84	0.25	$17,366.83	1	0
95.76	95.76	1	1	95.76	0.17	$16,368.95	1	0
95.66	95.66	1	1	95.66	0.07	$15,201.83	1	0
95.55	95.55	1	1	95.55	-100.00	$0.00	0	0
95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
95.69	95.69	1	1	95.69	-100.00	$0.00	0	0
95.9	95.9	1	1	95.90	0.21	$16,860.51	1	0
95.84	95.84	1	1	95.84	0.15	$16,128.57	1	0
95.76	95.76	1	1	95.76	0.07	$15,201.83	1	0
95.66	95.66	1	1	95.66	-100.00	$0.00	0	0
95.55	95.55	1	1	95.55	-100.00	$0.00	0	0
95.39	95.39	1	1	95.39	-100.00	$0.00	0	0
						Reg	3	0
						100	12	0
						50	12	0
						25	7	0
						10	3	0
						5	2	0
						2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$50,300.36
100	$220,469.81
50	$205,886.01
25	$113,111.08
10	$49,196.44
5	$31,338.11
2	$0.00

g elevations for all storm events at buildings that potentially flood
ıor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
ıent floor elevation by substracting 2.44m from the first floor elevation
ıent window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land us
g depths based on lowest opening elevation and flooding elevations for all storms
g damages for each return period based on the flooding depths and damage curve equations

SITE #35 – MORR0098T

LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 35 - MORR0098T
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	35

Feb 11/08 – avogt

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Site #35 (MORR0098T) Implementation Program
Recommended Management Approach/Project Scope: • Flood control upstream of site (See Site 33) • Upgrade Chartwell Road crossing by adding 3 m by 1.6 m box culvert to existing 3 m by 1.6 m box culvert
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein. This project would require an Environmental Assessment to determine the feasibility of a flood storage area upstream. The additional culvert could be considered following possible reduction of flows from flood protection upstream
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Certification of Approval • Others
Approval Requirements: (Would require both Class EA approval and detail design approval) • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality for potential water and wastewater servicing alterations • Ministry of Environment approval of flood control facility design • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Class Environmental Assessment for assessing feasibility of upstream flood control controls • As part of the EA o Hydrologic modeling refinement o Hydraulic modeling refinement o Vegetation assessment o Fisheries assessment o Natural channel design assessment • Approval process with private land owners • Detail design of flood control facility based on Class EA • Revision to hydraulic modeling at Site 35 and assessment of reduced flows on flood impacts • Topographic survey of crossing and creek to facilitate hydraulic modeling and detail design • Hydraulic modeling of Site with proposed culvert addition once potential flood control in place
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Lack of feasibility to implement upstream flood controls, or flood controls not effective in reducing downstream flows as required • Land ownership • Fisheries constraints
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Would have to be determined within the Class EA
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study • Potential projects already identified by Conservation Halton

Site #35 (MORR0098T) Implementation Program
Other Funding Opportunities:
• To be discussed/ determined with the Town of Oakville and Conservation Halton
• Others

Site #35 (MORR0098T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Chartwell Road crossing 3 m by 1.6 m resulting in overflow (spill across road to Site 37) • Spill across Maple Road resulting from 3.1 m by 1.22 m box culvert (Site 33)
Screened Alternatives: • 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
Preferred Management Approach: • Upgrade Chartwell Road crossing • See Site 33
Potential Linkage to Adjacent Sites: • Site 33

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
35	1.6	0.0	0.0	0.0	0.0	0.0	30.0	16.0	8.0	**55.6**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
35	Design Flood Criteria	Arterial	10	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.08	2	2
35	Private Vehicle	EMS Route	10	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.00	5	0
35	Emergency Vehicle	EMS Route	10	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
35	Private Vehicle Acess to Facilities	Partial	0	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	Arterial / 1:100 - Reg	0.08	3	0
35	Emergency Vehicle Access to Facilities	Partial	0	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.00	7	0
35	Private Vehicle Driveway Access (Multiuser)	Medium Vehicle Usage	0	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.00	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
35	92.69	93	93.51	93.64	93.69	93.74	93.61	0	0	1	1	1	2	1

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
35	3	125	90	40	0	0	3	3	3	6	3	50	20	10	4	2	1	0.4	55.2	3	10	30

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
482 Maple Av	96.2	93.8	95.6	94.62	95.67	10	10	95.67	0.08	$15,314.70	1	0
482 Maple Av	96.2	93.8	95.6	94.91	95.8	10	10	95.80	0.21	$16,860.51	1	0
482 Maple Av	96.2	93.8	95.6	94.79	95.68	10	10	95.68	0.09	$15,428.40	1	0
482 Maple Av	96.2	93.8	95.6	94.67	95.67	10	10	95.67	0.08	$15,314.70	1	0
482 Maple Av	96.2	93.8	95.6	94.5	95.63	10	10	95.63	0.04	$14,868.20	1	0
482 Maple Av	96.2	93.8	95.6	94.34	95.56	10	10	95.56	-100.00	$0.00	0	0
482 Maple Av	96.2	93.8	95.6	93.93	94.79	10	10	94.79	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	94.62	95.67	10	10	95.67	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	94.91	95.8	10	10	95.80	0.11	$15,658.34	1	0
486 Maple Av	96.3	93.9	95.7	94.79	95.68	10	10	95.68	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	94.67	95.67	10	10	95.67	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	94.5	95.63	10	10	95.63	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	94.34	95.56	10	10	95.56	-100.00	$0.00	0	0
486 Maple Av	96.3	93.9	95.7	93.93	94.79	10	10	94.79	-100.00	$0.00	0	0
										Reg	1	0
										100	2	0
										50	1	0
										25	1	0
										10	1	0
										5	0	0
										2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$15,314.70
100	$32,518.85
50	$15,428.40
25	$15,314.70
10	$14,868.20
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
35	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$2,439	$44,524	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	1	1	0	$14,868	0	0	0	0	0	0	$14,868					
	25	93.64	1	1	0	$15,315	0	0	0	0	0	0	$15,315					
	50	93.69	1	1	0	$15,428	0	0	0	0	0	0	$15,428					
	100	93.74	2	2	0	$32,519	0	0	0	0	0	0	$32,519					
	Reg	93.61	1	1	0	$15,315	0	0	0	0	0	0	$15,315					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$366	$6,679	2	4	8
$0					
$2,230					
$2,297					
$2,314					
$4,878					
$2,297					

Evaluation Process

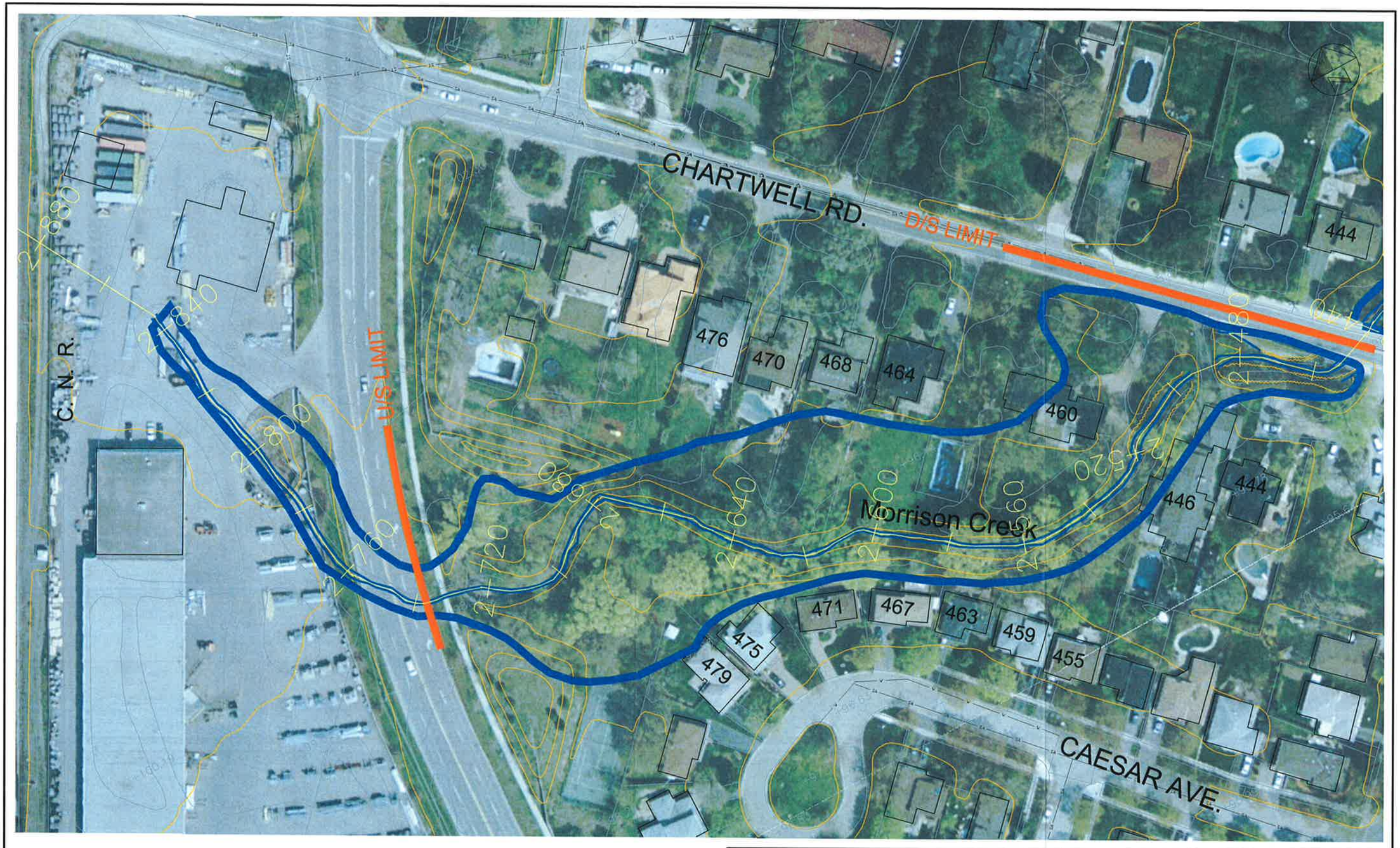
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
482 Maple	96.2	93.8	95.6	94.62	95.67	10	10	95.67	0.08	$15,314.70	1	0
482 Maple	96.2	93.8	95.6	94.91	95.8	10	10	95.80	0.21	$16,860.51	1	0
482 Maple	96.2	93.8	95.6	94.79	95.68	10	10	95.68	0.09	$15,428.40	1	0
482 Maple	96.2	93.8	95.6	94.67	95.67	10	10	95.67	0.08	$15,314.70	1	0
482 Maple	96.2	93.8	95.6	94.5	95.63	10	10	95.63	0.04	$14,868.20	1	0
482 Maple	96.2	93.8	95.6	94.34	95.56	10	10	95.56	-100.00	$0.00	0	0
482 Maple	96.2	93.8	95.6	93.93	94.79	10	10	94.79	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	94.62	95.67	10	10	95.67	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	94.91	95.8	10	10	95.80	0.11	$15,658.34	1	0
486 Maple	96.3	93.9	95.7	94.79	95.68	10	10	95.68	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	94.67	95.67	10	10	95.67	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	94.5	95.63	10	10	95.63	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	94.34	95.56	10	10	95.56	-100.00	$0.00	0	0
486 Maple	96.3	93.9	95.7	93.93	94.79	10	10	94.79	-100.00	$0.00	0	0
										Reg	1	0
										100	2	0
										50	1	0
										25	1	0
										10	1	0
										5	0	0
										2	0	0

Summarized Direct Damage Costs ($)
$15,314.70
$32,518.85
$15,428.40
$15,314.70
$14,868.20
$0.00
$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #36 – MORR2445T



LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 36 - MORR2445T
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	36

Feb 11/08 – avogt

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Site #36 (MORR2445T) Implementation Program
Recommended Management Approach/Project Scope: • Upgrade driveway crossing at 446 Chartwell Road, from 2.4 by 1.8 Elliptical CSP to 1.8 by 1.6 m+ box culvert or equivalent • Flood proofing of 446, 460 Chartwell Road and 479 Caesar Avenue
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality of Halton for water and wastewater servicing alterations • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Detailed topographic survey of area • Vegetation assessment • Natural channel design assessment • Hydraulic modeling refinement • Approval process with private land owners
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed grading • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #36 (MORR2445T) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Driveway crossing for 446 Chartwell Road (2.4 m by 1.8 m Elliptical CSP) • Floodplain capacity • Encroachment
Screened Alternatives: • 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. • Floodplain improvements are impractical due to private property and existing vegetation.
Preferred Management Approach: • Culvert upgrade • Flood-proofing of 479 Caesar Avenue approximately 0.01 m. Topographic survey required to verify building elevation and flood proofing required.
Potential Linkage to Adjacent Sites: • No linkage

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
36	0.0	0.0	0.0	0.0	0.0	0.0	40.0	16.0	8.0	**64**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight	Road/ Driveway Elevation	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met	Storm Event Frequency Modifier Selected	Evaluation Scale Category Importance/ Significance	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
			(4,6,8,10)	(m)																												(2-100, Reg)	(0.4-50)	(1-10)	
36	Design Flood Criteria	Arterial	10	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	2	0
36	Private Vehicle	EMS Route	10	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	5	0
36	Emergency Vehicle	EMS Route	10	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
36	Private Vehicle Acess to Facilities	No	0	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
36	Emergency Vehicle Access to Facilities	No	0	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
36	Private Vehicle Driveway Access (Multiuser)	NA	0	94.66	93.8	93.9	94.0	94.1	94.2	94.3	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	NA	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)							Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)				People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
36	93.7	93.81	93.89	93.99	94.05	94.11	93.86	1	1	1	3	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40	3	3	3	9	9	9	3	40	20	10	4	2	1	0.4	304.2	4	10	40

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2 100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
446 Chartwell	96.3	93.9	95.7	95.33	95.9	60	20	95.52	-100.00	$0.00	0	0
446 Chartwell	96.3	93.9	95.7	95.67	96.06	60	20	95.80	0.11	$15,658.34	1	0
446 Chartwell	96.3	93.9	95.7	95.63	96.03	60	20	95.76	0.07	$15,239.36	1	0
446 Chartwell	96.3	93.9	95.7	95.56	95.98	60	20	95.70	0.01	$14,541.90	1	0
446 Chartwell	96.3	93.9	95.7	95.27	95.92	60	20	95.49	-100.00	$0.00	0	0
446 Chartwell	96.3	93.9	95.7	95.19	95.86	60	20	95.41	-100.00	$0.00	0	0
446 Chartwell	96.3	93.9	95.7	94.88	95.81	60	20	95.19	-100.00	$0.00	0	0
460 Chartwell	96.5	94.1	95.9	95.33	95.9	60	50	95.81	-100.00	$0.00	0	0
460 Chartwell	96.5	94.1	95.9	95.67	96.06	60	50	96.00	0.10	$15,600.54	1	0
460 Chartwell	96.5	94.1	95.9	95.63	96.03	60	50	95.96	0.07	$15,239.36	1	0
460 Chartwell	96.5	94.1	95.9	95.56	95.98	60	50	95.91	0.02	$14,649.86	1	0
460 Chartwell	96.5	94.1	95.9	95.27	95.92	60	50	95.81	-100.00	$0.00	0	0
460 Chartwell	96.5	94.1	95.9	95.19	95.86	60	50	95.75	-100.00	$0.00	0	0
460 Chartwell	96.5	94.1	95.9	94.88	95.81	60	50	95.66	-100.00	$0.00	0	0
479 Caesar A	96.5	94.1	95.9	96.83	96.83	1	1	96.83	0.94	$28,932.20	1	1
479 Caesar A	96.5	94.1	95.9	96.93	96.93	1	1	96.93	1.04	$31,153.45	1	1
479 Caesar A	96.5	94.1	95.9	96.9	96.9	1	1	96.90	1.01	$30,469.74	1	1
479 Caesar A	96.5	94.1	95.9	96.87	96.87	1	1	96.87	0.98	$29,801.03	1	1
479 Caesar A	96.5	94.1	95.9	96.85	96.85	1	1	96.85	0.96	$29,363.40	1	1
479 Caesar A	96.5	94.1	95.9	96.81	96.81	1	1	96.81	0.92	$28,507.32	1	1
479 Caesar A	96.5	94.1	95.9	96.77	96.77	1	1	96.77	0.88	$27,676.20	1	1
										Reg	1	1
										100	3	1
										50	3	1
										25	3	1
										10	1	1
										5	1	1
										2	1	1

Frequency	Summarized Damage Costs ($)
Reg	$28,932.20
100	$62,412.33
50	$60,948.46
25	$58,992.79
10	$29,363.40
5	$28,507.32
2	$27,676.20

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
36	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$2,308	$42,130	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	0	$0	0	0	0	0	0	0	$0					
	25	93.64	2	2	0	$29,192	0	0	0	0	0	0	$29,192					
	50	93.69	3	3	0	$45,021	0	0	0	0	0	0	$45,021					
	100	93.74	3	3	0	$46,127	0	0	0	0	0	0	$46,127					
	Reg	93.61	0	0	0	$0	0	0	0	0	0	0	$0					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$346	$6,320	2	4	8
$0					
$0					
$4,379					
$6,753					
$6,919					
$0					

Evaluation Process

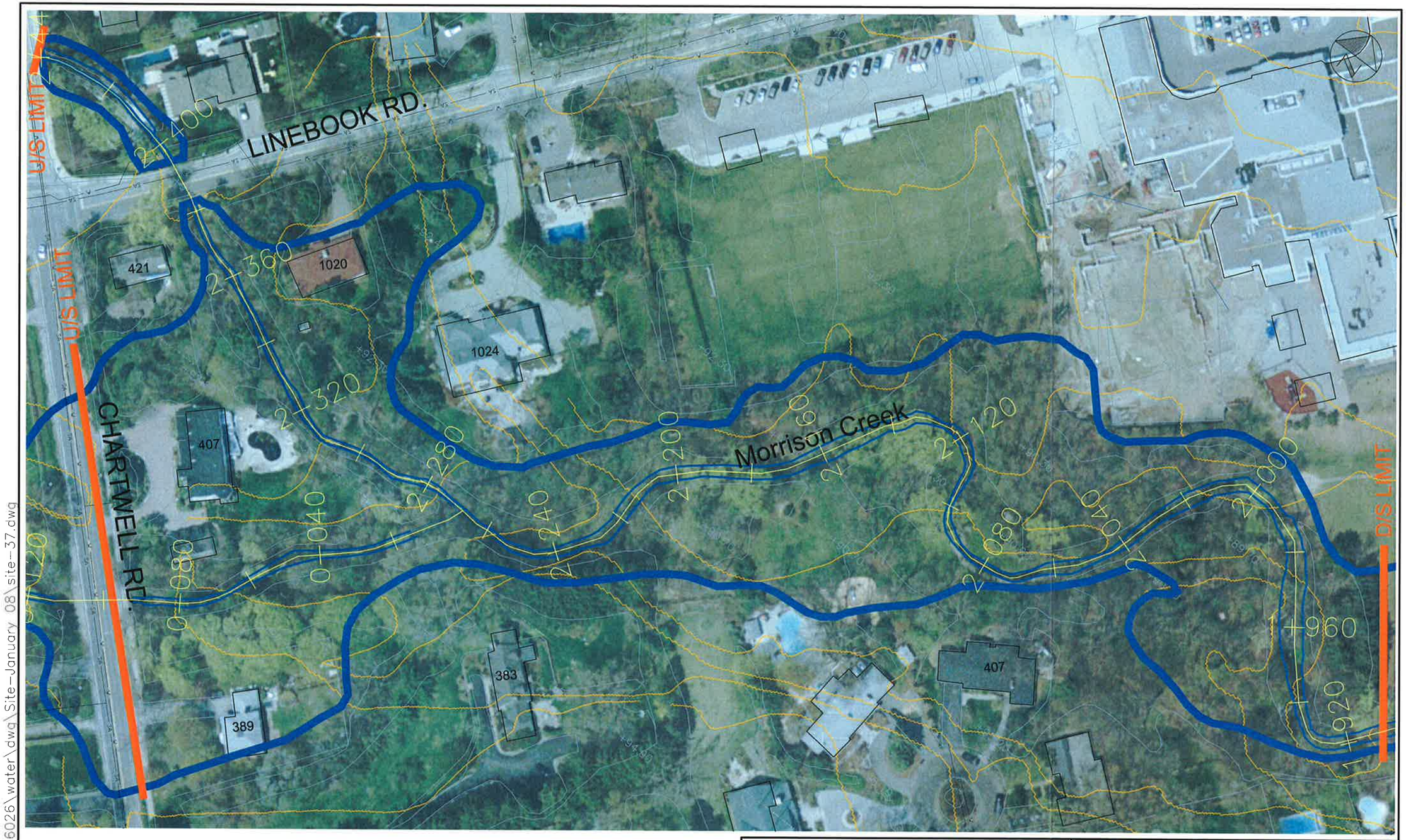
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream Reg Elevations 2-100/ Flood (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
446 Chartv	96.3	93.9	95.7	95.33	95.9	60	20	95.52	-100.00	$0.00	0	0
446 Chartv	96.3	93.9	95.7	95.67	96.06	60	20	95.80	0.11	$15,658.34	1	0
446 Chartv	96.3	93.9	95.7	95.63	96.03	60	20	95.76	0.07	$15,239.36	1	0
446 Chartv	96.3	93.9	95.7	95.56	95.98	60	20	95.70	0.01	$14,541.90	1	0
446 Chartv	96.3	93.9	95.7	95.27	95.92	60	20	95.49	-100.00	$0.00	0	0
446 Chartv	96.3	93.9	95.7	95.19	95.86	60	20	95.41	-100.00	$0.00	0	0
446 Chartv	96.3	93.9	95.7	94.88	95.81	60	20	95.19	-100.00	$0.00	0	0
460 Chartv	96.5	94.1	95.9	95.33	95.9	60	50	95.81	-100.00	$0.00	0	0
460 Chartv	96.5	94.1	95.9	95.67	96.06	60	50	96.00	0.10	$15,600.54	1	0
460 Chartv	96.5	94.1	95.9	95.63	96.03	60	50	95.96	0.07	$15,239.36	1	0
460 Chartv	96.5	94.1	95.9	95.56	95.98	60	50	95.91	0.02	$14,649.86	1	0
460 Chartv	96.5	94.1	95.9	95.27	95.92	60	50	95.81	-100.00	$0.00	0	0
460 Chartv	96.5	94.1	95.9	95.19	95.86	60	50	95.75	-100.00	$0.00	0	0
460 Chartv	96.5	94.1	95.9	94.88	95.81	60	50	95.66	-100.00	$0.00	0	0
479 Caesa	97.5	95.1	96.9	96.83	96.83	1	1	96.83	-100.00	$0.00	0	0
479 Caesa	97.5	95.1	96.9	96.93	96.93	1	1	96.93	0.04	$14,868.20	1	0
479 Caesa	97.5	95.1	96.9	96.9	96.9	1	1	96.90	0.01	$14,541.90	1	0
479 Caesa	97.5	95.1	96.9	96.87	96.87	1	1	96.87	-100.00	$0.00	0	0
479 Caesa	97.5	95.1	96.9	96.85	96.85	1	1	96.85	-100.00	$0.00	0	0
479 Caesa	97.5	95.1	96.9	96.81	96.81	1	1	96.81	-100.00	$0.00	0	0
479 Caesa	97.5	95.1	96.9	96.77	96.77	1	1	96.77	-100.00	$0.00	0	0
										Reg	0	0
										100	3	0
										50	3	0
										25	2	0
										10	0	0
										5	0	0
										2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$46,127.09
50	$45,020.62
25	$29,191.76
10	$0.00
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #37 – MORR1910M



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LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 37 - MORR1910M
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	37

Feb 11/08 – avogt

Site #37 (MORR1910M) Implementation Program
Recommended Management Approach/Project Scope: • Flood control upstream of site (See Site 33) • Upgrade Chartwell Road Culvert (Site 35) by adding 3 m by 1.6 m box culvert to existing 3 m by 1.6 m box culvert • Flood proofing of 1020 Linbrook Road once Chartwell Road culvert upgraded
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality of Halton for water and wastewater servicing alterations • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations • Approval from home owner for flood proofing
Need for, and Scope of Follow-Up Assessment/Analysis: • Class Environmental Assessment for assessing feasibility of upstream flood control controls • As part of the EA o Hydrologic modeling refinement o Hydraulic modeling refinement o Vegetation assessment o Fisheries assessment o Natural channel design assessment • Approval process with private land owners • Detail design of flood control facility based on Class EA • Revision to hydraulic modeling at Site 35 and assessment of reduced flows on flood impacts • Topographic survey of crossing and creek to facilitate hydraulic modeling and detail design • Hydraulic modeling of Site with proposed culvert addition once potential flood
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed grading • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance

Site #37 (MORR1910M) Implementation Program
Potential Interface with Other Town/Agency Programs:
• To be discussed/ determined with the Town of Oakville and Conservation Halton
• Potential opportunities with Town's Creek Erosion Study and road work
• Potential projects already identified by Conservation Halton
Other Funding Opportunities:
• To be discussed/ determined with the Town of Oakville and Conservation Halton
• Canada/ Ontario Municipal Renewal Infrastructure Fund
• Others

Site #37 (MORR1910M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Spill from Chartwell Road due to 3 m by 1.6 m box culvert • Encroachment
Screened Alternatives: • Upstream crossing upgrade (see Site 35) • Flood proofing – properties flooded on all sides, although 1020 Linebrook Road may be possible based on building elevations being verified through topographic survey. • Acquisition – 3 properties (costly) • Regulate
Preferred Management Approach: • Upstream crossing (see Site 35) • Flood proofing of 1020 Linbrook Road • Regulate
Potential Linkage to Adjacent Sites: • Linkage to Site 35

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
37	0	0	0	0	0	0	40	16	8	**64**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
37	Design Flood Criteria	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	2	0
37	Private Vehicle	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	5	0
37	Emergency Vehicle	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	6	0
37	Private Vehicle Acess to Facilities	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	3	0
37	Emergency Vehicle Access to Facilities	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	7	0
37	Private Vehicle Driveway Access (Multiuser)	Not Applicable	NA	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	Not Applicable	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
37	89.11	89.2	89.28	89.37	89.43	89.48	89.47	0	0	2	2	2	2	0

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
37	0	0	6	6	6	6	0	50	20	10	4	2	1	0.4	102	4	10	40

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons.For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2 100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
93.2	90.8	92.6	92.36	92.55	80	80	92.55	-100.00	$0.00	0	0
93.2	90.8	92.6	92.4	92.8	80	80	92.80	0.21	$16,860.51	1	0
93.2	90.8	92.6	92.34	92.76	80	80	92.76	0.17	$16,368.95	1	0
93.2	90.8	92.6	92.27	92.72	80	80	92.72	0.13	$15,891.72	1	0
93.2	90.8	92.6	92.16	92.65	80	80	92.65	0.06	$15,089.80	1	0
93.2	90.8	92.6	92.09	92.59	80	80	92.59	-100.00	$0.00	0	0
93.2	90.8	92.6	91.99	92.5	80	80	92.50	-100.00	$0.00	0	0
93.2	90.8	92.6	92.55	92.55	1	1	92.55	-100.00	$0.00	0	0
93.2	90.8	92.6	92.8	92.8	1	1	92.80	0.21	$16,860.51	1	0
93.2	90.8	92.6	92.76	92.76	1	1	92.76	0.17	$16,368.95	1	0
93.2	90.8	92.6	92.72	92.72	1	1	92.72	0.13	$15,891.72	1	0
93.2	90.8	92.6	92.65	92.65	1	1	92.65	0.06	$15,089.80	1	0
93.2	90.8	92.6	92.59	92.59	1	1	92.59	-100.00	$0.00	0	0
93.2	90.8	92.6	92.5	92.5	1	1	92.50	-100.00	$0.00	0	0
93.9	91.5	93.3	92.55	92.55	1	1	92.55	-100.00	$0.00	0	0
93.9	91.5	93.3	92.8	92.8	1	1	92.80	-100.00	$0.00	0	0
93.9	91.5	93.3	92.76	92.76	1	1	92.76	-100.00	$0.00	0	0
93.9	91.5	93.3	92.72	92.72	1	1	92.72	-100.00	$0.00	0	0
93.9	91.5	93.3	92.65	92.65	1	1	92.65	-100.00	$0.00	0	0
93.9	91.5	93.3	92.59	92.59	1	1	92.59	-100.00	$0.00	0	0
93.9	91.5	93.3	92.5	92.5	1	1	92.50	-100.00	$0.00	0	0
									Reg	0	0
									100	2	0
									50	2	0
									25	2	0
									10	2	0
									5	0	0
									2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$33,721.01
50	$32,737.89
25	$31,783.43
10	$30,179.60
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endange

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
37	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$4,521	$82,543	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	2	2	0	$30,180	0	0	0	0	0	0	$30,180					
	25	93.64	2	2	0	$31,783	0	0	0	0	0	0	$31,783					
	50	93.69	2	2	0	$32,738	0	0	0	0	0	0	$32,738					
	100	93.74	2	2	0	$33,721	0	0	0	0	0	0	$33,721					
	Reg	93.61	0	0	0	$0	0	0	0	0	0	0	$0					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$678	$12,381	2	4	8
$0					
$4,527					
$4,768					
$4,911					
$5,058					
$0					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
93.2	90.8	92.6	92.36	92.55	80	80	92.55	-100.00	$0.00	0	0
93.2	90.8	92.6	92.4	92.8	80	80	92.80	0.21	$16,860.51	1	0
93.2	90.8	92.6	92.34	92.76	80	80	92.76	0.17	$16,368.95	1	0
93.2	90.8	92.6	92.27	92.72	80	80	92.72	0.13	$15,891.72	1	0
93.2	90.8	92.6	92.16	92.65	80	80	92.65	0.06	$15,089.80	1	0
93.2	90.8	92.6	92.09	92.59	80	80	92.59	-100.00	$0.00	0	0
93.2	90.8	92.6	91.99	92.5	80	80	92.50	-100.00	$0.00	0	0
93.2	90.8	92.6	92.55	92.55	1	1	92.55	-100.00	$0.00	0	0
93.2	90.8	92.6	92.8	92.6	1	1	92.80	0.21	$16,860.51	1	0
93.2	90.8	92.6	92.76	92.76	1	1	92.76	0.17	$16,368.95	1	0
93.2	90.8	92.6	92.72	92.72	1	1	92.72	0.13	$15,891.72	1	0
93.2	90.8	92.6	92.65	92.65	1	1	92.65	0.06	$15,089.80	1	0
93.2	90.8	92.6	92.59	92.59	1	1	92.59	-100.00	$0.00	0	0
93.2	90.8	92.6	92.5	92.5	1	1	92.50	-100.00	$0.00	0	0
93.9	91.5	93.3	92.55	92.55	1	1	92.55	-100.00	$0.00	0	0
93.9	91.5	93.3	92.8	92.8	1	1	92.80	-100.00	$0.00	0	0
93.9	91.5	93.3	92.76	92.76	1	1	92.76	-100.00	$0.00	0	0
93.9	91.5	93.3	92.72	92.72	1	1	92.72	-100.00	$0.00	0	0
93.9	91.5	93.3	92.65	92.65	1	1	92.65	-100.00	$0.00	0	0
93.9	91.5	93.3	92.59	92.59	1	1	92.59	-100.00	$0.00	0	0
93.9	91.5	93.3	92.5	92.5	1	1	92.50	-100.00	$0.00	0	0
									Reg	0	0
									100	2	0
									50	2	0
									25	2	0
									10	2	0
									5	0	0
									2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$0.00
100	$33,721.01
50	$32,737.89
25	$31,783.43
10	$30,179.60
5	$0.00
2	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #38 – MORR0869M

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LEGEND :

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 38 - MORR0869M
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	JAnuary 2008
Scale	1:1,000
Figure No.	38

Site #38 (MORR0869M) Implementation Program
Recommended Management Approach/Project Scope: • Flood control upstream of site (See Site 33) • Upgrade Morrison Road crossing by twinning existing 3.6 m by 1.8 m box culvert
Appropriate Lead for Undertaking: • Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.
Governing Protocol Legislation: • Town of Oakville's Policies and protocols • Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations • Ministry of Natural Resources Lakes and Rivers Act • Department of Fisheries and Oceans Fisheries Act • Ministry of Environment Water Taking (required for damming and pumping operations)
Approval Requirements: • Town of Oakville • Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit • Regional Municipality of Halton for water and wastewater servicing alterations • Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required) • Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works) • Input from Utility companies for utility locations
Need for, and Scope of Follow-Up Assessment/Analysis: • Class Environmental Assessment for assessing feasibility of upstream flood control controls • As part of the EA o Hydrologic modeling refinement o Hydraulic modeling refinement o Vegetation assessment o Fisheries assessment o Natural channel design assessment • Approval process with private land owners • Detail design of flood control facility based on Class EA • Revision to hydraulic modeling at Site 38 and assessment of reduced flows on flood impacts • Topographic survey of crossing and creek to facilitate hydraulic modeling and detail design • Hydraulic modeling of Site with proposed culvert addition once potential flood control upstream determined
Suggested Timing, Need for Phasing: • Timing of project dependant on Capital Works Program budget and priority of project within the Program.
Possible Implementation Issues: • Private land owners consent to proposed grading • Town of Oakville potential easement requirements • Vegetation loss, requiring mitigation
Possible Monitoring Requirements: • Potentially Department of Fisheries and Oceans monitoring requirements
Need for Maintenance: • Potential vegetation replacement and seeding • Potential creek stabilization resulting from local grading impacts • Crossing maintenance
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton

Site #38 (MORR0869M) Implementation Program
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #38 (MORR0869M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Morrison Road crossing (3.6 m by 1.8 m concrete box) with Regional storm backwater of 1.05 m • Floodplain capacity of approximately the 5 year storm (16.5 m^3/s). Regional storm is 37.9 m^3/s • Encroachment
Screened Alternatives: • Crossing/culvert upgrades – twin existing culvert • Floodplain/channel improvements – not practical due to private property and existing vegetation. • Flood proofing – only possible for 1 out of 2 flooded homes, therefore this does not resolve the flooding problem • Acquisition would be expensive • Regulate
Preferred Management Approach: • Crossing upgrades by twinning existing 3.6 by 1.8 m concrete box culvert
Potential Linkage to Adjacent Sites: • Spill occurs Morrison Road to Site 39 would be eliminated and 177 Morrison Road would be flooded.

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	**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**	**Combined Products**
38	0.6	0.5	0.2	0.0	0.4	0.2	20.0	16.0	8.0	**46.0**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
38	Design Flood Criteria	Collector	8	82.44	81.7	82.0	82.2	82.7	82.7	82.8	82.9	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.8	0.8	0.8	0.8	1	0.4	0.2	0.08	0.04	0.02	0.01	Collector / 1:50-yr	0.04	2	0.6
38	Private Vehicle	EMS Route	10	82.44	81.7	82.0	82.2	82.7	82.7	82.8	82.9	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.8	0.8	0.8	0.8	1	0.4	0.2	0.08	0.04	0.02	0.01	Reg	0.01	5	0.5
38	Emergency Vehicle	EMS Route	10	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
38	Private Vehicle Acess to Facilities	Partial	5	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.00	3	0
38	Emergency Vehicle Access to Facilities	Partial	5	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	Reg	0.01	7	0.35
38	Private Vehicle Driveway Access (Multiuser)	Medium Vehicle Usage	6	93.47	92.7	93.0	93.5	93.6	93.7	93.7	93.6	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.0	0.0	0.0	0.7	0.7	0.7	0.6	1	0.4	0.2	0.08	0.04	0.02	0.01	Reg	0.01	4	0.24

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
38	82.78	82.75	82.68	82.59	81.53	81.61	81.35	0	0	0	1	2	2	2

Site No	Industrial Area (ha)							Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
38	0	0	0	3	6	6	6	50	20	10	4	2	1	0.4	32.4	2	10	20

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons. For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
82.87	80	75.0	82.9	0.177725	16467.62054	1	0
82.84	80	75.0	82.8	0.1471	16098.76803	1	0
82.76	80	75.0	82.8	0.0671	15173.74678	1	0
82.69	80	75.0	82.7	-100	0	0	0
82.38	80	75.0	82.4	-100	0	0	0
82.11	80	75.0	82.1	-100	0	0	0
81.75	80	75.0	81.8	-100	0	0	0
82.83	1	1.0	82.8	0.23	17116.85891	1	0
82.78	1	1.0	82.8	0.18	16495.35587	1	0
82.68	1	1.0	82.7	0.08	15319.22965	1	0
82.62	1	1.0	82.6	0.02	14654.19846	1	0
82.53	1	1.0	82.5	-100	0	0	0
82.45	1	1.0	82.5	-100	0	0	0
82.22	1	1.0	82.2	-100	0	0	0
					Reg	2	0
					100	2	0
					50	2	0
					25	1	0
					10	0	0
					5	0	0
					2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$33,584.48
100.00	$32,594.12
50.00	$30,492.98
25.00	$14,654.20
10.00	$0.00
5.00	$0.00
2.00	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
38	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$1,539	$28,099	2	8	16
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	0	$0	0	0	0	0	0	0	$0					
	25	93.64	1	1	0	$14,654	0	0	0	0	0	0	$14,654					
	50	93.69	2	2	0	$30,493	0	0	0	0	0	0	$30,493					
	100	93.74	2	2	0	$32,594	0	0	0	0	0	0	$32,594					
	Reg	93.61	2	2	0	$33,584	0	0	0	0	0	0	$33,584					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$231	$4,215	2	4	8
$0					
$0					
$2,198					
$4,574					
$4,889					
$5,038					

Evaluation Process

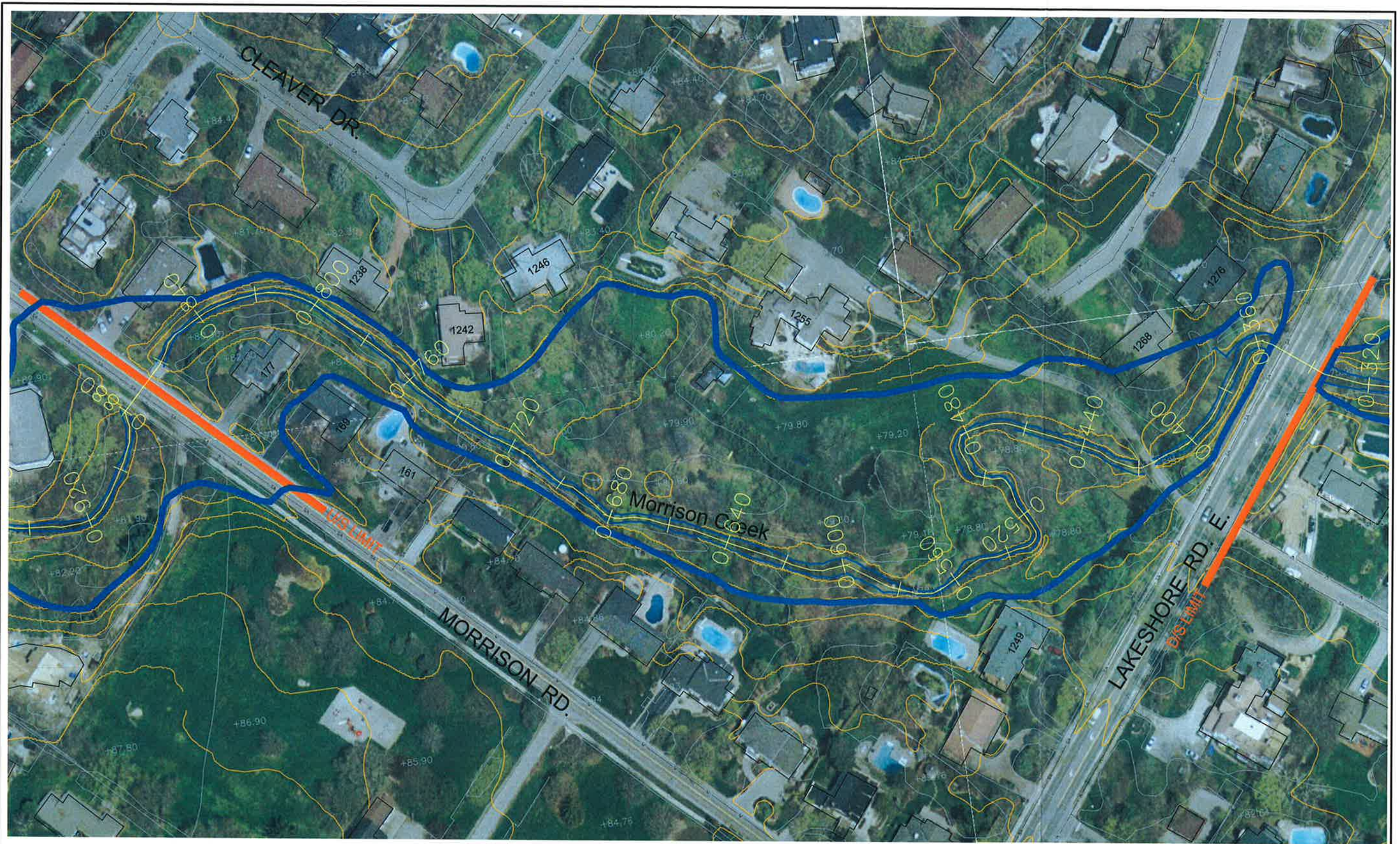
1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
82.87	80	75.0	82.9	0.177725	16467.62054	1	0
82.84	80	75.0	82.8	0.1471	16098.76803	1	0
82.76	80	75.0	82.8	0.0671	15173.74678	1	0
82.69	80	75.0	82.7	-100	0	0	0
82.38	80	75.0	82.4	-100	0	0	0
82.11	80	75.0	82.1	-100	0	0	0
81.75	80	75.0	81.8	-100	0	0	0
82.83	1	1.0	82.8	0.23	17116.85891	1	0
82.78	1	1.0	82.8	0.18	16495.35587	1	0
82.68	1	1.0	82.7	0.08	15319.22965	1	0
82.62	1	1.0	82.6	0.02	14654.19846	1	0
82.53	1	1.0	82.5	-100	0	0	0
82.45	1	1.0	82.5	-100	0	0	0
82.22	1	1.0	82.2	-100	0	0	0
					Reg	2	0
					100	2	0
					50	2	0
					25	1	0
					10	0	0
					5	0	0
					2	0	0

Frequency	Summarized Damage Costs ($)
Reg	$33,584.48
100.00	$32,594.12
50.00	$30,492.98
25.00	$14,654.20
10.00	$0.00
5.00	$0.00
2.00	$0.00

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #39 – MORR0338M



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LEGEND:

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY
TOWN OF OAKVILLE
SITE # 39 - MORR0338M
MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,250
Figure No.	39

Feb 11/08 – avogt

Site #39 (MORR0338M) Implementation Program

Recommended Management Approach/Project Scope:

- Flood control upstream of site (See Site 33)
- Upgrade Morrison Road crossing by twinning existing 3.6 m by 1.8 m box culvert (Site 38)

Appropriate Lead for Undertaking:

- Timing and phasing as per Town of Oakville Capital Works Program based on priority ranking established herein.

Governing Protocol Legislation:

- Town of Oakville's Policies and protocols
- Conservation Halton's Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Regulations
- Ministry of Natural Resources Lakes and Rivers Act
- Department of Fisheries and Oceans Fisheries Act
- Ministry of Environment Water Taking (required for damming and pumping operations)

Approval Requirements:

- Town of Oakville
- Conservation Halton Development; Interference with Wetlands and Alteration to Shorelines and Watercourse Permit
- Regional Municipality of Halton for water and wastewater servicing alterations
- Ministry of Environment Permit to Take Water (should dam and pumping for creek diversion or dewatering be required)
- Potentially Department of Fisheries and Oceans (i.e. should a Harmful Alteration Disruption or Destruction (HADD) be identified to occur based on the proposed works)
- Input from Utility companies for utility locations
- Home owner's approval for flood proofing

Need for, and Scope of Follow-Up Assessment/Analysis:

- Class Environmental Assessment for assessing feasibility of upstream flood control controls
- As part of the EA
    - Hydrologic modeling refinement
    - Hydraulic modeling refinement
    - Vegetation assessment
    - Fisheries assessment
    - Natural channel design assessment
- Approval process with private land owners
- Detail design of flood control facility based on Class EA
- Revision to hydraulic modeling at Site 39and assessment of reduced flows on flood impacts
- Topographic survey of crossing and creek to facilitate hydraulic modeling and detail design
- Hydraulic modeling of Site with proposed culvert addition once potential flood control upstream determined

Suggested Timing, Need for Phasing:

- Timing of project dependant on Capital Works Program budget and priority of project within the Program.

Possible Implementation Issues:

- Private land owners consent to proposed grading
- Town of Oakville potential easement requirements
- Vegetation loss, requiring mitigation
- Home owner's approval for flood proofing

Possible Monitoring Requirements:

- Potentially Department of Fisheries and Oceans monitoring requirements

Need for Maintenance:

- Potential vegetation replacement and seeding
- Potential creek stabilization resulting from local grading impacts
- Crossing maintenance

Site #39 (MORR0338M) Implementation Program
Potential Interface with Other Town/Agency Programs: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Potential opportunities with Town's Creek Erosion Study and road work • Potential projects already identified by Conservation Halton
Other Funding Opportunities: • To be discussed/ determined with the Town of Oakville and Conservation Halton • Canada/ Ontario Municipal Renewal Infrastructure Fund • Others

Site #39 (MORR0338M) Specific Flood Management Alternative Assessment
Data/ Information: Flooding mechanisms: • Channel/floodplain capacity just under the Regional flow of 20.6 m^3/s • Spill across Morrison Road from Site No. 38
Screened Alternatives: • Floodplain/channel improvements – system is natural and exhibits good grading – improvements would not provide substantial reduction in flooding • Flood proofing of 177 Morrison Road • Spill reduction at Morrison Road
Preferred Management Approach: • Flood proofing of 177 Morrison Road, topographic survey required to verify building elevation and flood proofing required following spill reduction/elimination • Spill reduction – see Site No. 38
Potential Linkage to Adjacent Sites: • Site 38 and 39 are linked due to spill over Morrison Road

Table 7
Summary of Site Evaluation Results

Catergory Evaluation Products										
Site	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	Combined Products
39	0	0	0	0	0	0	0	0	0	**0**

Table 4
Road Flooding Flood Criteria Evaluation

Site No	Evaluation Scale Criteria	Evaluation Scale Measure (Road Classification/ Storm frequency)	Measure Weight (4,6,8,10)	Road/ Driveway Elevation (m)	Flood Elevations (m)							Road Flooding Depth (m)							Flow Velocities (m/s)							Storm Event Frequency Modifiers							Storm Event Flooding Starts/ or Criteria Not Met (2-100, Reg)	Storm Event Frequency Modifier Selected (0.4-50)	Evaluation Scale Category Importance/ Significance (1-10)	Product (Measure Weighting * Storm Frequency Modifier * Category Significance
					2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
39	Design Flood Criteria	Arterial	10	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	2	0
39	Private Vehicle	EMS Route	10	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	5	0
39	Emergency Vehicle	EMS Route	10	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	6	0
39	Private Vehicle Acess to Facilities	None	0	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	3	0
39	Emergency Vehicle Access to Facilities	None	0	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	7	0
39	Private Vehicle Driveway Access (Multiuser)	NA	0	80.08	77.0	77.1	77.3	77.4	77.5	77.6	77.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.4	0.2	0.08	0.04	0.02	0.01	None	0.0	4	0

Evaluation Process

1 Determine road crossing classification, whether urban local, collector etc. and then determine the appropriate design storm criteria (2-100, Regional)
2 Apply appropriate Evaluation Scale Weight (1-10), (ref. Table 1), i.e. Level 1 Roads have a Measure Weight of 10.
3 Determine lowest road elevation at crossing
4 Determine flood elevations for the 2-100 year storm events and Regional storm Hurricane Hazel
5 Calculate road crossing flow depths and flow velocities for all storm events that result in road flooding
6 For Evaluation Scale Criteria (Design Flood Criteria), determine for which storm event flooding occurs and the appropriate road design storm criteria
7 For the Evaluation Scale Criteira (Design Flood Criteria), determine the appropriate Storm Event Frequency Modifier for the Design Flood Evaluation Scale Criteria (0.4-50)
8 For the Design Flood Evaluation Scale Criteria calculate product of the Evaluation Scale Measure Weight, Stom Event Frequency Modifier, and the Evaluation Scale Catergory Significance
9 For both Private and Vehicle Passage, determine what storm event flooding conditions commence that prevent vehicle passage for the crossing, and then apply the appropriate Storm Event Frequency Modifier
10 For private and emergency vehicle access to government facilities determine if flooding conditions preclude access based on flooding depth and velocities
11 For Private vehicle driveway access to muilt-user land uses (schools, malls etc.) determine flooding depths and velocities at driveway entrance to property
12 For both Private and Vehicle Passage Evaluation Scale Criterion, calculate the product of the Evaluation Scale Measure Weight, Storm Event Frequency Modifier and the Evaluation Scale Category Significance

Table 5
Threat to Life Flood Criteria Evaluation

Site No	Site Downstream Flood Elevations (m)							Residential Units Flooded (#)							Industrial Area (ha)						
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg
39	76.98	77.13	77.26	77.42	77.51	77.6	77.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site No	Commercial Area (ha)							Institutional (ha)							Land Use Densities (pers/ ha or /unit)			
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg	Res	Ind	Com	Instit
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	125	90	40

Site No	People Endangered							Storm Event Frequency Modifiers							Normalized No. of People Using Storm Multipliers	Evaluation Scale Measure Weighting (1-10)	Composite Category Importance/ Significance (1-10) (7 - Day Usage) (10 - Day and Night Usage)	Product
	2	5	10	25	50	100	Reg	2	5	10	25	50	100	Reg				
39	0	0	0	0	0	0	0	50	20	10	4	2	1	0.4	0	0	10	0

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet - direct damages ref. below)
2 Determine flooding conditions that results in life endangerment (separate spreadsheet - direct damages). Note that for residential units, life endagerment has been included if the basement has been predicted to flood.
3 Determine number of people endangered based on land use population densities and flooding conditons. For residential -= 3 people/home for Non Residential related to building size (ref. Table 5)
4 Determine number of people endangered for each storm event. Apply appropriate Evaluation Scale Measure Weight for that frequency event based on the number of people endangered
5 Determine normalized number of people endangered for all storm events using the Storm Event Frequency Modifiers multiplied by number of endangered people for each respective storm
6 Apply adjustment factor (Value of Step 5 divided by 10)
7 Determine the product of the Ajusted No. of People times Measure Weight and the Evaluation Scale Category Significance

Building No.	Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)	Frequency	Summarized Damage Costs ($)
1268 Cambrid	81.3	78.9	80.7	78.31	78.31	1	1	78.31	-100.00	$0.00	0	0	Reg	$0.00
1268 Cambrid	81.3	78.9	80.7	78.2	78.2	1	1	78.20	-100.00	$0.00	0	0	100	$0.00
1268 Cambrid	81.3	78.9	80.7	78	78	1	1	78.00	-100.00	$0.00	0	0	50	$0.00
1268 Cambrid	81.3	78.9	80.7	77.72	77.72	1	1	77.72	-100.00	$0.00	0	0	25	$0.00
1268 Cambrid	81.3	78.9	80.7	77.49	77.49	1	1	77.49	-100.00	$0.00	0	0	10	$0.00
1268 Cambrid	81.3	78.9	80.7	77.32	77.32	1	1	77.32	-100.00	$0.00	0	0	5	$0.00
1268 Cambrid	81.3	78.9	80.7	77.13	77.13	1	1	77.13	-100.00	$0.00	0	0	2	$0.00
1249 Lakesho	82.1	79.7	81.5	79.12	79.64	140	118	79.56	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	79.05	79.63	140	118	79.54	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	78.87	79.58	140	118	79.47	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	78.64	79.56	140	118	79.42	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	78.27	79.5	140	118	79.31	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	77.84	79.46	140	118	79.21	-100.00	$0.00	0	0		
1249 Lakesho	82.1	79.7	81.5	77.74	79.43	140	118	79.16	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	81.36	81.82	80	1	81.37	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	81.3	81.75	80	1	81.31	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	81.19	81.61	80	1	81.20	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	81.06	81.58	80	1	81.07	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	80.89	81.4	80	1	80.90	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	80.75	81.19	80	1	80.76	-100.00	$0.00	0	0		
169 Morrison	83.4	81.0	82.8	80.6	80.99	80	1	80.60	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	81.36	81.82	80	70	81.76	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	81.3	81.75	80	70	81.69	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	81.19	81.61	80	70	81.56	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	81.06	81.58	80	70	81.52	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	80.89	81.4	80	70	81.34	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	80.75	81.19	80	70	81.14	-100.00	$0.00	0	0		
177 Morrision	82.5	80.1	81.9	80.6	80.99	80	70	80.94	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	81.36	81.82	80	70	81.76	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	81.3	81.75	80	70	81.69	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	81.19	81.61	80	70	81.56	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	81.06	81.58	80	70	81.52	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	80.89	81.4	80	70	81.34	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	80.75	81.19	80	70	81.14	-100.00	$0.00	0	0		
185 Morrision	82.9	80.5	82.3	80.6	80.99	80	70	80.94	-100.00	$0.00	0	0		
										Reg	0	0		
										$100.00	0	0		
										$50.00	0	0		
										$25.00	0	0		
										$10.00	0	0		
										$5.00	0	0		
										$2.00	0	0		

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine the number of people endangered by flooding: 3 people for residential based the building incurring flooding, other land uses require certain flood depths and velocities for life endan

Table 6

Flooding Damages Evaluation Scale Category: Site Assessment

Site	Event	WSEL	Homes	Basement Flooding	First Floor	Residential Damage Value	Industrial Area	Industrial Damage Value	Commercial Area	Commercial Damage Value	Institutional Area	Institutional Damage Value	Total Direct Damage Value	Average Annual Damages 2007 Direct Damages	Present Worth (50 Year, 5%) Direct Damages	Measure Weight	Category Importance/ Significance	Product
	(Yr)	(m)	(No.)	(No.)	(No.)	($)	(ha)	($)	(ha)	($)	(ha)	($)	($)	($)	($)	(1-10)	(1-10)	
39	2	92.69	0	0	0	$0	0	0	0	0	0	0	$0	$0	$0	0	8	0
	5	93.00	0	0	0	$0	0	0	0	0	0	0	$0					
	10	93.51	0	0	2	$0	0	0	0	0	0	0	$0					
	25	93.64	0	0	3	$0	0	0	0	0	0	0	$0					
	50	93.69	0	0	3	$0	0	0	0	0	0	0	$0					
	100	93.74	0	0	8	$0	0	0	0	0	0	0	$0					
	Reg	93.61	0	0	22	$0	0	0	0	0	0	0	$0					

Total Indirect Damage Value	Average Annual Damages 2007 Indirect Damages	Present Worth (50 Year, 5%) Indirect Damages	Measure Weight	Category Importance/ Significance	Product
($)	($)	($)	(1-10)	(1-10)	
$0	$0	$0	0	4	0
$0					
$0					
$0					
$0					
$0					
$0					

Evaluation Process

1 Determine flooding conditions for all buildings within the site, depth of flooding and velocities (separate speadsheet)
2 Determine flooding conditions that results in direct damages (separate spreadsheet - direct damages) related to whether building is subjected to flooding or not
3 Determine The Total Value for Direct Damages and Indirect Damages (15% of Direct Damages)
4 Determine Average Annual Damages (AAD) for Direct and Indirect damages
5 Determine Present Value based on AAD and Engineering Lifetime of 50 Years and Discount Rate of 5% for Direct and Indirect Damages (for information purposes only)
6 Determine the product of the Measure Weight and the Evaluation Scale Category Significance for Direct and Indirect Damages

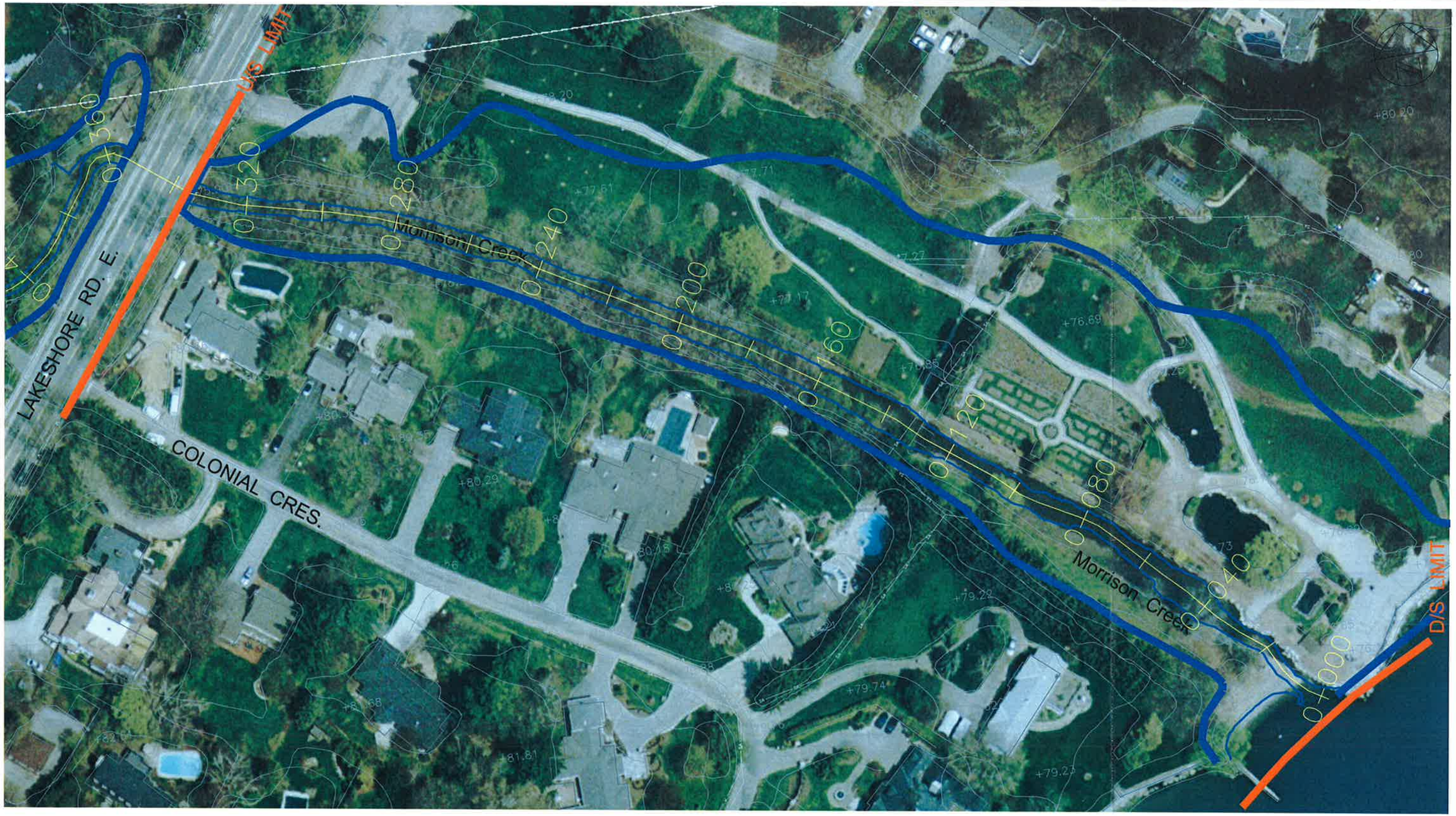
Finished Floor Elevation (m)	Basement Floor Elevation (m)	Lowest Opening (m)	Downstream 2-100/ Reg Flood Elevations (m)	Upstream 2-100/ Reg Flood Elevations (m)	Section Distance	Distance from Downstream Section	Interpolated Property 2-100/ Reg Flood Elevations (m)	Building Flood Depth (m)	Damage Costs ($)	Basement Flooding (Yes/ No)	First Floor Flooding (Yes/ No)
81.3	78.8616	80.7	78.3	78.31	1	1	78.31	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	78.2	78.2	1	1	78.2	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	78.0	78	1	1	78	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	77.7	77.72	1	1	77.72	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	77.5	77.49	1	1	77.49	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	77.3	77.32	1	1	77.32	-100.00	0.00	$0.00	0
81.3	78.8616	80.7	77.1	77.13	1	1	77.13	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	79.1	79.64	140	118	79.55828571	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	79.1	79.63	140	118	79.53885714	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	78.9	79.58	140	118	79.46842857	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	78.6	79.56	140	118	79.41542857	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	78.3	79.5	140	118	79.30671429	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	77.8	79.46	140	118	79.20542857	-100.00	0.00	$0.00	0
82.1	79.6616	81.5	77.7	79.43	140	118	79.16442857	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	81.4	81.82	80	1	81.36575	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	81.3	81.75	80	1	81.305625	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	81.2	81.61	80	1	81.19525	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	81.1	81.58	80	1	81.0665	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	80.9	81.4	80	1	80.896375	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	80.8	81.19	80	1	80.7555	-100.00	0.00	$0.00	0
83.4	80.9616	82.8	80.6	80.99	80	1	80.604875	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	81.4	81.82	80	70	81.7625	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	81.3	81.75	80	70	81.69375	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	81.2	81.61	80	70	81.5575	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	81.1	81.58	80	70	81.515	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	80.9	81.4	80	70	81.33625	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	80.8	81.19	80	70	81.135	-100.00	0.00	$0.00	0
82.5	80.0616	81.9	80.6	80.99	80	70	80.94125	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	81.4	81.82	80	70	81.7625	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	81.3	81.75	80	70	81.69375	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	81.2	81.61	80	70	81.5575	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	81.1	81.58	80	70	81.515	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	80.9	81.4	80	70	81.33625	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	80.8	81.19	80	70	81.135	-100.00	0.00	$0.00	0
82.9	80.4616	82.3	80.6	80.99	80	70	80.94125	-100.00	0.00	$0.00	0

Summarized Damage Costs ($)	
Frequency	
Reg	0
100	0
50	0
25	0
10	0
5	0
2	0

Reg	$0.00	0
100.00	$0.00	0
50.00	$0.00	0
25.00	$0.00	0
10.00	$0.00	0
5.00	$0.00	0
2.00	$0.00	0

1 Determine flooding elevations for all storm events at buildings that potentially flood
2 Determine first floor elevation by reviewing topographic mapping elevations at building footprint and add 0.5m +/-
3 Determine basement floor elevation by substracting 2.44m from the first floor elevation
4 Determine basement window opening elevation by adding 1.83m to basement floor elevation (lowest opening, except if building has a walkout or is not residential land use)
5 Determine flooding depths based on lowest opening elevation and flooding elevations for all storms
6 Determine flooding damages for each return period based on the flooding depths and damage curve equations

SITE #40 – MORR0000M



LEGEND :

REGULATORY FLOODLINE

TOWNWIDE FLOODING STUDY

TOWN OF OAKVILLE

SITE # 40 - MORR0000M

MORRISON CREEK

PHILIPS ENGINEERING

Project No.	106026
Date	January 2008
Scale	1:1,000
Figure No.	40

Feb 11/08 – avgat

G:\Work\106026\water\dwg\Site-January 08\site-40.dwg

Lower Morrison Creek Photo Log (October 2016)

1: D/S Face of Lakeshore Road 7.9m x 3.2m Conc. Arch Culvert, Station 354.4469

2: U/S Face of Morrison Road 3.7m x 2.05m Conc. Box Culvert, Station 878.3941

3: D/S Face of Linbrook Road 7.3m x 1.1m Conc Arch Culvert, Station 120.4545

4: D/S Face of Chartwell Road Twin Conc. Box 3.0m x 1.9m, Station 176.7459

Lower Morrison Creek Photo Log (October 2016)

5: D/S Face Maple Avenue 3.0m x 1.2m Box Culvert, Station 2711.132

Lower Wedgewood Creek Photo Log (October 2016)

1: D/S Face Lakeshore Road 3.8m x 1.9m Conc Arch, Station 242.8122

2: U/S Face of Warren Drive Park 4.2m x 1.5m CSP, Station 644.3186

3: D/S Face of Wedgewood Drive 5.5m x 1.5m CSP Arch, Station 675.4334

4: Bridge at Weaver Avenue Pedestrian Bridge 2.3m x 14.1m, Station 1480.446

Lower Wedgewood Creek Photo Log (October 2016)

5: D/S Face Devon Road Twin Conspan Arch 4.3m x 2.0m, Station 1587.402

6: U/S Face of Amber Crescent CSP Ellipse 2.6m x 2.1m, Station 1711.164

7: U/S Face Duncan Road culvert CMP Ellipse 2.45m x 1.8m, Station 1844.065

8: U/S Face Drummond Road CSP Arch 1.15m x 1.7m, Station 263.7177

Lower Wedgewood Creek Photo Log (October 2016)

9: D/S Face Cumnock Crescent 600mm CSP, Station 409.8072

10: U/S Face of Morrison Road CSPA 1.8 x 1.26, Station 2.465

D.A. (DAVE) BLOOMER, P.Eng.
MANAGER OF DESIGN

THE CORPORATION OF
THE
TOWN OF OAKVILLE

The Corporation of the Town of Oakville
Department of Public Works
2274 Trafalgar Road
Oakville, Ontario L6J 4C2
Phone: (905) 338-4423
Fax: (905) 338-4159

Lower Morrison/Wedgewood Creeks

Flood, Erosion and Master Drainage Plan Study

Technical Report

January 1993

R.V. Anderson Associates Limited
consulting engineers and architect

ERRATUM No. 1

A study was undertaken to update the sites and priorities for implementation of erosion control works that were identified in the Lower Morrison/Wedgewood Creeks - Flood, Erosion and Master Drainage Plan Study. The Study Update involved an erosion site inventory and development of numerical ratings for each erosion site. This Erratum presents the ratings and the priorities for each erosion site along the Lower Morrison/Wedgewood Creeks.

IT IS RECOMMENDED THAT THE RATINGS DEVELOPED DURING THIS STUDY UPDATE REPLACE THE PRIORITIES ASSIGNED DURING THE MASTER DRAINAGE PLAN STUDY. A HIGH RATING INDICATES THAT EROSION CONTROL WORKS SHOULD BE IMPLEMENTED BEFORE AN EROSION SITE WITH A LOWER RATING.

A procedure was developed to assign a numerical rating or value to each erosion site. The maximum rating for any site is 20 and the minimum value is five (5). The rating procedure developed during this Study is expected to yield more consistent results when evaluating erosion sites than the subjective procedures used in the Master Drainage Plan Study. Ratings for each of the streambank erosion sites are shown in Tables Err.1 and Err.2.

A detailed report of the streambank erosion inventory and analyses undertaken during the Study Update was provided under separate cover to the Corporation of the Town of Oakville.

Table ERR.1 LOWER MORRISON CREEK EROSION INVENTORY SUMMARY

Site Location	Site Number	Type of Erosion	Extent of Erosion	Consequences of Failure	Remedial Measures	Rating
100 m upstream of Maple Avenue	I	bank	shape undercut length 20 m width 2 m	loss of land.	provide erosion protection.	6
Adjacent to Cedar Grove Boulevard	J	toe	shape bluff length 45 m width 6 m	loss of land.	remove trees, protect toe to promote undergrowth.	14
Balmoral Place	K	bank	shape rect. length 10m width 2m	loss of storm drain outlet.	repair drain outlet and provide erosion protection.	11
160 m upstream of Morrison Road	L	toe	shape bluff length 160 m height 4 m	loss of buildings, loss of land, imminent risk.	construct retaining wall.	13
30 m upstream of Morrison Road	M	bank	shape undercut length 20 m width 2 m	loss of land.	construct retaining wall.	7
Morrison Road	N	bank	shape rect. length 1 m width 1.5 m	loss of erosion protection.	extend protection (a) and key into bank (b).	6
Lakeshore Road East	O	bed	shape rect. length 35 m width 4 m	loss of culvert (footings exposed).	protect footings.	7

Table ERR.2 LOWER WEDGEWOOD CREEK EROSION INVENTORY AND REMEDIAL MEASURES

Site Location	Site Number	Type of Erosion	Extent of Erosion	Consequences of Failure	Remedial Measures	Rating
Watercourse realignment, north of QEW	A	sheet/rill under construction.	shape trap. length 200m width 10m	loss of land.	seed and mulch.	Completed
Cornwall Road	B	bank/bed existing rip rap displaced.	shape trap. length 50m width 4 6m	culvert washout.	replace riprap with massive or anchored protection.	Completed
150 m downstream of Cornwall Road	C	bank/toe	shape bluff length 30m height 4m	loss of land.	massive, anchored flexible system also slope protection, removal of trees and stabilize slope.	14
Devon Road	D	frost heaved concrete	shape trap. length 16m width 12m	loss of access road.	monitor erosion. replace retaining wall on south bank & stabilize north bank.	9
60 m downstream of Devon Road	E	toe	shape bluff length 75m		monitor to identify when protection is required.	8
150 m upstream of Wedgewood Drive	F	bank	shape undercut length 30m height 2m	loss of land.	construction of retaining wall (a) & (b).	11
180 m upstream of Lakeshore Road East	G	bank	shape undercut length 30m width 2m	loss of swimming pool.	monitor to determine if and when a retaining wall will be necessary.	10
20 m downstream of Lakeshore Road East	H	deteriorating channel protection.	shape rect. length var. width 2m	loss of land.	recommend examination for integrity and reconstruction.	5

SUMMARY

Development pressures within the Lower Morrison and Lower Wedgewood Creeks necessitated that flooding and erosion be identified and remedial measures recommended before development could proceed.

The Town of Oakville requested that a Study carry out the following:

- prepare Flood Plain Mapping of the Lower Morrison and Lower Wedgewood Creeks;
- an erosion inventory;
- a hydrologic/hydraulic analyses;
- determine impacts of future development; and
- identify and recommend remedial measures to mitigate potential flooding and erosion.

The Study was carried out under the guidance of a Project Administration Team comprised of individuals from the Town of Oakville, the Halton Region Conservation Authority, Environment Canada and Pro Urban Developments.

The Study was conducted using the Canada/Ontario Flood Damage Reduction Program standards. Funding was provided by the Corporation of the Town of Oakville, Pro Urban Developments Limited and Markborough Properties Incorporated.

R. V. Anderson Associates Limited was retained to carry out the Study with Bennett & Norgrove Limited producing the topographic mapping and Gartner Lee Limited conducting the erosion inventory.

The Flood Plain Mapping identified 26 potentially flooded buildings within the Regulatory Flood Plain along Lower Morrison Creek and potentially 42 buildings along Lower Wedgewood Creek.

The erosion inventory identified only one (1) site which endangered two (2) private residential buildings that should receive immediate attention. Two (2) additional sites should be monitored on a regular basis to determine when remedial measures should be implemented. The remainder of the erosion sites would not require immediate action but would warrant remedial works.

The recommended works to mitigate potential erosion and flooding are shown in Table S.1. Five (5) erosion sites that require quick attention are identified as high priority. The total cost to implement the works is approximately $4.6 million. The completion of the Plan will involve a considerable time period and monetary effort. The Plan when completed will eliminate potential flood and erosion damages along the Lower Morrison/Wedgewood Creek. Since the time to completion could be considerable, peak runoff rates from all new development sites should be controlled to 50% of predevelopment levels until the plan is completed.

If the above policies are followed then flood and erosion damages within the watershed should not increase as a result of new development.

Table S.1 RECOMMENDED FLOOD AND EROSION CONTROL WORKS

Location	Watercourse	Priority	Works	Ownership	Type of Works	Costs
Lower Morrison/Wedgewood Creeks	LM/WC	high	SWM Policy			
Morrison Road - 160 m u/s	L. Morrison	high	retaining wall	private	erosion	$ 480,000
Lakeshore Road East - 180 m u/s	L. Wedgewood	high	monitor	private	erosion	-
60 m d/s of Devon Road	L. Wedgewood	high	monitor	private	erosion	-
north of QEW	L. Wedgewood	high	seed and mulch	private	erosion	$ 15,000
Lakeshore Road East	L. Morrison	medium	protect footings	public	erosion	$ 95,000
Balmoral Place	L. Morrison	medium	repair drain outlet	public	erosion	$ 20,000
Lakeshore Road East	L. Morrison	low	floodproof 1 building	private	flood	$ 30,000
Morrison Road	L. Morrison	low	floodproof 5 buildings	private	flood	$ 150,000
Morrison Road	L. Morrison	low	erosion protection	public	erosion	$ 5,000
Morrison Road - 30 m upstream	L. Morrison	low	erosion protection	private	erosion	$ 40,000
Cedar Grove Boulevard	L. Morrison	low	remove trees, protect toe	private	erosion	$ 30,000
Chartwell-Linbrook Road	L. Morrison	low	floodproof 3 buildings	private	flood	$ 90,000
Maple Avenue	L. Morrison	low	floodproof 12 buildings	private	flood	$ 360,000
Maple Avenue - 100 m u/s	L. Morrison	low	erosion protection	private	erosion	$ 30,000
CN Railway Spur Line	L. Morrison	low	floodproof 3 buildings	private	flood	$ 90,000
Chartwell Road - East Branch	L. Morrison	low	floodproof 2 buildings	private	flood	$ 60,000
Lakeshore Road East	L. Wedgewood	low	floodproof 1 building	private	flood	$ 30,000
Lakeshore Road East - 20 m d/s	L. Wedgewood	low	structural examination	public	erosion	$ 5,000
Wedgewood Drive - d/s	L. Wedgewood	low	enlarge park & Wedgewood	public	flood	$ 1,030,000
Wedgewood Drive - u/s	L. Wedgewood	low	floodproof 4 buildings	private	flood	$ 120,000
Wedgewood Drive - 150 m u/s	L. Wedgewood	low	retaining wall	private	erosion	$ 150,000
Devon Road	L. Wedgewood	low	enlarge Devon Rd. culvert & floodproof 3 buildings	public & private	flood	$ 340,000
Amber Crescent	L. Wedgewood	low	enlarge Amber culvert	public	flood	$ 100,000
Cornwall Road - 150 m d/s	L. Wedgewood	low	erosion protection	private	erosion	$ 350,000
Cornwall Road	L. Wedgewood	low	replace rip rap	public	erosion	$ 40,000
Duncan Road	L. Wedgewood	low	enlarge Duncan Rd. culvert & floodproof 1 building	public & private	flood	$ 270,000
Duncan Road - u/s	L. Wedgewood	low	floodproof 1 building	private	flood	$ 30,000
Canadian Road	L. Wedgewood	low	floodproof 1 building	private	flood	$ 30,000
Drummond Road	L. Wedgewood	low	enlarge Drummond Rd. cul. & floodproof 4 building	public & private	flood	$ 470,000
Morrison Road	L. Wedgewood	low	floodproof 5 buildings	private	flood	$ 150,000
					TOTAL	$4,610,000

L. Morrison - Lower Morrison
L. Wedgewood - Lower Wedgewood

HYDROLOGIC ANALYSIS

Chapter 3

3.0 HYDROLOGIC ANALYSIS

3.1 General

A hydrologic analysis of the watersheds is required to determine peak flow rates at points of interest within the basin. These flow rates are needed in the subsequent hydraulic analysis for determining water levels. Methods used to estimate peak flow rates include:

- frequency analysis of a station's recorded flood flows;
- regional flood frequency analysis; and
- rainfall/runoff simulation.

The most accurate and preferred method of generating peak flow rates would be a frequency analysis of a station's recorded flood flow rates. Stations with a sufficient period of record would have to be located at the points of interest and the upstream land use would have remained constant over the period of record. The single station frequency analysis cannot be used because no stations are located within the Lower Morrison/Wedgewood Creeks' watersheds.

The second most appropriate method would be a regional flood frequency analysis. Three (3) methods have been developed to determine peak flow rates from mostly rural/undeveloped watersheds. However, the Lower Morrison/Wedgewood basins are mostly developed. Regional flood frequency analysis cannot consider land uses different from the basin from which the procedures were developed. Also regional flood frequency analysis cannot consider changing land use within the study basin.

The rainfall/runoff simulation method was chosen to calculate peak flow rates from the Lower Morrison/Wedgewood basins. The three (3) regional flood frequency analysis methods developed by Environment Canada (Index Flood Method and Regression Analysis) and the Ministry of Natural Resources (Regression Analysis) were used to check the peak flow rates developed from the rainfall/runoff simulation.

3.2 Methodology

The process used to calculate peak flow rates for the Lower Morrison/Wedgewood Creeks included the following steps:

- select a rainfall/runoff simulation model appropriate for the study area;
- collect data and build model input files;
- calibrate the model;
- use the 100 year design storm to perform a sensitivity analysis of appropriate model input parameters;
- calculate peak flow rates for the Regional, 100 year, 50 year, 20 year, 10 year, 5 year and 2 year return period storms for existing and future land use conditions; and
- check peak flow rates using Environment Canada's Index Flood Method, Regression Analysis and the Ministry of Natural Resources' Regression Analysis Method.

3.3 Simulation Model

The rainfall/runoff simulation model OTTHYMO was used for determining peak flow rates. OTTHYMO is basically the hydrologic model, HYMO, with the following capabilities implemented by the University of Ottawa:

- urban basin runoff calculation;
- rural basin runoff calculation using the Nash method;
- variable initial abstraction; and
- closed conduit runoff routing of runoff.

The urban runoff calculation method was developed at the University of Ottawa and uses a two parallel linear reservoir model. The Nash method, published in 1957, calculates runoff from natural/rural basins. The original HYMO natural/rural runoff calculation method of J.R. Williams, which uses a two (2) parameter gamma distribution and recession constant, is included in OTTHYMO.

The University of Ottawa (OTTHYMO) urban runoff calculation method (URBHYD), which is the only urban hydrograph method, was applied to the areas of the Lower Morrison/Wedgewood Creeks.

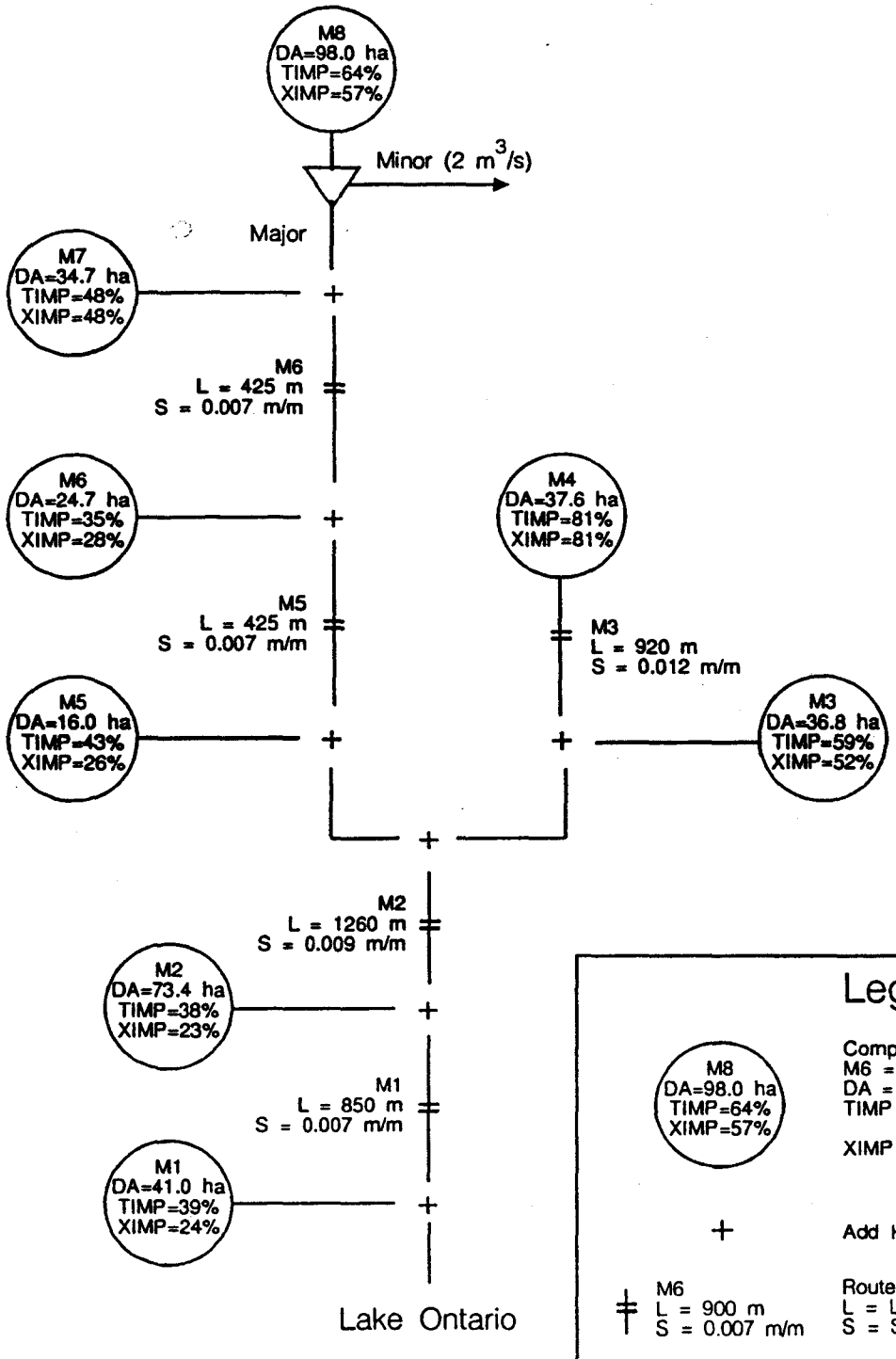
Input required by OTTHYMO includes the following:

- design storm hyetograph;
- basin physical characteristics; and
- travel time and flow depth between points of interest along the watercourse.

The physical characteristic input data required for this study are specifically:

- drainage area;
- directly connected impervious : total basin area ratio;
- total impervious : total basin area ratio;
- depression storage and linear storage coefficients for pervious and impervious areas; and
- runoff curve number.

The Lower Morrison/Wedgewood Creek basins were sub-divided for specific points of interest and hydrologic characteristics. The resulting sub-basins are depicted in Figure 3-1. Schematic diagrams of the OTTHYMO procedure are given in Figures 3-2 and 3-3 for the Lower Morrison Creek and Lower Wedgewood Creek, respectively.



Legend

M8
DA=98.0 ha
TIMP=64%
XIMP=57%

Compute Hydrograph
M6 = Basin Number
DA = Drainage Area, ha
TIMP = Basin Total Impervious Area (percent)
XIMP = Basin Directly Connected Impervious Area (percent)

\+ Add Hydrographs

M6
L = 900 m
S = 0.007 m/m

Route Hydrograph through M6
L = Length, m
S = Slope, m/m

Figure 3-2

Computation Schematic Lower Morrison Creek

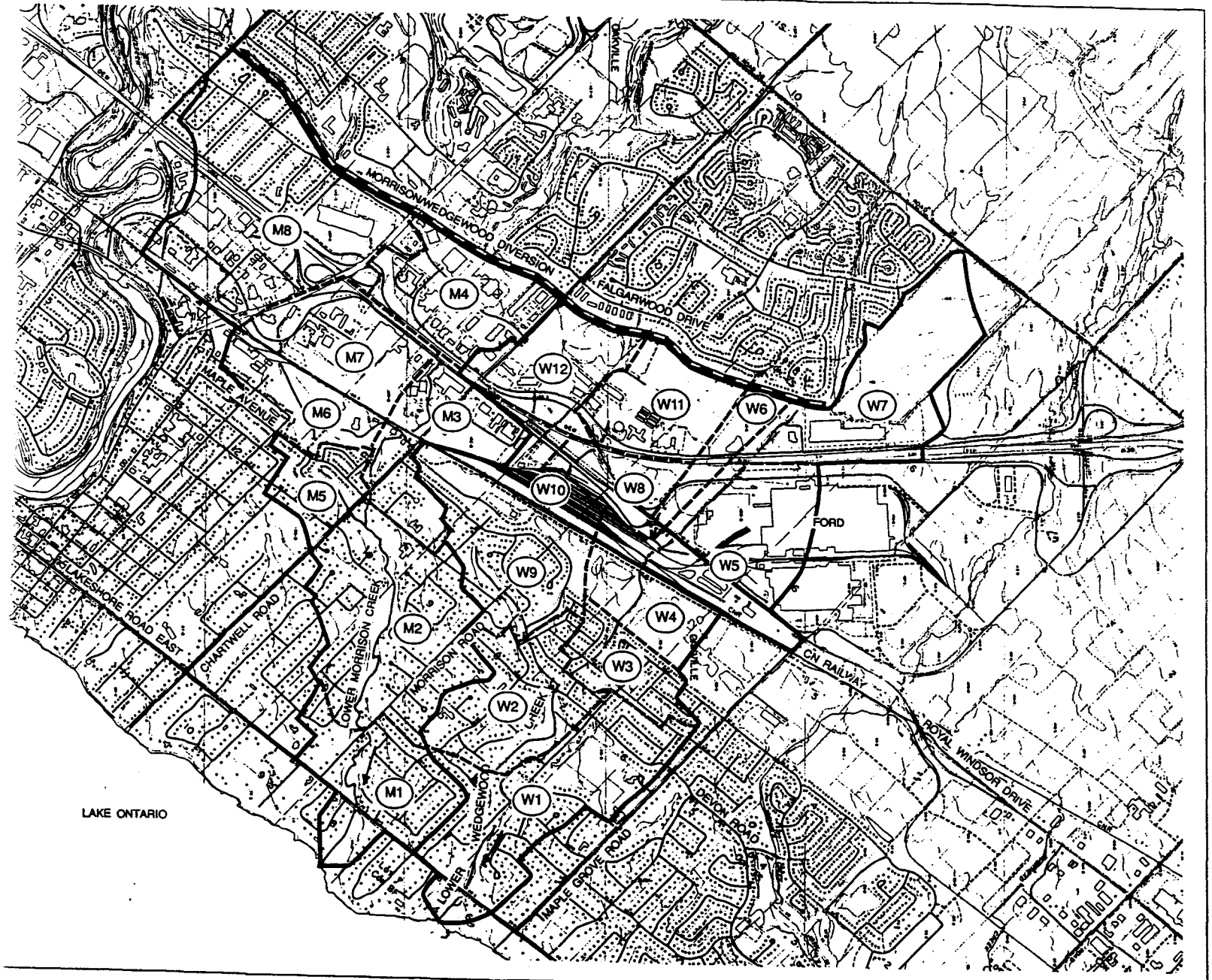


Figure 3-1

Watershed Sub-Basins

N

M1 Sub-Basin Number

Sub-Basin Boundary

Watershed Boundary

Watercourse

Diversion

Scale

0 0.5 1.0 km.

Note: Base Map is a reproduction of 1:10,000 Ontario Base Mapping produced from aerial photography dated 1982.

THE CORPORATION OF THE TOWN OF OAKVILLE

Markborough PROPERTIES INC.

R.V. Anderson Associates Limited
consulting engineers and architect

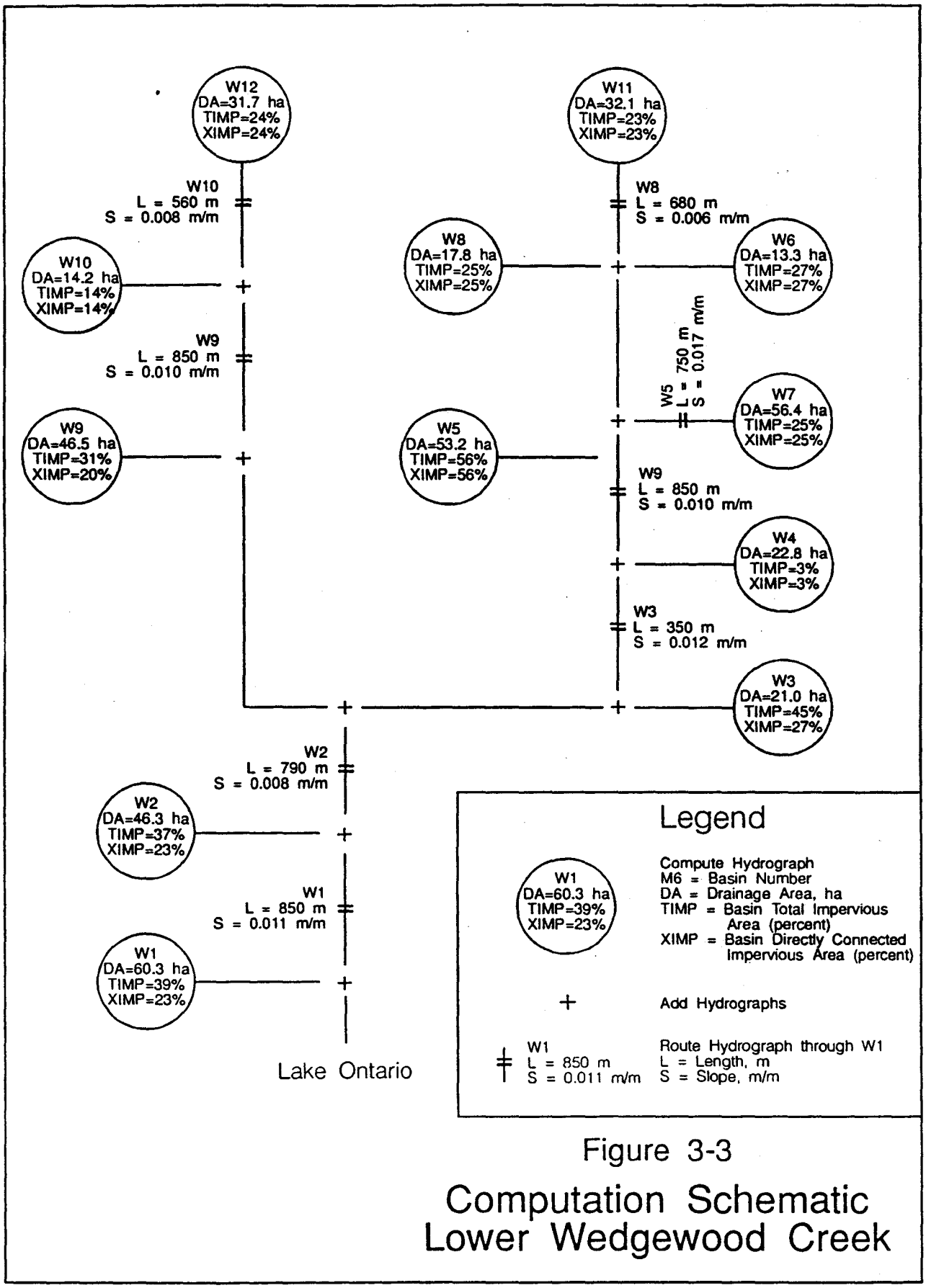


Figure 3-3

Computation Schematic
Lower Wedgewood Creek

3.4 Design Storms

Regional Storm - Hurricane Hazel

The Regional Storm for the Lower Morrison/Wedgewood Creeks as specified by the Ministry of Natural Resources is Hurricane Hazel which passed through Southern Ontario. The 12 hour design storm, shown in Table 3.1, is applied to basins where the upstream circular drainage area is greater than 25 km^2 (10 mi^2). The hourly rainfall values are multiplied by the percentages shown in Table 3.2 for circular drainage areas larger than 25 km^2.

The circular drainage areas for the Lower Morrison and the Lower Wedgewood Creeks are less than 25 km^2 and therefore no reduction factors were applied to the 12 hour Regional Storm values.

2 to 100 Year Design Storms

Design storms for return periods ranging from 2 to 100 years were developed using the Keifer & Chu method which is presently used by the Town of Oakville. The Keifer & Chu design storm has a variable duration and time step that are selected based on the physical characteristics of the watershed. A time step of 15 minutes and a storm duration of 24 hours were used in the simulations. The procedures used by the OTTHYMO model require a calculation time step equal to the time of concentration of the sub-basins. The sub-basins were selected assuming a time of concentration of approximately 15 minutes. A 24 hour storm was selected to include the largest time of concentration for each of the Study basins. Selecting a shorter duration storm could simulate runoff events with lower peak flow rates.

A long storm duration such as 24 hours will generate a higher peak flow rate for pervious areas than a shorter duration storm. However, for urban areas where peak flow rates are largely influenced by rainfall intensity, peak flow rates will only slightly change for a long duration storm. For the Keifer and Chu design storm, peak rainfall intensities do not vary with storm durations and therefore peak flow rates will not significantly change.

Table 3.1 HURRICANE HAZEL STORM

In the first 36 hours the total rainfall recorded was 73 mm. The following 12 hours represents the Ontario Ministry of Natural Resources Regional Storm.

	Depth (mm)	Percent of Total
37th hour	6	3
38th hour	4	2
39th hour	6	3
40th hour	13	6
41st hour	17	8
42nd hour	13	6
43rd hour	23	11
44th hour	13	6
45th hour	13	6
46th hour	53	25
47th hour	38	18
48th hour	13	6
Total	212 mm	100

Table 3.3 INTENSITY- DURATION-FREQUENCY VALUES

AES TORONTO (BLOOR STREET) GAUGE
43 YEARS OF RECORD 1940 - 1986

Duration (Minutes)	Rainfall Intensity (mm/hr) 2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
5	117	164	194	233	262	291
10	80	108	126	149	166	183
15	65	90	107	129	145	160
30	41	58	69	83	93	103
60	25	35	41	48	54	60
120	15	20	23	27	30	33
360	6.1	8.1	9.4	11	12	13
720	3.6	4.6	5.3	6.2	6.8	7.5
1440	2.0	2.5	2.9	3.4	3.7	4.1

Table 3.4 RAINFALL INTENSITY EQUATION COEFFICIENTS*

AES TORONTO (BLOOR STREET) GAUGE
43 YEARS OF RECORD - 1940 TO 1986

Return Period (Years)	Coefficient A	b	c	Correlation Coefficient
2	835	4.9	0.809	0.999942
5	1155	5.1	0.841	0.999854
10	1400	5.7	0.847	0.999762
25	1680	5.6	0.851	0.999730
50	1960	5.8	0.861	0.999683
100	2150	5.7	0.861	0.999628

* Corrected for partial duration series.

$$i = \frac{A}{(t_d + b)^c}$$ = rainfall intensity, mm/hr

A, b and c constants.
t_d = duration, minutes.

Table 3.6 BASIN PARAMETERS - LOWER MORRISON CREEK

			Existing Conditions				
		Drainage	Pervious Curve Number		% Impervious		Length Parameter
Basin Number	OTTHYMO Command	Area (ha)	II	III	Total	Direct	(metres)
M-1	URBHYD	41.0	68	84	39	24	520
M-2	URBHYD	73.4	67	83	38	23	700
M-3	URBHYD	36.8	72	86	59	52	500
M-4	URBHYD	37.6	81	92	81	81	500
M-5	URBHYD	16.0	63	80	43	26	330
M-6	URBHYD	24.7	73	87	35	28	410
M-7	URBHYD	34.7	78	90	48	48	1200
M-8	URBHYD	96.7	82	92	64	58	1800

			Future Conditions				
		Drainage	Pervious Curve Number		% Impervious		Length Parameter
Basin Number	OTTHYMO Command	Area (ha)	II	III	Total	Direct	(metres)
M-1	URBHYD	41.0	68	84	39	24	520
M-2	URBHYD	73.4	67	83	38	23	700
M-3	URBHYD	36.8	71	86	66	60	500
M-4	URBHYD	37.6	81	92	81	81	500
M-5	URBHYD	16.0	63	80	43	26	330
M-6	URBHYD	24.7	70	85	67	60	410
M-7	URBHYD	34.7	79	91	70	70	1200
M-8	URBHYD	96.7	83	93	67	60	1800

II average antecedent precipitation conditions
III wet antecedent precipitation conditions

Table 3.7 BASIN PARAMETERS - LOWER WEDGEWOOD CREEK

Existing Conditions

Basin Number	OTTHYMO Command	Drainage Area (ha)	Pervious Curve Number II	Pervious Curve Number III	% Impervious Total	% Impervious Direct	Length Parameter (metres)
W-1	URBHYD	60.3	64	81	39	23	630
W-2	URBHYD	46.3	65	82	37	23	560
W-3	URBHYD	21.0	65	82	45	27	370
W-4	URBHYD	22.8	58	76	3	3	390
W-5	URBHYD	53.2	68	84	56	56	580
W-6	URBHYD	13.3	71	86	27	27	300
W-7	URBHYD	56.4	82	92	25	25	370
W-8	URBHYD	17.8	73	87	25	25	380
W-9	URBHYD	46.5	69	85	31	20	560
W-10	URBHYD	14.2	72	86	14	14	310
W-11	URBHYD	32.1	77	89	23	23	460
W-12	URBHYD	31.7	77	89	24	24	460

Future Conditions

Basin Number	OTTHYMO Command	Drainage Area (ha)	Pervious Curve Number II	Pervious Curve Number III	% Impervious Total	% Impervious Direct	Length Parameter (metres)
W-1	URBHYD	60.3	64	81	39	23	630
W-2	URBHYD	46.3	65	82	37	23	560
W-3	URBHYD	21.0	65	82	45	27	370
W-4	URBHYD	22.8	66	82	81	81	390
W-5	URBHYD	53.2	72	86	78	78	580
W-6	URBHYD	13.3	67	83	63	63	300
W-7	URBHYD	56.4	82	92	30	30	370
W-8	URBHYD	17.8	73	87	25	25	380
W-9	URBHYD	46.5	67	83	52	41	560
W-10	URBHYD	14.2	72	86	14	14	310
W-11	URBHYD	32.1	80	91	76	76	460
W-12	URBHYD	31.7	79	91	64	64	460

II average antecedent precipitation conditions
III wet antecedent precipitation conditions

Soils within the Lower Morrison/Wedgewood basins are described in the "Soils of Halton County, Report No. 43 of the Ontario Soil Survey". The soil maps cover only portions of the two (2) watersheds. The soils within the remaining areas were interpolated.

The Ontario Ministry of Transportation's Drainage Manual (Volumes I, II, and III) were used to determine the following hydrologic soil types found within the basins:

Soil Type	Hydrologic Soil Group	Percentage of Total Basin
Bottom Lands	D	5
Brady sandy loam	AB	12
Chinguacousy clay loam	C	34
Cooksville clay	D	2
Fox sandy loam	AB	40
Jeddo clay loam	C	3
Oneida clay loam	D	4

The various soil types within the Lower Morrison/Wedgewood watersheds are shown in Figure 3-4.

All vegetation within the Lower Morrison/Wedgewood Creeks basins was classified under one of the following:

- meadows
- woods
- lawns

Curve numbers for the different classes of vegetation and soils are shown in Table 3.8. The values were abstracted from the National Engineering Handbook published by the U.S. Soil Conservation Service.

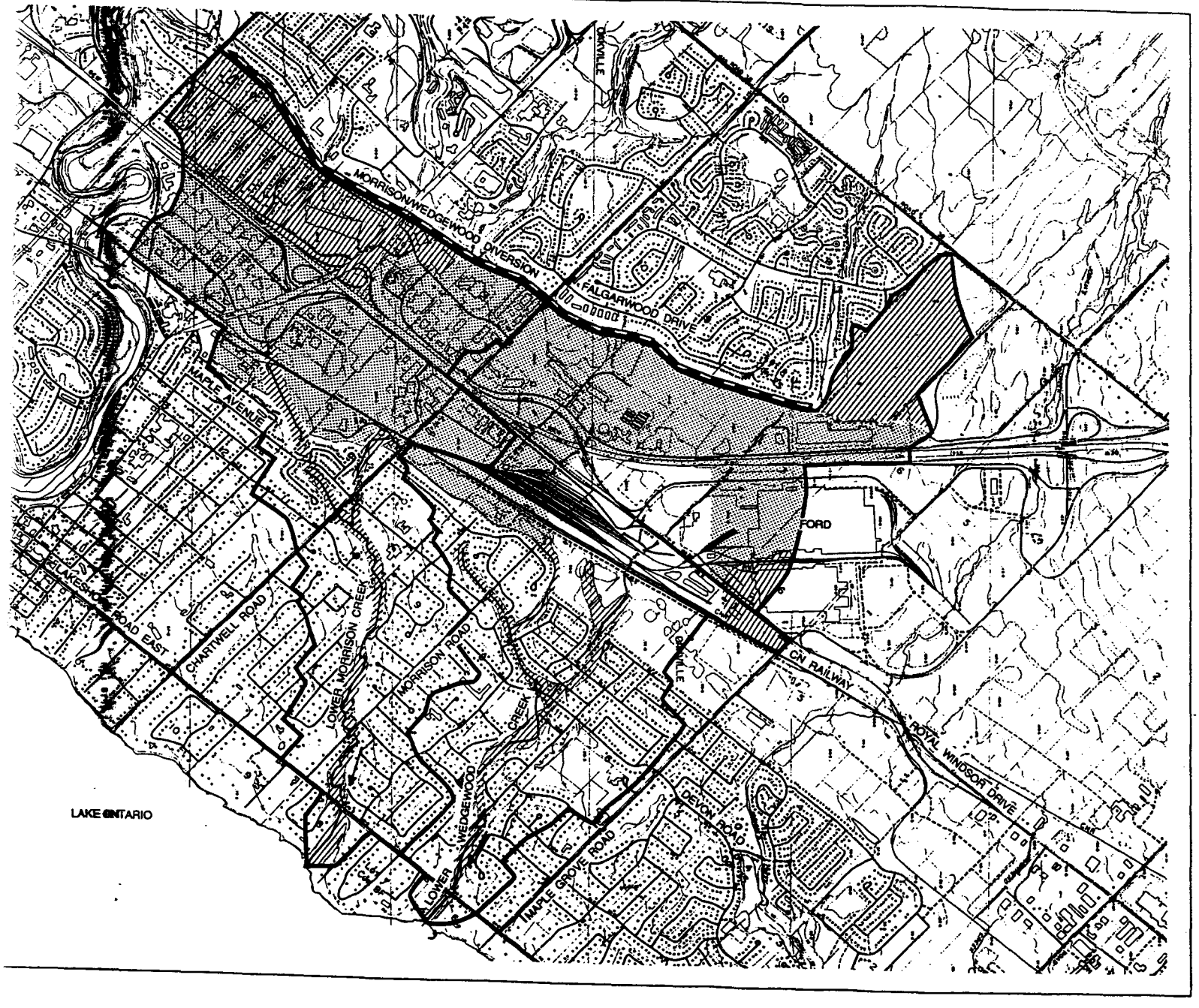


Figure 3-4

Hydrologic Soil Groups

N

- Soil Group AB
- Soil Group C
- Soil Group D
- Watershed Boundary
- Watercourse
- Diversion

Scale

0 0.5 1.0 km.

Note: Base Map is a reproduction of 1:10,000 Ontario Base Mapping produced from aerial photography dated 1982.

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Table 3.8 CURVE NUMBERS[1]

Vegetation Cover	Hydrologic Soil Group A	B	C	D
meadows	46	66	77	82
woods	36	60	73	79
lawns	56	71	81	85

The curve numbers for each of the sub-basins are shown in Table 3.6 for Lower Morrison Creek and Table 3.7 for Lower Wedgewood Creek. The curve number calculations are shown in Appendix A. The curve numbers shown in Table 3.8 represent average soil moisture conditions. Table 3.9 shows the relationship between dry (1), average (2) and wet (3) antecedent conditions. A large amount of rainfall preceded the maximum twelve (12) hour amount used for the Regional (Hurricane Hazel) Storm. Curve numbers shown in Table 3.8 must be increased from average to wet soil conditions for the Hurricane Hazel storm.

Depression storage values for impervious and pervious areas were set equal to 3 and 5 mm respectively. The values were determined after a review of the OTTHYMO User's Manual and a review of the Mimico Creek Study prepared for the Metropolitan Toronto and Region Conservation Authority.

The linear storage coefficient which determines the shape of the hydrograph may be input by the analyst/modeller or determined internally by specifying the overland flow length, Mannings roughness coefficients and the basin slope. Data is not available to estimate directly the linear storage coefficients. The storage coefficients for Lower Morrison/Wedgewood Creeks were determined internally by OTTHYMO.

Manning roughness coefficients for impervious and pervious areas were set equal to 0.015 and 0.250 respectively. The values were abstracted from a review of the OTTHYMO's and SWMM IV User's Manuals.

1. Page 9.2 National Engineering Handbook, Section 4, Hydrology, U.S. Soil Conservation Service, March 1985.

Table 3.9 VARIATION IN CURVE NUMBER BASED ON ANTECEDENT PRECIPITATION

Condition			Condition			Condition		
I	II	III	I	II	III	I	II	III
100	100	100	48	68	84	19	36	56
97	99	100	47	67	83	18	35	55
94	98	99	46	66	82	18	34	54
91	97	99	45	65	82	17	33	53
89	96	99	44	64	81	16	32	52
87	95	98	43	63	80	16	31	51
85	94	98	42	62	79	15	30	50
83	93	98	41	61	78	12	25	43
81	92	97	40	60	78	9	20	37
80	91	97	39	59	77	6	15	30
78	90	96	38	58	76	4	10	22
76	89	96	37	57	75	2	5	13
75	88	95	36	56	75	0	0	0
73	87	95	35	55	74			
72	86	94	34	54	73			
70	85	94	33	53	72			
68	84	93	32	52	71			
67	83	93	31	51	70			
66	82	92	31	50	70			
64	81	92	30	49	69			
63	80	91	29	48	68			
62	79	91	28	47	67			
60	78	90	27	46	66			
59	77	89	26	45	65			
58	76	89	25	44	64			
57	75	88	25	43	63			
55	74	88	24	42	62			
54	73	87	23	41	61			
53	72	86	22	40	60			
52	71	86	21	39	59			
51	70	85	21	38	58			
51	69	85	20	37	57			

I dry antecedent precipitation conditions
II average antecedent precipitation conditions
III wet antecedent precipitation conditions

The overland flow length for each sub-basin was determined by taking the square root of the drainage area (hectares) divided by 1.5 and multiplying by 100. The values for each of the sub-basins are shown in Tables 3.6 and 3.7. The impervious and pervious lengths were assumed equal for all storage coefficient calculations.

The OTTHYMO input parameters are shown in Appendix B.

3.6 Routing

The transposition of a hydrograph from one point of interest to another is referred to as routing. OTTHYMO requires a table of flow depths and travel times for specific flow rates to route a hydrograph from one point of interest to another.

The analyst/modeller may enter the values directly or have the values determined internally by the program. OTTHYMO will calculate the flow rates, depths and travel times if the following values are input:

- channel and flood plain slopes;
- cross section described by distance and elevation measured from the left bank;
- Manning's roughness coefficients; and
- routing length.

3.7 Model Calibration

Computer simulation models usually require the calibration of parameters which cannot be accurately measured to simulate the rainfall/runoff process. Calibration is recommended to adjust those input parameters until a good agreement is obtained between measured and simulated hydrographs.

Calibration of the Lower Morrison/Wedgewood Creek models cannot be undertaken as no rainfall or runoff gauges exist within the watersheds. When calibration cannot be carried out on the study basin it is common to undertake a calibration/verification of input

parameters on adjacent basins. Sixteen Mile Creek and the Credit River have both rainfall and runoff gauges located within the watersheds. The watersheds have been the subject of recent flood plain mapping studies which involved the calibration/verification of the hydrologic models. However, the studies did not calibrate or verify specifically the URBHYD routine of the OTTHYMO model. The Mimico Creek Study carried out for the Metropolitan Toronto and Region Conservation Authority calibrated and verified the URBHYD routine for that watershed. That Study was reviewed to abstract calibrated parameters which would be representative of conditions within the Lower Morrison/Wedgewood Creeks.

Mimico Creek Study

The Study calibrated the NASH HYD and the URBHYD routines on the Mimico and Etobicoke Creeks. An initial abstraction of 3 mm for the Etobicoke Creek was determined from an analysis of recorded rainfall and runoff.

The Study found that curve numbers and overland flow lengths did not have to be varied from standard procedures to accurately simulate recorded hydrographs.

No variations in the overland flow lengths and the curve numbers values will be made to the Lower Morrison/Wedgewood Creek models.

An analysis was carried out to compare peak flow rates determined by the URBHYD routine with values estimated by regional frequency analysis. The following three (3) regional frequency methods were chosen for comparison with URBHYD:

(i) Environment Canada - Index Flood Method
(ii) Environment Canada - Regression Analysis
(iii) Ministry of Natural Resources - Regression Analysis

The three (3) regional frequency analysis methods are based on recorded runoff from rural or undeveloped basins. Peak flow rates calculated using URBHYD assuming existing or highly developed conditions would be much higher than the regional methods. The URBHYD input parameters of the Lower Morrison/Wedgewood basins were changed to reflect natural/rural land uses. The impervious portions of all basins were set equal to 0.0 and curve numbers for each of the basins were recalculated assuming a land use composed of two thirds (2/3) meadow and one third (1/3) woods. The Mannings roughness coefficient for overland flow was increased from 0.25 to 0.40.

Peak flow rates determined from the regional frequency analysis for several points of interest within the Lower Morrison/Wedgewood Creeks are shown in Appendix C. The following is a comparison of the 100 year peak flow rates calculated at Lake Ontario:

			Environment Canada				
			Index Flood				
Watershed	URBHYD (m^3/s)	MNR Regression (m^3/s)	Region 7 (m^3/s)	Region 8 (m^3/s)	Regression (m^3/s)	Upper Bound (m^3/s)	Lower Bound (m^3/s)
Lower Morrison	10.6	9.2	5.8	6.9	2.7	20	2
Lower Wedgewood	15.1	10.7	6.4	7.8	3.1	25	3

Note : All peak flow rates represent natural/rural land use conditions.
Upper and lower bounds are defined by Environments Canada for Region 8.

The peak flow rates generated by URBHYD are relatively high in comparison to the three (3) regional flood frequency methods. It should be remembered that URBHYD was developed for urban basins with significant impervious areas and efficient drainage systems. Although the peak flow rates are relatively high the values fall within the upper and lower bounds for Region 8 as defined by Environment Canada.

The values show that the URBHYD routine of OTTHYMO generates high values for natural/rural areas but within acceptable levels. It can be concluded that the URBHYD routine can be used to define flood hydrographs for flood plain management purposes.

3.8 Sensitivity Analysis

A sensitivity analysis was undertaken to determine the variation of runoff hydrographs as a result of variations in input parameters. The input parameters varied during the analysis include the following:

- overland flow lengths;
- curve number;
- ratio of total impervious area to total drainage area;
- ratio of impervious areas to total drainage area.

The analysis was conducted for future land use conditions using the 100 year design storm. The 100 year storm will yield the largest variation in runoff when compared to Hurricane Hazel and the other return period storms.

Overland flow lengths in OTTHYMO are calculated by taking the square root of the drainage area divided by 1.5. The OTTHYMO User's Manual assumes a basin length to width ratio of 1.5. The sensitivity analysis varied the length to width ratio from 1.0 to 2.0. The results shown in Table 3.10 indicate a 2% variation in peak flow rates for the Lower Morrison/Wedgewood Creek's basins.

Curve numbers for the pervious areas were varied by 10 above and below the values determined for the design values. The Lower Morrison/Wedgewood Creek's peak flow rates varied by approximately 8%.

Impervious ratios were increased and decreased by 20% from design values. Peak flow rates increased/decreased proportionally by approximately 15%. The values varied depending upon location within the basin. The largest increases were observed in the upper portions of the basin with the smallest in the lower reaches.

Roof leaders draining onto grassed areas yielded significant differences in total impervious and directly connected areas. A sensitivity analysis was made to determine increases in peak flow rates as a result of converting indirectly connected impervious areas to directly

connected. Table 3.10 shows that peak flow rates increased by approximately 6% by assuming all impervious areas were directly connected.

3.9 Peak Flow Rates

Peak flow rates for existing and future land use scenarios are shown in Table 3.11. Generally, Lower Morrison Creek peak flow rates for future conditions are approximately 10% higher than values for existing land use conditions. Along Lower Wedgewood Creek peak flow rates for future land use conditions are approximately 40% higher than values for existing land use conditions.

Peak flow rates at Lake Ontario for the 100 year Storm were slightly less than the Regional (Hurricane Hazel) values. Upstream the 100 year peak flow rates were significantly larger than the Regional flows.

The Regulatory Flood is the greater of the Regional or the 100 year flood. The Regulatory Flood Plain will be determined using the Regional storm peak flow rates for the lower reaches of the watercourses, while the upper reaches will be defined using the 100 year values.

The Lower Morrison/Wedgewood Creek peak flow rates are conservative as the values have been calculated assuming no storage behind road/railway embankments. Storage behind road/railway embankments attenuates peak flow rates which leads to lower downstream peak flow rates and water surface elevations. Standard flood plain management practice assumes no storage behind road/railway crossing embankments as a culvert/bridge can be replaced at any time. The storage behind the embankment would be lost and peak flow rates downstream would be increased.

TABLE 3.10 SENSITIVITY ANALYSIS - OTTHYMO

			FUTURE CONDITIONS						
	Drainage Area	100 year Peak Flow	Overland L/W = 1	Flow Length L/W = 2	Curve Number - 10	Curve Number + 10	% Impervious * 0.8	% Impervious * 1.2	% Impervious XIMP = TIMP
Location	(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
LOWER WEDGEWOOD CREEK									
Lake Ontario	420	43.8	42.9	44.5	40.4	46.8	38.5	50.3	45.6
Alscot Crescent	360	43.6	42.6	44.5	40.7	46.7	37.6	50.3	45.6
East Branch									
Amber Crescent	220	39.2	38.2	39.8	37.7	41.6	33.3	45.0	39.2
Constance Drive	200	39.2	38.2	39.8	37.7	41.6	33.3	45.0	39.2
CN Railway	170	37.2	36.1	37.9	35.7	39.5	31.7	42.6	37.2
QEW	60	10.8	10.3	11.2	9.5	12.8	9.8	11.9	10.8
East Branch - Western Tributary									
CN Railway	30	11.1	10.9	11.3	10.8	11.5	9.6	12.7	11.1
West Branch									
Drummond Road	90	13.1	12.7	13.4	12.2	14.4	11.3	14.9	14.4
CN Railway	45	9.7	9.5	9.9	9.3	10.3	8.4	11.0	9.7
QEW	30	9.7	9.5	9.9	9.3	10.3	8.4	11.0	9.7
LOWER MORRISON CREEK									
Lake Ontario	360	35.3	33.9	36.1	32.4	39.0	30.0	40.0	37.4
Morrison Road	320	34.5	33.3	35.1	32.4	37.4	29.7	39.2	36.3
Linbrook road	75	16.8	16.3	17.1	16.3	17.5	14.2	17.3	17.3
QEW	40	13.3	13.0	13.5	13.1	13.7	11.4	15.2	13.3
West Branch									
Chartwell Drive	170	25.6	24.1	25.5	25.0	27.1	21.5	30.2	27.2
Maple Avenue	160	25.6	24.1	25.8	25.0	27.1	21.5	30.2	27.2
CN Railway	130	25.6	24.1	27.1	25.0	27.1	21.5	30.2	27.2

TABLE 3.11 PEAK FLOW RATES

Location	Drainage Area (ha)	Regional Existing (m^3/s)	Regional Future (m^3/s)	100 Year Existing (m^3/s)	100 Year Future (m^3/s)	50 Year Existing (m^3/s)	50 Year Future (m^3/s)	25 Year Existing (m^3/s)	25 Year Future (m^3/s)	10 Year Existing (m^3/s)	10 Year Future (m^3/s)	5 Year Existing (m^3/s)	5 Year Future (m^3/s)	2 Year Existing (m^3/s)	2 Year Future (m^3/s)
LOWER WEDGEWOOD CREEK															
Lake Ontario	420.0	44.9	47.7	31.6	43.8	26.8	38.5	22.7	33.2	17.6	26.2	14.0	21.6	10.9	17.1
Alscot Crescent	360.0	39.0	42.0	30.1	43.6	25.8	38.4	21.9	33.2	17.0	26.2	13.6	21.6	10.6	17.1
East Branch															
Amber Crescent	220.0	24.8	27.2	26.7	39.2	23.4	34.7	20.2	30.3	16.1	24.7	13.3	20.7	10.3	16.2
Constance Drive	200.0	22.6	25.0	26.7	39.2	23.4	34.7	20.2	30.3	16.1	24.7	13.3	20.7	10.3	16.2
CN Railway	170.0	20.8	22.2	26.7	37.2	23.4	33.0	20.2	28.8	16.1	23.5	13.3	19.7	10.3	15.4
QEW	60.0	6.8	6.9	9.9	10.8	8.6	9.4	7.4	8.1	5.7	6.4	4.7	5.2	3.5	4.0
East Branch - Western Tributary															
QEW	30.0	4.0	4.5	5.4	11.1	4.7	9.9	4.0	8.7	3.1	7.2	2.5	6.1	1.9	4.8
West Branch															
Drummond Road	90.0	10.4	11.3	8.7	13.1	7.5	11.5	6.4	10.0	4.9	8.1	3.9	6.7	3.0	5.2
CN Railway	45.0	5.5	5.9	5.7	9.7	4.9	8.6	4.2	7.6	3.3	6.2	2.6	5.2	1.9	4.1
QEW	30.0	3.9	4.3	5.4	9.7	4.7	8.6	4.0	7.6	3.1	6.2	2.5	5.2	1.9	4.1
LOWER MORRISON CREEK															
Lake Ontario	360.0	37.0	37.9	32.0	35.3	27.4	30.4	23.5	26.2	18.2	20.6	14.6	16.5	11.2	12.7
Morrison Road	320.0	32.7	33.6	31.5	34.5	27.4	30.4	23.5	26.2	18.2	20.6	14.6	16.5	11.2	12.7
East Branch															
Linbrook Road	75.0	9.9	10.0	15.9	16.8	14.1	14.9	12.4	13.1	10.1	10.7	8.5	9.1	6.7	7.1
QEW	40.0	5.3	5.3	13.3	13.3	11.9	11.9	10.5	10.5	8.6	8.6	7.3	7.3	5.7	5.7
West Branch															
Chartwell Drive	170.0	17.0	17.9	23.0	25.6	20.0	22.5	17.0	19.3	13.2	15.1	10.6	12.2	7.6	8.9
Maple Avenue	160.0	15.3	16.2	23.0	25.6	20.0	22.5	17.0	19.3	13.2	15.1	10.6	12.2	7.6	8.9
CN Railway	130.0	12.9	13.5	23.0	25.6	20.0	22.5	17.0	19.3	13.2	15.1	10.6	12.2	7.6	8.9

9.8 Corrective - Structural Alternatives to Modify the Flood

Structural alternatives to modify the flood include storage ponds, dykes, channel improvements (crossings and alignment) and diversions. Several alternatives were formulated for the Lower Morrison/Wedgewood Creeks after a review of the flood damage locations and the hydrologic/hydraulic results.

The detailed cost breakdowns for each of the alternatives discussed in this section are shown in Appendix H.

9.8.1 Flood Storage - Lower Morrison Creek

The only vacant land that could be used for a detention facility is located in Figure 9-3, upstream of Maple Avenue along the West Tributary. Only vacant land was considered due to the large social disruption of acquiring occupied land.

The hydraulic analysis results indicated that the majority of potential flooding within the Study area was the result of inadequate culvert capacities. Any detention facility would have to reduce peak flow rates to the capacity of the smallest downstream culvert.

The dry detention pond was designed to have a maximum outflow rate of approximately 10 m^3/s or the capacity of the Maple Avenue culvert. The existing Maple Avenue culvert would be retained as an outlet with appropriate inlet works being constructed.

The detention facility would be designed to accommodate runoff from both the West and East Branches. Runoff from the East Branch would be diverted by a trapezoidal Terrafix block (or equivalent) lined channel from the CN Railway culvert to the upstream face of the Maple Avenue culvert.

A diversion is necessary to reduce flooding along the East Branch and downstream of the confluence. Without the diversion the detention facility would only reduce flooding along the West Branch. Peak runoff rates from the East Branch watershed would be greater than the capacities of the downstream culverts. Characteristics of the pond and the diversion channel are described in Table 9.1 and 9.2.

Table 9.1 LOWER MORRISON CREEK DETENTION FACILITY CHARACTERISTICS

Property Required	8 ha
Maximum Water Level	95.0 m
Maximum Water Depth	1.9 m
Maximum Storage	4.8 ha-m
Outlet - Maple Avenue Culvert	3.1 x 1.2 m rectangular concrete
Peak Outflow Rate	12.9 m^3/s (Regional future)
Peak Inflow Rate	35.0 m^3/s (100 year future)
Maximum Ponding Duration	4.0 hours
Excavation Required	11.0 ha-m
Terrafix Block (or equivalent) Low Flow Channel	

Table 9.2 LOWER MORRISON CREEK DIVERSION CHANNEL CHARACTERISTICS

Length	500 m
Side Slopes	3:1 (horizontal to vertical)
Bottom Width	1 m
Maximum Depth	2 m
Channel Slope	0.004 m/m
Material	Terrafix Block (or equivalent)

The detention facility would have sufficient capacity to eliminate damages for the 100 year flood downstream along both the East and West Branches. However, the pond would not significantly affect flood damages for the Regional event. Other measures such as floodproofing and culvert enlargement would be required to completely eliminate flood damages.

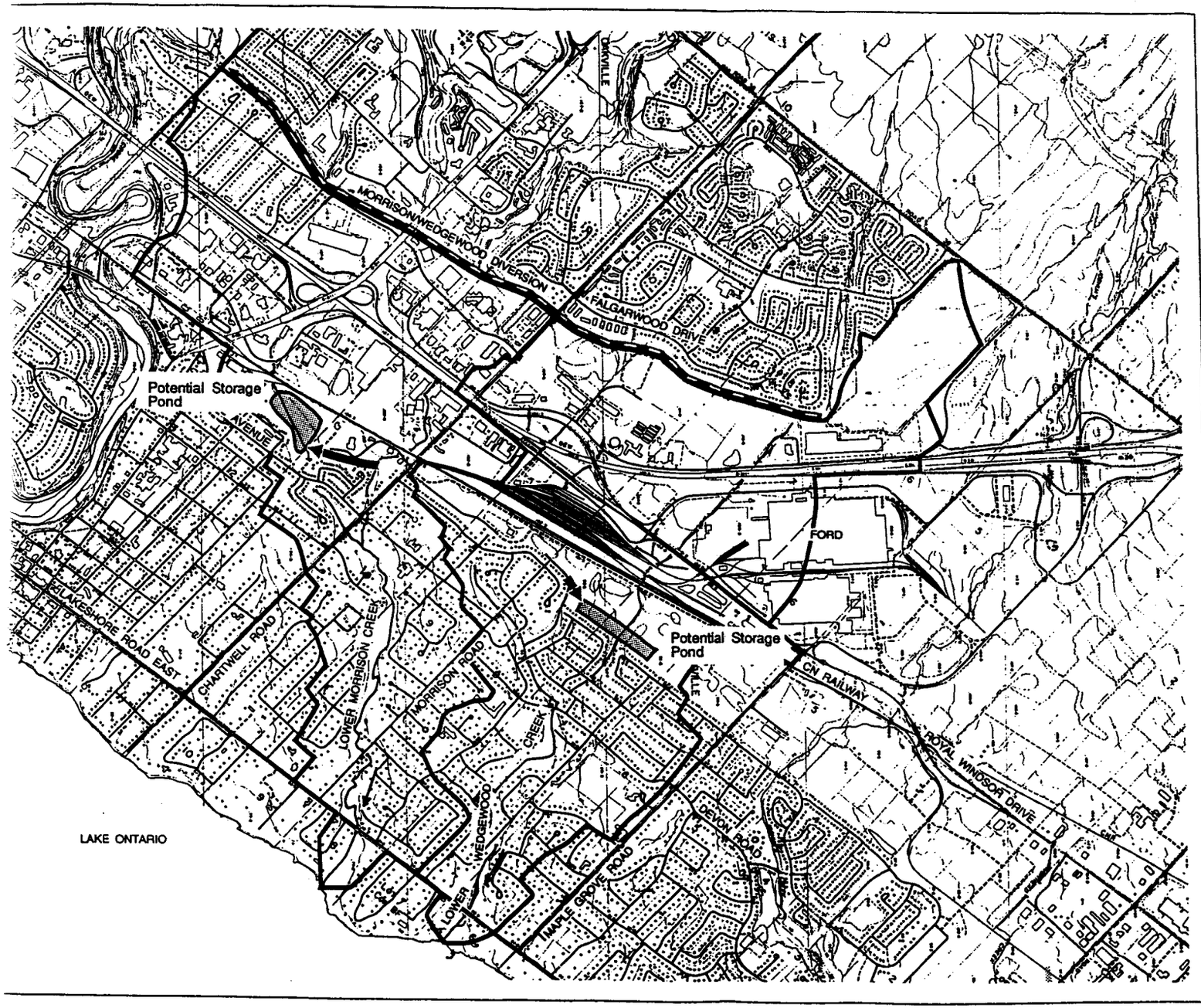

Figure 9-3

Potential Storage Pond Locations

N

Diverion Channel

Storage Pond Location

Watershed Boundary

Watercourse

Diversion

Scale

0 0.5 1.0 km.

Note: Base Map is a reproduction of 1:10,000 Ontario Base Mapping produced from aerial photography dated 1982.

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The proposed diversion and detention facilities would have a total cost of $12.9 million. Construction costs are estimated at $3.2 million; land costs at $9 million. Annual operation and maintenance are estimated at $20,000. Average annual flood damages would be reduced by $95,000 to $120,000.

The maximum pond elevation is limited by the ground elevation (95.5 m) of adjacent properties. The properties drain through a rear yard swale to the Maple Avenue culvert.

9.8.2 Flood Storage - Lower Wedgewood Creek

Two (2) locations along the East Branch of Lower Wedgewood Creek were identified for detention facilities.

One was located between Cornwall Road and the CN Railway and the other was located east of Cornwall Road adjacent to the residential subdivision.

The proposed detention facility located south of Cornwall Road was favoured because it could accommodate a diversion from the West Branch. Without the diversion the detention facility would only reduce peak flow rates and damages along the East Branch.

An embankment and outlet structure would have to be constructed in order to detain runoff. Details of the diversion and the detention facility can be found in Table 9.3 and 9.4. Peak outflow rates would have to be reduced to the downstream minimum culvert capacity of approximately 9.0 m^3/s. The outlet works would consist of a concrete box culvert. The embankment would have a length of approximately 700 m.

A diversion channel from the West Branch would be constructed along the upstream face of the detention embankment. The trapezoidal Terrafix (or equivalent) lined channel would be approximately 4 m deep with 3:1 side slopes and a bottom width of 1.0 m.

The hydrologic analysis of the proposed detention facility found that the pond did have sufficient volume to eliminate flood damages for the Regional event. Other measures such as floodproofing and culvert enlargement would have to be employed to eliminate damages for the Regional Flood.

The proposed diversion and detention facility would have a total cost of $12.2 million. Included are land costs at approximately $9.0 million and construction costs at approximately $3.2 million. Annual operation and maintenance is estimated at $20,000. Average annual flood damages would be reduced from $360,000 to $37,000 (future land use).

Table 9.3 LOWER WEDGEWOOD CREEK DETENTION FACILITY CHARACTERISTICS

Property Required	8 ha
Maximum Water Level	97.0 m
Maximum Water Depth	2.5 m
Maximum Storage	5.1 ha-m
Outlet -	
Peak Outflow Rate	18.3 m^3/s (Regional future)
Peak Inflow Rate	52 m^3/s (100 year future)
Maximum Ponding Duration	4.0 hours
Excavation Required	7.0 ha-m

Terrafix Block (or equivalent) Low Flow Channel

Table 9.4 LOWER WEDGEWOOD CREEK DIVERSION CHANNEL CHARACTERISTICS

Length	360 m
Side Slopes	3:1
Bottom Width	1 m
Maximum Depth	4 m
Channel Slope	0.004 m/m
Material	Terrafix Block (or equivalent)

Designation of Trafalgar Road as a permanent flood route may impact other essential services during flooding events. Emergency services may not be able to utilize Trafalgar Road due to the depth of flood waters in the subway.

Approximately $50,000 has been allotted to designate Trafalgar Road as a permanent flood route. The cost includes time for Town of Oakville staff to conduct the necessary analyses and investigations. Average annual damages along Lower Morrison Creek would be reduced from $215,000 to $140,000 and one (1) building would be removed from the Regulatory Flood Plain. The building is located adjacent to the Maple Avenue crossing. Flood levels upstream of Maple Avenue would be reduced by approximately 0.1 m.

9.8.7 Diversion - Lower Morrison Creek, Cornwall Road

This alternative would reduce potential flood damages along both the West and East Tributaries of Lower Morrison Creek. Cornwall Road will be extended from Chartwell to Trafalgar Road. The alignment has been selected, but construction has not started. A culvert could be constructed to divert runoff from the upper reaches of Lower Morrison Creek to the Sixteen Mile Creek. The culvert would be constructed within the Cornwall Road right-of-way and would follow Trafalgar Road to Sixteen Mile Creek.

Runoff rates higher than the existing 2 year peak flow rates would be diverted to Sixteen Mile Creek. The construction cost is based on a concrete box culvert which varies in size from 2.0 m X 2.0 m to 4.0 m X 2.0 m. The total length of the diversion culvert would be approximately 1.3 km. The culvert would require a significant outlet structure into Sixteen Mile Creek. The capacity of the 4.0 m X 2.0 m concrete box culvert is approximately 26 m^3/s. The 100 year peak flow rate is approximately 26 m^3/s. Peak flow rates greater than 8 m^3/s would be diverted to Sixteen Mile Creek. The 4.0 X 2.0 m box culvert would convey runoff from both the East and West Tributaries.

CONCLUSIONS AND RECOMMENDATIONS

Chapter 12

12.0 CONCLUSIONS AND RECOMMENDATIONS

The Regulatory Flood Plain for the Lower Morrison/Wedgewood Creeks was delineated on topographic mapping with a scale of 1:2,000.

The Regulatory Flood would potentially inundate approximately 26 buildings along Lower Morrison Creek and 42 buildings along Lower Wedgewood Creek. The Regulatory Flood would potentially create approximately $2,030,000 in flood damages along both watercourses. Potential average annual flood damages for the Lower Morrison Creek are approximately $215,000 and $360,000 along Lower Wedgewood Creek.

An erosion inventory of the Lower Morrison/Wedgewood Creeks was undertaken during October 1989. A total of 15 erosion sites were identified.

One (1) of the sites requires immediate attention as two (2) buildings are located within one (1) metre of the top of bank. Two (2) additional sites require regular monitoring. The remainder of the sites were classified as medium or low priority.

A number of alternative flood control measures were identified and evaluated. The evaluation considered both social and environmental factors.

The implementation of the master drainage plan will cost approximately $3,410,000 and is expected to be completed within the next 10 to 20 years.

A master drainage plan was developed. It is composed of preventive stormwater management policies and structural flood and erosion control works.

The flood control works consisted of culvert enlargement, floodproofing and channelization. The erosion control measures included, retaining walls, culvert protection and seed and mulch.

A stormwater management policy was developed to ensure future development would not increase flood and erosion damages.

IT IS RECOMMENDED THAT THE AUTHORITY AND THE TOWN ADOPT THE FLOOD PLAIN MAPPING TO REGULATE FUTURE DEVELOPMENT IN THE FLOOD PLAIN.

IT IS RECOMMENDED THAT THE AUTHORITY AND THE TOWN IMPLEMENT THE MASTER DRAINAGE PLAN TO ALLEVIATE EXISTING FLOODING AND EROSION AND TO PREVENT FUTURE DEVELOPMENT FROM INCREASING FLOODING AND EROSION.