



Enhancing our communities



Drainage Master Plan

MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT PHASES 1 & 2

City of Barrie

Document Control

File:

117076

Prepared by:

Tatham Engineering Limited
115 Sandford Fleming Drive,
Suite 200
Collingwood, Ontario L9Y 5A6

Prepared for:

City of Barrie
70 Collier Street
Barrie, Ontario L4M 4T5

Date:

**March 29,
2019**

T 705-444-2565
tathameng.com

Authored by:	Reviewed by:
	
Daniel Twigger, B.Sc.Eng., P.Eng. Senior Engineer, Group Leader	Dan Hurley, B.A.Sc., P.Eng., LEED AP President

Disclaimer	Copyright
The information contained in this document is solely for the use of the Client identified on the cover sheet for the purpose for which it has been prepared and Tatham Engineering Limited undertakes no duty to or accepts any responsibility to any third party who may rely upon this document.	This document may not be used for any purpose other than that provided in the contract between the Owner/Client and the Engineer nor may any section or element of this document be removed, reproduced, electronically stored or transmitted in any form without the express written consent of Tatham Engineering Limited.

Issue	Date	Description
1	March 29, 2019	Final Report



Document Contents

Executive Summary	1
1 Introduction	16
1.1 Study Area	16
1.2 Background	18
1.3 Project Team	28
1.4 Master Planning Process – Approach #2	29
1.5 Existing Policies	30
2 Problem/Opportunity Statement	43
2.1 Problem Statement	43
2.2 Watershed/Drainage Area Specific Problems	43
2.3 Opportunity Statement	47
3 Project Environment	48
3.1 Physical Environment	48
3.2 Natural Environment	58
3.3 Social Environment	63
3.4 Cultural/Archeological Environment	64
3.5 Economic Environment	65
4 Existing Condition System Analysis	67
4.1 Model Updates	67
4.2 Interwatershed Spills Analysis	71
5 Future Peak Flow Spill Analysis	75
5.1 Interwatershed Spills Analysis	76
6 Spill Analysis with MTO's Proposed Highway 400 Improvements	80
7 Screening of Improvement Options	85
7.1 Flow Reduction/Water Quality Improvement Options	85



7.2	Conveyance Capacity Improvement Options	85
7.3	Flow Reduction/Water Quality Improvement Options	85
7.4	Conveyance Capacity Improvements Options	95
8	Description of Overall Improvement Alternatives	98
8.1	Existing Conditions	98
8.2	Flow Reduction/Water Quality Improvements	98
8.3	Conveyance Capacity Improvements	100
9	Public Consultation – Public Information Centre (PIC#1)	101
9.1	Notice of Study Commencement and Public Information Centre	101
9.2	Results of Public Consultation	101
9.3	Identified Drainage Issues	102
9.4	Public Preference	102
9.5	Private Property Drainage Issues	104
10	Overall Improvement Alternatives Assessment	106
10.1	Existing Conditions	106
10.2	Flow Reduction/Water Quality Improvements	107
10.3	Conveyance Capacity Improvements	124
11	Overall Alternatives Evaluation	137
12	Preferred Approach	148
12.1	Flow Reduction / Water Quality Improvements	148
13	Public Consultation – Public Information Center (PIC#2)	151
13.1	Notice of Study Commencement and Public Information Centre	151
13.2	Results of Public Consultation	151
14	Individual Drainage Project Evaluation	153
14.1	Kidd’s Creek Watershed	170
14.2	Bunkers Creek Watershed	187
14.3	Dyments Creek Watershed	208



14.4	Hotchkiss Creek Watershed	230
14.5	Huron Creek Drainage Area	247
14.6	Whiskey Creek Watershed	249
14.7	Lovers Creek Watershed	281
14.8	Hewitts Creek Watershed	302
14.9	Georgian Creek Watershed	306
14.10	Little Lake Watershed	310
14.11	Bear Creek Watershed	316
14.12	Johnson Drainage Area	323
14.13	Nelson Drainage Area	325
15	Preferred Solution / Individual Drainage Projects	326
15.1	General Recommendations	326
15.2	Individual Drainage Solutions (Projects)	327
15.3	Project Costs	340
15.4	Property Acquisition	341
16	Conditional Projects	343
17	Project Prioritization	349
18	Detailed Design and Construction	358
19	Climate Change	360
20	SWM Funding	362
20.1	Funding Mechanisms	362
20.2	Funding Mechanism Comparison	366
20.3	Recommended Funding Mechanism	366
21	Conclusions	368



Tables

Table 1: Drainage Area Summary	17
Table 2: SWMF Asset Management Plan – SWMF Renewal/Enhancement	26
Table 3: SWMF Asset Management Plan - SWMF Inspection and Maintenance Program.....	26
Table 4: DSWMMP - SWMF Retrofit Summary.....	27
Table 5: DSWMMP – New SWMF Summary	27
Table 6: Flow Design Guidelines for Road Crossings.....	32
Table 7: Summary of Private Properties within the Regulatory Floodplain	49
Table 8: Road Classification Summary	52
Table 9: Mapped Fish Species Summary	60
Table 10: Creek Thermal Regime and Fishery Timing Windows	61
Table 11: Existing Conditions Hydrologic Modelling Results Summary	69
Table 12: Dyments Creek Flow Summary (Existing Conditions).....	72
Table 13: Existing Condition Peak Flows for Barrie Creeks Drainage Study Area.....	73
Table 14: Existing Condition Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area.....	74
Table 15: Future Conditions Hydrologic Modelling Results Summary	76
Table 16: Dyments Creek Flow Summary (Future Conditions)	77
Table 17: Future Condition Peak Flows for Barrie Creeks Drainage Study Area.....	78
Table 18: Future Condition Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area	79
Table 19: Existing Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements).....	82
Table 20: Future Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements).....	83
Table 21: Existing Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements)	84
Table 22: Future Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements).....	84
Table 23: SWMF (Existing and Proposed Ponds) Pre-Screening Summary.....	86
Table 24: SWMF's (Existing and Proposed Ponds) Eliminated from Further Evaluation	88
Table 25: SWMF's (Existing and Proposed Ponds) Recommended for Further Evaluation.....	90
Table 26: Centralized LIDs – Pre-Screening Evaluation	92
Table 27: Centralized LIDs Eliminated from Further Evaluation.....	93
Table 28: Centralized LIDs Recommended for Further Evaluation	94
Table 29: Public Consultation Preliminary Preferred Alternative Solution.....	103



Table 30: Public Consultation Respondent Preference.....	104
Table 31: Flow Reduction Hydrologic Model Results Summary (SWMF Retrofits) – Alternative 2A	107
Table 32: Water Quality Treatment / Phosphorus Reduction Summary – Alternative 2A	108
Table 33: Project Cost Estimates – Alternative 2A	109
Table 34: Water Quality Treatment / Phosphorus Reduction Summary – Alternative 2B	110
Table 35: Flow Reduction Hydrologic Model Results Summary – Alternative 2B.....	111
Table 36: Flow Reduction Hydrologic Model Results Summary (Watershed) – Alternative 2A and 2B in Combination.....	113
Table 37: Project Cost Estimates – Alternative 2B.....	114
Table 38: Infiltration Summary – Alternative 2C	115
Table 39: Infiltration Summary – Alternative 2D	116
Table 40: Flow Reduction Hydrologic Model Results Summary – Alternatives 2D	117
Table 41: Project Cost Estimates – Alternative 2D	119
Table 42: Infiltration Summary – Alternative 2E.....	121
Table 43: Flow Reduction Hydrologic Model Results Summary – Alternatives 2E	122
Table 44: Phosphorus Reduction Summary – Alternatives 2C through 2E	123
Table 45: Project Cost Estimates – Alternative 2E.....	124
Table 46: Culvert Improvement Summary – Alternative 3A	125
Table 47: Project Cost Estimates – Alternative 3A (Culvert Improvements).....	131
Table 48: Project Cost Estimates – Alternative 3A (Watercourse Improvements).....	132
Table 49: Project Cost Estimates – Alternative 3A (Trunk Sewers)	133
Table 50: Culvert Summary – Alternative 3B	133
Table 51: Project Cost Estimates – Alternative 3B.....	136
Table 52: Assessment of Improvement Alternatives – Existing Conditions.....	138
Table 53: Assessment of Improvement Alternatives – Flow Reduction / Water Quality Improvements	140
Table 54: Assessment of Improvement Alternatives – Conveyance Capacity Improvements ..	146
Table 55: Qualitative Individual Project Evaluation.....	154
Table 56: Quantitative Individual Project Evaluation	162
Table 57: Project No. 163 – Impacted Properties.....	182
Table 58: Project No. 10 – Impacted Properties.....	184
Table 59: Project No. 183 – Impacted Properties.....	213
Table 60: Project No. 51 – Impacted Properties.....	215
Table 61: Final Preferred Solution Summary.....	328
Table 62: Project Costs Summary - Preferred Solution	340
Table 63: Property Acquisition Summary – Preferred Solution.....	341



Table 64: Conditional Projects	344
Table 65: Preferred Solution Prioritization Table	350
Table 66: Stormwater Utility Service Fees	364

Appendices

Appendix A: Figures

Appendix B: Hydrologic & Hydraulic Modelling Technical Memorandum

Appendix C: Background Recommendations

Appendix D: Private Property Flooding

Appendix E: Fluvial Geomorphologic & Erosion Threshold Assessment

Appendix F: Source Water Protection Technical Memorandum

Appendix G: Natural Heritage Assessment Technical Memorandum

Appendix H: Stage 1 Archeological Assessment Technical Memorandum

Appendix I: Cultural Heritage Review

Appendix J: Discretionary Public Information Centre (PIC #1)

Appendix K: Assessment of SWMFs and LIDs to Reduce Phosphorous Discharges Technical Memorandum

Appendix L: Preliminary Preferred Solutions

Appendix M: Mandatory Public Information Center (PIC #2)

Appendix N: Final Preferred Solutions Conceptual Designs

Appendix O: Final Preferred Solutions Cost Estimates

Appendix P: Third Party Drainage Solutions

Appendix Q: Phosphorus Credits Trading Registry



Executive Summary

In March 2017, the City of Barrie (City) retained Tatham Engineering Limited (Tatham) to prepare a Drainage Master Plan for the City following Approach #2 of the Master Planning process outlined in the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment Document (October 2000, as amended in 2007, 2011 and 2015). The study area for the Drainage Master Plan includes the entire City of Barrie excluding the Sophia Creek watershed, Mulcaster drainage area and Annexation Lands.

The City of Barrie has previously invested in the preparation of Master Drainage Plans and stormwater management studies for a number of watersheds and drainage areas across the City. The Master Drainage Plans identify drainage deficiencies in the City, evaluate alternative solutions to address the deficiencies, and recommend a preferred alternative solution for implementation. Similarly, the stormwater management studies provide recommendations for drainage improvements required for existing infrastructure and outline SWM requirements for future development.

As part of this Drainage Master Plan, the recently prepared city wide minor and major drainage system models were updated and used to evaluate the drainage systems city wide and identify the existing minor and major drainage system deficiencies. Also, a flood spill analysis was completed to quantify the interwatershed flood spills within the Barrie Creek study area. Public Information Centre #1 was also held to elicit feedback from residents and interested stakeholders regarding the drainage issues they have witnessed throughout the City.

Currently, portions of the City experience flooding during both minor and major storm events. Frequent flooding of private and municipal property during minor and major storm events has been documented throughout the City along much of the watercourses due to insufficient culvert and channel capacities. The flooding has caused historic damage to both private and municipal property and causes concern for public safety. Also, there is significant erosion along a number of the channel reaches in the City that threaten both private and municipal property and also causes concern for public safety.

In addition to flooding, the existing storm infrastructure is reaching its service life expectancy and deteriorating. A majority of the aging storm sewers are undersized considering historic rainfall data and current climate models predict future increases in rainfall intensities and volumes. In some locations, municipal storm infrastructure is located on private property outside the municipal right-of-way making it difficult to access and maintain. Also, there are areas absent of minor drainage systems and stretches of deficient overland flow routes across the City. Development, intensification, urbanization and growth in the City have also adversely



impacted the stormwater quality and ecological health of the various creeks and Lake Simcoe. The culmination of the above noted factors results in a storm system that does not meet the City's engineering and development standards.

The City is planning to mitigate the drainage deficiencies and replace the aging and deteriorating storm infrastructure throughout the study area as part of future works. Opportunity exists to improve the drainage system level of service to a level that conforms with current drainage policies and design guidelines, improves water quality and water balance conditions, reduces flooding and erosion, improves maintenance opportunities and eliminates public safety hazards. As such, the City has initiated this Master Drainage Plan to identify and evaluate drainage improvements based on their impacts to the physical, natural, social, cultural and economic environments. A set of preferred improvement solutions having the greatest positive impact on the project environments and a recommended approach for implementing the solutions is the end product of the study.

In developing alternatives to address the drainage deficiencies, a two tier approach was used. First, overall drainage alternatives were developed, evaluated and presented to the public to establish a preferred approach to addressing the drainage deficiencies city wide. Second, general recommendations applicable to the entire City and site specific individual projects were developed from the preferred approach and evaluated and presented to the public.

Each project was evaluated based on its impact on the physical, natural, social, cultural and economic environments. To aid in the evaluation, conceptual designs, project cost estimates and the following supporting documents were prepared:

- Fluvial Geomorphologic & Erosion Threshold Assessment. Water's Edge Environmental Solutions Team (January 2018);
- Source Water Protection Considerations Technical Memorandum. Azimuth Environmental Consulting Inc. (November 2018);
- Planning Level Environmental Impact Study. Azimuth Environmental Consulting Inc. (January 2019);
- Stage 1 Archeological Assessment for the City of Barrie Drainage Master Plan. Archeoworks Inc. (June 2018);
- Cultural Heritage Review Technical Memo. ERA Architects Inc. (January 2019); and
- Preliminary *Geotechnical Investigation*. Peto MacCallum Ltd. (January 2018).

The preferred overall approach to addressing the drainage deficiencies across the City established through an overall alternatives evaluation and public consultation is a combination of the following:



- Existing Conditions
 - Alternative 1A – “Do Nothing” Minor Drainage Systems
 - Alternative 1B – “Do Nothing” Major Drainage Systems
- Flow Reduction / Water Quality Improvements
 - Alternative 2A – Retrofit / New SWMF’s for Quantity Control
 - Alternative 2B – Retrofit / New SWMF’s for Quality Control
 - Alternative 2C – Lot Level Low Impact Development
 - Alternative 2D – Linear Low Impact Development
 - Alternative 2E – Centralized Low Impact Development
- Conveyance Capacity Improvements
 - Alternative 3A – Culvert / Watercourse / Major Drainage System Improvements (MDP Recommended Design Flood Frequency Criteria)
 - Alternative 3B – Culvert / Watercourse / Major Drainage System Improvements (City Design Flood Frequency Criteria)

It is noted that the preferred approach is a combination of the alternatives listed above. The combination of alternatives is dependent on the watershed and drainage area.

After the preferred approach was established, general recommendations and individual projects were developed from each overall alternative to address city wide and site specific drainage issues, respectively. The following general recommendations were developed from the preferred approach and are recommended as part of the preferred solution for each watershed and drainage area across the City:

- As a general requirement for all capital projects, it is recommended that upsizing the local storm sewers to satisfy current design standards be considered as part of future road reconstruction projects.
- Similarly, relocating storm sewer to the municipal road allowance should also be considered as part of future road reconstruction projects. There are sections of storm sewer throughout the City that are currently located outside the municipal road allowance on private property. As local improvement projects proceed these storm sewers should be relocated to municipal lands for access and maintenance.
- It is also recommended that the streets identified as being absent of a minor drainage system throughout the study area include storm sewers as part of road reconstruction projects.



- It is recommended that solutions to address the identified major overland deficiencies be evaluated as part of future road reconstruction projects where feasible through oversizing the storm sewer and/or adjusting the road profile/cross-section.
- The implementation of lot level Low Impact Development (LID) measures on private property across the City should be promoted. The use of rain barrels and implementation of soakaway pits by residents and property owners should be encouraged by the City.
- The City should implement linear low impact development measures such as perforated pipe systems or infiltration systems as part of local road reconstruction projects and intensification in the City of Barrie.

The projects developed to address site specific drainage issues are divided into five groups; 1) culvert improvements, 2) watercourse improvements, 3) trunk storm sewer improvements, SWMF retrofit / creation projects and centralized LIDs. Conceptual designs of each project have been prepared and the minor and major drainage system hydrologic and hydraulic models were updated to include the projects to assess their ability to address the studies problem statement. Specifically, each projects impact on peak flows, flooding, water quality, phosphorus reduction, and erosion was assessed.

The preferred projects established through an individual project evaluation and public consultation are provided in the following table:



Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Kidd's Creek Watershed (Refer to Figure 23)	1	SWMF Retrofit No. 11 (KD06)	Livingstone St. W. and Ford St.	Construct underground infiltration system for water quality treatment, erosion control and active storage offset (SWMF KD02).	2B	-	\$3,970,038	A+	Pre-Approved
	2	SWMF Retrofit No. 18 (KD05)	Livingstone St. W. and Neelands St.	Construct underground infiltration system for water quality treatment and phosphorus removal. Grade major overland flow route to prevent private property flooding.	2B		\$1,409,538	A+	Pre-Approved
	3	SWMF Retrofit No. 13 (KD03)	Between Irwin Dr. and Sunnidale Rd.	Construct underground infiltration system for water quality treatment, phosphorus removal and active storage offset (SWMF KD02).	2B	-	\$1,649,080	A+	Pre-Approved
	4	Watercourse Improvement No. 1	Kidd's Creek between Lilian Cres. and Cundles Rd. W. (Reaches Ki-1 through Ki-2)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	3A/3B	-	\$1,584,898	B	New Project
	5	Culvert Improvement No. 13	Cundles Rd. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,090,797	A	Pre-Approved
	161	Watercourse Improvement No. 34	Kidd's Creek between Cundles Rd. and Highway 400 (Reach Ki-3 through Ki-6)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion	3A/3B	-	\$1,766,852	B	New Project
	8A	Culvert Improvement No. 16	Thomson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP).	3A	27 Thomson St. 22 Thomson St. (portion of)	\$1,452,335	B	New Project
	162A	Trunk Storm Sewer No. 9	Thomson St., Sophia St. W. and Florence St.	Thomson St., Sophia St. W., Florence St., Park St. and Eccles St. N.	3A/3B	-	\$1,790,457	B	New Project
	163	Watercourse Improvements No. 2	Kidd's Creek between Thomson St. and Eccles St. (Reach Ki-8a)	Watercourse improvements along Kidd's Creek to stabilize existing bank failures/erosion.	3A/3B	22 Thomson St. (portion of) 18 Thomson St. (portion of) 14 Thomson St. (portion of) 77 Eccles St. N. (portion of) 75 Eccles St. N. (portion of)	\$1,601,080	B	New Project
	9	Culvert Improvement No. 18	Wellington St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$178,464	A	Pre-Approved
	10	Watercourse Improvement No. 3	Kidd's Creek between Eccles St. and Henry St. (Reaches Ki-10b through Ki-10c)	Watercourse improvements on Kidd's Creek to stabilize existing bank failures/erosion.	3A/3B	Address Not Available (portion of) 19 Donald St. (portion of) 11 Donald St. (portion of) 38 Eccles St. N. (portion of) 10 Henry St. (portion of) 17 Eccles St. N.	\$1,751,137	B	New Project
	165	Watercourse Improvement No. 25	Kidd's Creek between Eccles St. and Dunlop St. W. (Reach Ki-11)	Daylight watercourse through 150 Dunlop St. W.	3A/3B	150 Dunlop St. W. (portion of)	\$2,639,671	B	New Project
	166	Culvert Improvement No. 145	Dunlop St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	150 Dunlop St. W. (portion of)	\$4,233,858	B	New Project
	167	Watercourse Improvement No. 26	Kidd's Creek between Dunlop St. W. and Bradford St. (Reach Ki-11)	Daylight watercourse through 125 Dunlop St. W.	3A/3B	-	\$887,618	B	New Project
	11A	Trunk Storm Sewer No. 11	Bradford St.	Trunk storm sewer extension to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,473,926	A+	Pre-Approved

Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Bunkers Creek Watershed (Refer to Figure 23)	31	SWMF Retrofit No. 10 (BK03)	Northwest of Shelley Ln. and Anne St. N. Intersection	Construct underground infiltration system for water quality treatment and phosphorus removal. SWMF outlet modifications for peak flow attenuation.	2A/2B	-	\$2,917,720	A+	Pre-Approved
	32	Trunk Storm Sewer No. 1	Anne St. N. from BK03 to Edgehill Dr.	Construct trunk storm sewer on Anne St. N. to divert flows reducing downstream flooding and erosion on Bunkers Creek (Reach Bu-3).	3A/3B	-	\$4,613,860	A+	Pre-Approved
	34	Watercourse Improvement No. 4	Bunkers Creek downstream of Shirley Ave. (Reach Bu-3)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-3).	3A/3B	-	\$1,015,852	B	New Project
	35	Watercourse Improvement No. 5	Bunkers Creek downstream of Edgehill Rd. (Reach Bu-7)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-7).	3A/3B	-	\$366,016	B	New Project
	36	Culvert Improvement No. 143	Highway 400 - Bunkers Creek (North Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$877,848	MTO Project	
	37	Culvert Improvement No. 142	Highway 400 - Bunkers Creek (Central Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$1,955,101	MTO Project	
	38	Culvert Improvement No. 141	Highway 400 - Bunkers Creek (South Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$699,116	MTO Project	
	39	SWMF Retrofit No. 94	New SWMF within future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south/central branches of Bunkers Creek.	2A		\$3,247,879	MTO Project	
	40B	Trunk Storm Sewer No. 2	Dunlop St. W. and Anne St. S. from Highway 400 E/W-N-ramp to Perry St.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	3A/3B	-	\$2,908,081	A+	Pre-Approved
	41	Watercourse Improvement No. 8	Bunkers Creek between Anne St. S. and Innisfil St. (Reaches Bu-11 and Bu-15)	Toe treatment to mitigate bank scour and undercutting on Bunkers Creek (Reach Bu-11 and Bu-15).	3A/3B	130 Vespra St. (portion of)	\$1,051,863	B	New Project
	42	Pond Retrofit No. 95 (Milligan's Pond)	Milligan's Pond between Boyz St. and Innisfil St.	Cleanout accumulated sediment from Milligans Pond and reinstate watercourse.	2B	-	\$2,020,838	A	Pre-Approved
	43	Culvert Improvement No. 22	Innisfil St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Bunkers Creek MDP).	3A	80 Bradford St. (portion of)	\$3,129,638	B	Time Lapse
	44	Culvert Improvement No. 23	Commercial Plaza Entrance Road	Remove existing culvert and daylight watercourse. Install pedestrian bridge for access to paking lot.	3A	80 Bradford St. (portion of)	\$1,729,121	B	Time Lapse
	45	Culvert Improvement No. 24	Bradford St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	100 Bradford St. (portion of)	\$5,172,158	B	Time Lapse
	46	Watercourse Improvement No. 27	Bunkers Creek (Reach Bu-16)downstream of Bradford St. to Lakeshore Dr.	Natural watercourse enhancement on Bunkers Creek (Reach Bu-16) to increase conveyance capacity, habitat and canopy.	3A/3B	93 Bradford St. 20 Checkley St. (portion of)	\$3,533,104	B	Time Lapse
Dyments Creek Watershed (Refer to Figure 23)	49	Watercourse Improvement No. 29	Downstream of Sproule Dr. to SWMF Retrofit No. 78	Realign Dyments Creek from Sproule Dr. into SWMF Retrofit No. 78.	3A/3B	-	\$809,778	B	New Project
	181	SWMF Retrofit No. 78	Between Sproule Dr. and Dunlop St. W.	Construct peak flow attenuation SWMF.	2A	Address Not Available	\$5,359,588	B	Time Lapse
	182	Culvert Improvement No. 28	Dunlop St. W.	Relocate and upgrade culvert to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$978,965	A	Pre-Approved
	183	Watercourse Improvement No. 9	Dunlop St. W. to Ferndale Dr. N. (Reach Dy-2a)	Realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. to facilitate SWMF retrofit (No. 78) and increase conveyance capacity.	3A/3B	Address Not Available (portion of) Address Not Available (portion of) 461 Dunlop St. W. (portion of) 100 Ferndale Dr. N. (portion of)	\$4,203,944	B	Time Lapse
	50	Culvert Improvement No. 29	Ferndale Dr. N.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,763,208	A	Pre-Approved
	51	Watercourse Improvement No. 10	Ferndale Dr. N. to Sarjeant Dr. (Reach Dy-2b)	Regrade/reshape Dyments Creek from Ferndale Dr. N. to Sarjeant Dr. to provide positive drainage and increased conveyance capacity.	3A/3B	425 Dunlop St W. (portion of) 433 Dunlop St. W. (portion of) 441 Dunlop St. W. (portion of) 97 Ferndale Dr. N. (portion of) 105 Ferndale Dr. N. (portion of) 30 Elliott Ave. (portion of) 20 Elliott Ave. (portion of) 8 Sarjeant Dr. (portion of)	\$4,757,426	B	Time Lapse

Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Dyments Creek Watershed (Refer to Figure 23)	52	Culvert Improvement No. 30	Sarjeant Dr. and Dunlop St. W.	Realign and upgrade culvert to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$8,294,081	A	Pre-Approved
	53	Culvert Improvement No. 31	Highway 400 E/W-S and N-E/W Ramps	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$2,253,740	MTO Project	
	54	Culvert Improvement No. 33	Highway 400	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$5,851,055	MTO Project	
	55	Culvert Improvement No. 32	Hart Dr.	Extend Highway 400 Culvert under Hart Dr.	3B	-	\$2,338,970	A	Pre-Approved
	56	Watercourse Improvement No. 11	Downstream of Hart Dr. (Reach Dy-3)	Daylight watercourse (through 55 Hart Dr.)	3A/3B	55 Hart Dr. (portion of)	\$916,057	B	New Project
	57	Culvert Improvement No. 34	George St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$1,254,767	A	Pre-Approved
	169	Culvert Improvement No. 35	Victoria St.	Remove roadway and culvert crossing daylighting channel	2A	-	\$1,137,960	A+	New Project
	170B	SWMF Retrofit No. 79 (DY01)	Between George St. and Anne St. S.	Remove Victoria Street culvert crossing, channel improvements through SWMF DY01 from Georga St. to Anne St. S and utilize floodplain storage for peak flow attenuation during major storms.	2A	-	\$5,049,510	B	Time Lapse
	58	Culvert Improvement No. 36	Anne St. S. and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	71 Anne St. S. (portion of)	\$5,146,253	B	Time Lapse
	59	Watercourse Improvement No. 12	Dyments Creek between Anne St. S. and Innisfil St. (Reach Dy-5)	Toe treatment to mitigate bank scouring and undercutting.	3A/3B	-	\$138,866	B	New Project
	60	Culvert Improvement No. 37	Innisfil Street	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$4,149,088	A	Pre-Approved
	61	Culvert Improvement No. 38	Sanford St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	100 Sanford St. (portion of) 95 Sanford St. (portion of)	\$2,912,991	B	Time Lapse
	62	Culvert Improvement No. 39	Bradford St.	Culvert upgrades to satisfy Regulatory flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	176 Bradford St.	\$7,063,031	B	Time Lapse
	63	Watercourse Improvement No. 28	Dyments Creek downstream of Bradford St. to Lakeshore Dr. (Reach Dy-6)	Watercourse improvements to increase conveyance capacity and decrease flooding.	3A/3B	-	\$1,241,691	B	Time Lapse
Hotchkiss Creek Watershed (Refer to Figure 20)	12	Culvert Improvement No. 41	Mayfair Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	3B	-	\$292,820	A	Pre-Approved
	13	Culvert Improvement No. 42	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$307,285	A	Pre-Approved
	16	Culvert Improvement No. 44	Essa Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,321,039	MTO Project	
	17	SWMF Retrofit No. 44	85 Morrow Rd.	Construct wetland SWMF for water quality treatment, erosion control and peak flow attenuation.	2B	85 Morrow Rd. (portion of)	\$7,355,787	B	New Project
	19	SWMF Retrofit No. 81	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	2A	50 Wood St. (portion of)	\$11,125,634	B	Time Lapse
	20	SWMF Retrofit No. 96	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	2A	50 Wood St. (portion of)	\$1,011,112	B	Time Lapse
	21	Culvert Improvement No. 135	BCRY Railway Crossing (between Wood St. and Tiffin St.)	Construct proposed SWMF Retrofit No. 96 outlet controls.	2A	155 Tiffin St. (portion of) 47 Alfred St.	\$3,272,716	B	Time Lapse
	22	Culvert Improvement No. 48	Tiffin St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,286,009	A	Pre-Approved
	23	Watercourse Improvement No. 6	Hotchkiss Creek between Tiffin St. and Anne St. S. (Reach Ho-8)	Daylight watercourse through 115 Brock St., 128 Anne St. S. and 134 Tiffin St.	3A/3B	128 Anne St. S. (portion of) 134 Tiffin St. 115 Brock St. (portion of)	\$3,593,757	B	New Project

Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Hotchkiss Creek Watershed (Refer to Figure 20)	24	Culvert Improvement No. 49	Anne St. S.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,377,484	A	Pre-Approved
	25	Watercourse Improvement No. 13	Hotchkiss Creek between Anne St. S. and Innisfil St. (Reach Ho-9)	Daylight watercourse through 108 and 120 Tiffin St.	3A/3B	Address Not Available 120 Tiffin St.	\$2,325,960	B	New Project
	27	Culvert Improvement No. 50	Innisfil St.	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Hotchkiss Creek MDP).	2A	215 Innisfil St. (portion of) 108 Tiffin St. (portion of)	\$1,814,946	B	Time Lapse
	28	Watercourse Improvement No. 14	Hotchkiss Creek between Innisfil St. and Bradford St. (Reach Ho-9)	Watercourse improvements along Hotchkiss Creek to stabilize existing bank erosion.	3A/3B	Address Not Available (portion of)	\$659,474	B	New Project
	30	Trunk Storm Sewer No. 10	Essa Rd. (Fairview Rd. to Gowan St.)	Construct trunk storm sewer to convey 100 year peak flows.	3A/3B	-	\$1,165,584	A+	Pre-Approved
Whiskey Creek Watershed (Refer to Figure 24)	67	SWMF Retrofit No. 42	Between Beacon Rd. and Montserrand St.	Construct combination underground infiltration system and dry SWMF for water quality treatment, erosion control and peak flow attenuation.	2B	Address Not Available (portion of)	\$3,605,747	B	New Project
	68	Culvert Improvement No. 53	Harvie Road	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$916,477	A	Pre-Approved
	70	Culvert Improvement No. 54	Harvie Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$401,685	A	Pre-Approved
	171	Watercourse Improvement No. 15	From Harvie Road to Highway 400 (Reach Wh-3)	Realign Whiskey Creek (Reach Wh-3) from Harvie Road to Highway 400.	3A/3B	-	\$354,167	B	New Project
	172A	Culvert Improvement No. 55	Highway 400	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$5,521,851	A	Pre-Approved
	71	Culvert Improvement No. 56	Fairview Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,794,391	A	Pre-Approved
	72	Culvert Improvement No. 57	Bayview Dr.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	Address not Available (portion of)	\$1,693,030	A	Pre-Approved
	73	Watercourse Improvement No. 16	Downstream of Bayview Dr. (Reach Wh-4a)	Minor watercourse realignment for long-term channel bed stabilization.	3A/3B	Address Not Available (portion of)	\$1,560,499	B	New Project
	74	Watercourse Improvement No. 30	Downstream of Bayview Dr. (Reaches Wh-4a through 4C)	Watercourse improvements to increase conveyance capacity and decrease flooding.	3A/3B	50 Welham Rd. (portion of) 279 Bayview Dr. (portion of) Address Not Available (portion of) Address Not Available (portion of)	\$7,395,846	B	Active
	75	SWMF Retrofit No. 40	43 Chieftain Cres. and 110 Fairview Rd.	Construct combination underground infiltration system and dry SWMF in combination with Emergency Services Campus SWMF.	2B	43 Chieftain Cres.	\$1,117,889	B	New Project
	76	Watercourse Improvement No. 17	Downstream of Bayview Drive (Reach Wh-5)	Watercourse improvements along Whiskey Creek to stabilize existing bed and bank erosion.	3A/3B	-	\$406,294	B	New Project
	77	Watercourse Improvement No. 18	Downstream of Bayview Drive (Reach Wh-6)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	3A/3B	-	\$246,352	B	New Project
	78	Culvert Improvement No. 147	BCRY Railway Crossing	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$702,657	A	Pre-Approved
	80	Culvert Improvement No. 60	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,974,559	B	Active
	81	Watercourse Improvement No. 31	Downstream of Huronia Rd. (Reach Wh-7b through 7c)	Watercourse realignment between Huronia Rd. and SWMF WK01.	3A/3B	205 Huronia Rd. (portion of)	\$875,742	B	Active
	83	SWMF Retrofit No. 25 (WK01)	Little Ave. and Firman Dr.	Construct a wetland permanent pool cell to provide water quality treatment.	2B	-	\$1,117,353	A+	Pre-Approved
	84	Culvert Improvement No. 62	Little Ave.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$4,326,677	A	Pre-Approved
	179	Watercourse Improvement No. 32	Downstream of Little Ave. (Reach Wh-9)	Watercourse improvements downstream of Little Ave. to improve conveyance capacity.	3A/3B	322 Little Ave.	\$3,208,658	B	Active
	85	Culvert Improvement No. 63	Yonge St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,904,903	A	Pre-Approved
	86	Culvert Improvement No. 138	Metrolink Railway Crossing (between Yonge St. and Tollendal Mill Rd.)	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$1,109,522	Metrolink Project	

Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Whiskey Creek Watershed (Refer to Figure 24)	88	Culvert Improvement No. 64	Hurst Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,102,238	A	Pre-Approved
	89	Watercourse Improvement No. 19	Between Tollendal Mill Rd. and The Boulevard (Reach Wh-10)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	3A/3B	207 The Boulevard 211 The Boulevard (portion of) 215 The Boulevard (portion of) 217 The Boulevard (portion of) 219 The Boulevard (portion of) 221 The Boulevard (portion of) 223 The Boulevard (portion of) 225 The Boulevard (portion of)	\$2,016,053	B	New Project
	174A	Culvert Improvement No. 65	The Boulevard	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$1,496,483	A	Pre-Approved
	175	Watercourse Improvement No. 20	Between The Boulevard and Brennan Avenue (Reach Wh-10)	Reconstruct/regrade the watercourse between The Boulevard and Brennan Avenue to increase conveyance capacity.	3A/3B	7 Brennan Ave. 199 The Boulevard (portion of)	\$1,709,277	B	Active
	176	Culvert Improvement No. 66	Brennan Ave.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$2,459,821	A	Pre-Approved
	177	Watercourse Improvement No. 21	Downstream of Brennan Ave. to Kempenfelt Bay (Reach Wh-10)	Reconstruct/regrade the watercourse downstream of Brennan Avenue to increase conveyance capacity.	3A/3B	-	\$2,038,261	B	Active
Lovers Creek Watershed (Refer to Figure 24)	96	SWMF Retrofit No. 87 (LV17)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	2B	-	\$519,831	A+	Pre-Approved
	97	SWMF Retrofit No. 65 (LV07)	Between Bayview Dr. and Saunders Rd.	Retrofit existing SWMF to include a sediment forebay and underground infiltration system for water quality treatment.	2B	-	\$3,958,825	A+	Pre-Approved
	98	Culvert Improvement No. 126	BCRY Railway Crossing (north of Lockhart Rd.)	Culvert upgrades to satisfy 100 Year design flood frequency criteria.	3A	140 Lockhart Rd. (portion of)	\$1,608,745	B	New Project
	99	Culvert Improvement No. 89	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	211 Lockhart Rd. (portion of)	\$3,215,731	A	Pre-Approved
	101	Culvert Improvement No. 91	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$3,666,069	A	Pre-Approved
	102	SWMF Retrofit No. 45 (LV05)	Between Highway 400 and Bayview Drive	SWMF cleanout and channel improvements to repair and stabilize existing bed and bank erosion.	2B	-	\$2,192,882	B	New Project
	105B	Culvert Improvement No. 123	BCRY Railway Crossing (south of Maplevue Dr. E.)	Culvert upgrades to convey Regional (Hurricane Hazel) peak flows to reduce backwater impacts on Culvert Improvements No. 94 and 95 eliminating these deficiencies.	3A	-	\$1,172,712	A	Pre-Approved
	107	Culvert Improvement No. 92	Huron Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$985,793	A	Pre-Approved
	109	Culvert Improvement No. 99	Ellis Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	3B	-	\$593,489	A	Pre-Approved
	110	Culvert Improvement No. 98	Welham Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	3B	455 Welham Rd. (portion of)	\$2,345,989	B	New Project
	111	SWMF Retrofit No. 30 (LV02)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$2,077,734	A+	Pre-Approved

Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Lovers Creek Watershed (Refer to Figure 24)	112	SWMF Retrofit No. 31 (LV03)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$401,489	A+	Pre-Approved
	113	Culvert Improvement No. 97	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$722,056	A	Pre-Approved
	114	Trunk Storm Sewer No. 7	Esther Drive from Dean Ave. to SWMF LV19	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	3A/3B	-	\$12,441,728	A+	Pre-Approved
	120	Watercourse Improvement No. 22	Between Yonge St. and Hurst Dr. (Reach Lo-19)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and Watercourse meander.	3A/3B	-	\$1,297,799	B	New Project
	121	Watercourse Improvement No. 23	Upstream of Tollendal Mill Rd. (Reach Lo-20)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and Watercourse meander.	3A/3B	-	\$1,597,880	B	New Project
	122	Culvert Improvement No. 105	Tollendal Mill Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	3B	-	\$1,041,132	A	Pre-Approved
Hewitts Creek Watershed (Refer to Figure 26)	125	Culvert Improvement No. 83	Mapleview Dr. E.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	793 Mapleview Dr. E. (portion of)	\$2,047,524	A	Pre-Approved
	130	Trunk Storm Sewer No. 6	Princess Margaret Gate and Camelot Sq. from Loyalist Crt. to SWMF HW06	Construct a trunk storm sewer to eliminate overland flow deficiency.	3A/3B	-	\$2,056,274	A+	Pre-Approved
Georgian Creek Watershed (Refer to Figure 22)	135	Trunk Storm Sewer No. 3	SWMF GR04 to SWMF GR01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF GR04 to GR01.	3A/3B	-	\$11,671,180	A+	Pre-Approved
	137	Trunk Storm Sewer No. 4	Dunsmore Park to Penetanguishene Rd.	Construct a trunk storm sewer to convey the 100 year peak flow from Dunsmore Park to Penetanguishene Rd..	3A/3B	-	\$13,723,594	A+	Pre-Approved
	139	Culvert Improvement No. 82	Penetanguishene Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$623,484	A	Pre-Approved
Little Lake Watershed (Refer to Figure 22)	141	Trunk Storm Sewer No. 5	SWMF LT02 to SWMF LT01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF LT02 to LT01 to eliminate overland flow route deficiencies.	3A/3B	-	\$6,118,979	A+	Pre-Approved
	142	SWMF Retrofit No. 77 (LT01)	Between Cardinal St. and St. Vincent St.	SWMF expansion for water quality treatment (wet pond), erosion control and peak flow attenuation.	2A	496 St. Vincent St. 500 St. Vincent St.	\$4,009,233	B	New Project
	143	Watercourse Improvement No. 24	Downstream of Livingstone St. E. (Reach Li-1)	Watercourse improvements along Little Lake Creek to stabilize existing bank erosion.	3A/3B	-	\$151,980	B	New Project
	145	SWMF Retrofit No. 84 (LTGM)	509 Bayfield St.	Expand existing SWMF to increase the permanent pool and active storage volume for water quality treatment and peak flow attenuation.	2B	509 Bayfield St. (portion of)	\$6,767,642	B	New Project
Bear Creek Watershed (Refer to Figure 25)	150	SWMF Retrofit No. 61 (BR08b)	Between Red Oak Dr. and County Rd. 27	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment.	2B	-	\$815,679	A+	Pre-Approved
	154	Culvert Improvement No. 78	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$362,726	A	Pre-Approved
	155	Watercourse Improvement No. 33	Downstream of Ardagh Rd. (Reach Be-14)	Watercourse improvements along Bear Creek to stabilize existing bed erosion.	3A/3B	-	\$292,719	B	New Project
Johnson Drainage Area (Refer to Figure 22)	159	Trunk Storm Sewer No. 8	Johnson St. from Steel St. to Kempenfelt Bay	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	3A/3B	-	\$4,523,034	A+	Pre-Approved
Nelson Drainage Area (Refer to Figure 22)	180	Trunk Storm SewerNo. 12	Blake St. from Johnson St. to Puget St.	Construct trunk storm sewer to service Blake St. and eliminate overland flow deficiencies.	3A/3B	-	\$308,259	A+	Pre-Approved

The costs of the general recommendations and individual projects recommended as part of the preferred solution developed through this Drainage Master Plan are summarized in the following table:

Project Costs Summary - Preferred Solution

PROJECT COST ITEM	COST
General Recommendations	
Minor Drainage System Improvements	\$48,421,000
New Storm Sewer (where absent/required)	\$9,827,000
Linear Low Impact Development	\$20,017,000
Subtotal - General Recommendations	\$78,265,000
Individual Projects	
Kidd's Creek Watershed	\$28,480,000
Bunkers Creek Watershed	\$35,239,000
Dyments Creek Watershed	\$65,621,000
Hotchkiss Creek Watershed	\$37,910,000
Whiskey Creek Watershed	\$53,057,000
Lovers Creek Watershed	\$39,840,000
Hewitts Creek Watershed	\$4,104,000
Georgian Creek Watershed	\$26,019,000
Little Lake Watershed	\$17,048,000
Bear Creek Watershed	\$1,472,000
Johnson Drainage Area	\$4,524,000
Nelson Drainage Area	\$309,000
Subtotal - Individual Projects	\$313,623,000
Total	\$391,888,000



To implement the preferred solution, a number of properties or portions thereof have been identified for acquisition by the City. The properties recommended for acquisition under the preferred solution are summarized in the following table

Property Acquisition Summary – Preferred Solution

PROJECT	ADDRESS	PROJECT	ADDRESS
125	793 Mapleview Dr. E. ¹	8A	22 Thomson St. ¹ 27 Thomson St.
163	14 Thomson St. ¹ 18 Thomson St. ¹ 22 Thomson St. ¹ 75 Eccles St. N. ¹ 77 Eccles St. N. ¹	10	Address Not Available ¹ 11 Donald St. ¹ 19 Donald St. ¹ 17 Eccles St. N. 38 Eccles St. N. ¹ 10 Henry St. ¹
165	150 Dunlop St. W. ¹	166	150 Dunlop St. W. ¹
41	130 Vespra St. ¹	43	80 Bradford St. ¹
44	80 Bradford St. ¹	45	100 Bradford St. ¹
46	93 Bradford St. 20 Checkley St. ¹	181	Address Not Available
183	Address Not Available Address Not Available 461 Dunlop St. W. ¹ 100 Ferndale Dr. N. ¹	51	425 Dunlop St. W. ¹ 433 Dunlop St. W. ¹ 441 Dunlop St. W. ¹ 97 Ferndale Dr. N. ¹ 105 Ferndale Dr. N. ¹ 20 Elliott Ave. ¹ 30 Elliott Ave. ¹ 8 Sarjeant Dr. ¹
56	55 Hart Dr.	58	71 Anne St. S. ¹
61	95 Sanford St. ¹ 100 Sanford St. ¹	62	176 Bradford St.
17	85 Morrow Rd. ¹	19	50 Wood St. ¹
20	50 Wood St. ¹	21	155 Tiffin St. ¹ 47 Alfred St.
23	128 Anne St. S. ¹ 115 Brock St. ¹ 134 Tiffin St.	25	Address Not Available 120 Tiffin St.



PROJECT	ADDRESS	PROJECT	ADDRESS
27	215 Innisfil St. ¹ 108 Tiffin St. ¹	28	Address Not Available ¹
67	Address Not Available ¹	72	Address Not Available ¹
75	43 Chieftain Cres.	81	205 Huronia Rd. ¹
73	Address Not Available ¹	74	Address Not Available ¹ Address Not Available ¹ 50 Welham Rd. ¹ 279 Bayview Dr. ¹
175	7 Brennan Ave. 199 The Boulevard ¹	98	140 Lockhart Rd. ¹
99	211 Lockhart Rd. ¹	110	455 Welham Rd. ¹
179	322 Little Ave.	89	207 The Boulevard ¹ 211 The Boulevard ¹ 215 The Boulevard ¹ 217 The Boulevard ¹ 219 The Boulevard ¹ 221 The Boulevard ¹ 223 The Boulevard ¹ 225 The Boulevard ¹
142	496 St. Vincent St. 500 St. Vincent St.	145	509 Bayfield St. ¹

¹ only a portion of the property is required

In accordance with By-law 90-92, it is recommended that the City proactively acquire lands or interest therein (easements) over the various Creeks and their tributaries throughout the City. The City currently owns lands or has interest therein (easements) over portions of various watercourses in the City. Additional lands will be dedicated to the City from future developments through Subdivision Agreements and Site Plan Conditions. However, lands or easements over the remaining reaches of each creek will have to be purchased or expropriated from the existing land owners.

The City currently has easements over portions of various watercourses in the City. An easement grants the City access to lands owned by others for a specific purpose such as maintenance. However, the City routinely encounters issues accessing lands through an easement due to fences, sheds, other structures and landscaping constructed/installed by the property owner. As the Creeks convey drainage from Municipal lands, maintenance of the conveyance systems is generally the responsibility of the City. As such, it is recommended that



the City acquire the lands over the watercourses rather than interests therein (easements) when it is in the City's interest to do so. The width of land to acquire over each watercourse should be determined on a reach by reach basis considering the channel width, erosion threshold, meander belt width and existing floodplain.

The individual projects included as part of the preferred solution have been prioritized in order of importance through a risk assessment consistent with the methodology outlined in the City of Barrie Corporate Asset Management Plan (November 2011). Specifically, a probability of failure has been assigned to each project based on the frequency of occurrence. The economic, social and environmental consequence of failure has been evaluated for each project. The risk assessment matrix was applied to establish the risk associated with each project based on the probability and consequence of failure.

The projects were prioritized for each watershed and drainage area to assist the City in the development of their capital plans. Other factors were considered when prioritizing the projects such as current capital plans, the MTO proposed Highway 400 improvements, neighbourhood renewal programs, and condition assessments.

Following ratification by City Council and successful completion of the Class EA process, the individual projects will proceed to detailed design and construction subject to available capital funding. Prior to construction, approval for the proposed works will be required from the Lake Simcoe Region Conservation Authority (LSRCA) and Nottawasaga Valley Conservation Authority (NVCA) under Ontario Regulation 179/06, from the Ministry of the Environment, Conservation and Parks (MECP) under the Ontario Water Resources Act and Fisheries and Oceans Canada under the Fisheries Act. All subsequent permits and approvals that may be required for the implementation of the Preferred Solution are as follows:

- Development, Interference with Wetlands & Alteration to Shorelines & Watercourses Permit – LSRCA;
- Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Permit – NVCA;
- Environmental compliance approval for Municipal and Private Sewage Works – MECP; and
- Permit to Take Water – MECP (If required)

Additional requirements that may need to be considered as part of detailed design and construction are the archaeological, cultural and natural heritage constraints of each project including migratory birds nesting periods, fishery timing windows, and species at risk.

The recommendations of this Drainage Master Plan will be presented to the General Committee for ratification. Those individuals and parties that requested to be kept informed of the



Municipal Class EA process will be notified of the selection of a Preferred Solution and the steps of the process moving forward after ratification.

Following the successful completion of the Municipal Class EA process (no Part II Orders received) it would be the City's intention to implement the Preferred Solution, subject to available capital funding and Council approval.



1 Introduction

In March 2017, the City of Barrie (City) retained Tatham Engineering Limited (Tatham) to prepare a Drainage Master Plan for the City following Approach #2 of the Master Planning process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). This Drainage Master Plan is a broad level assessment detailing the drainage deficiencies identified in the study area, it considers improvement options to address these deficiencies, and completes an evaluation of these alternatives developing a preferred alternative solution to be implemented moving forward. Approach #2 involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process fulfilling the requirements for Schedule B projects.

1.1 STUDY AREA

The study area for the Drainage Master Plan includes the entire City of Barrie excluding the Sophia Creek watershed, Mulcaster drainage area and Annexation Lands. The Study Area is illustrated on Figure 1 - Study Area Location Plan provided in Appendix A.

The Sophia Creek watershed and Mulcaster drainage area are excluded from the study as a similar Municipal Class Environmental Assessment was recently undertaken for these areas. A Drainage and Stormwater Management Master Plan (DSWMMP) was prepared in 2013 for the Annexation Lands to satisfy the requirements of the Lake Simcoe Protection Plan, specifically Policy 4.5-SA. Subwatershed Impact Studies have also been prepared for the Hewitt's Secondary Plan Area (Burnside, 2016) and the Salem Secondary Plan Area (Stantec, 2017) outlining recommended drainage and stormwater management strategies for development in the Annexation Lands.

For discussion purposes the Study Area is broken into three drainage study areas as follows:

- Barrie Creeks Drainage Study Area;
- NVCA Watershed Drainage Study Area; and
- Lovers Creek, Hewitts Creek and Sandy Cove Drainage Study Area.

The drainage study areas are further divided into watersheds and drainage areas as illustrated on Figure 2 - Watershed/Drainage Area Delineation Plan provided Appendix A. A summary of the watersheds and drainage areas is provided in the following table.



Table 1: Drainage Area Summary

DRAINAGE STUDY AREAS	WATERSHED/DRAINAGE AREA			CONSERVATION AUTHORITY JURISDICTION
	Name	Area (ha)	Imperviousness (%)	
Barrie Creeks (3,447 ha)	Sophia Creek ¹	463	47	LSRCA
	Kidd's Creek	488	35	
	Bunkers Creek	361	46	
	Dyments Creek	580	35	
	Hotchkiss Creek	483	43	
	Whiskey Creek	638	33	
	Johnson	83	42	
	Nelson	62	36	
	Rodney	29	36	
	St. Vincent	36	36	
	Mulcaster ¹	41	57	
	Williams	69	43	
	Holgate	15	34	
	Huronian	93	38	
	Minets	6	39	
NVCA Watershed (2,898 ha)	Little Lake	445	51	NVCA
	Bear Creek	1,700	22	
	Georgian Creek	270	43	
	Thornton Creek ¹	483	-	
Lovers Creek, Hewitts Creek and Sandy Cove (3,685 ha)	Lovers Creek	2,538	24	LSRCA
	Hewitts Creek	762	19	
	Sandy Cove ¹	302	-	
	Bayshore	50	40	
	Gray Lane	19	31	
	Royal Oak	14	31	
Total	City of Barrie	10,030	29	LSRCA and NVCA

¹ watersheds/drainage areas excluded from the study

1.2 BACKGROUND

The City of Barrie has previously invested in the preparation of Master Drainage Plans and stormwater management studies for a number of watersheds and drainage areas across the City. The Master Drainage Plans identify drainage deficiencies in the City, evaluate alternative solutions to address the deficiencies, and recommend a preferred alternative solution for implementation. Similarly, the stormwater management studies provide recommendations for drainage improvements required for existing infrastructure and outline SWM requirements for future development. The recommended drainage improvements from the previous studies are illustrated on Figure 3 - Previous Drainage Improvement Recommendations From Background Master Drainage Plan provided in Appendix A. A summary of the relevant background studies is provided in the following sections.

1.2.1 Sophia Creek Watershed and Mulcaster Drainage Area Environmental Assessment Update (2017)

As discussed, the Sophia Creek watershed and Mulcaster drainage area are excluded from this study as a Municipal Class Environmental Assessment was recently undertaken by C.C. Tatham & Associates Ltd. for these areas. The EA was undertaken in accordance with the Schedule 'B' Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). The EA details the drainage deficiencies identified in the watershed/drainage area, improvement options considered to address these deficiencies, and the evaluation of these alternatives towards developing a preferred alternative solution to be implemented moving forward.

1.2.2 Intensification & Annexed Lands Drainage and Stormwater Management Master Plan (2013)

As discussed, a *Drainage and Stormwater Management Master Plan* (DSWMMP) has been prepared by AMEC Environment & Infrastructure for the Annexation Lands to satisfy the requirements of the Lake Simcoe Protection Plan, specifically Policy 4.5-SA. The DSWMMP follows Approach #2 of the Master Planning process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). The DSWMMP provides an integrated assessment of the existing stormwater management systems, natural drainage features, and existing infrastructure in the annexation lands and establishes the requirement for drainage improvements for existing and future conditions.

1.2.3 Minor and Major Drainage System City Wide Models (2017)

In 2015, C.C. Tatham & Associates Ltd. (CCTA) was retained by the City of Barrie to develop minor and major drainage system models of the City's storm infrastructure across the entire



City of Barrie. CCTA prepared, calibrated, and verified a PCSWMM hydrologic/hydraulic model of Barrie's minor drainage systems citywide. Similarly, CCTA prepared a Visual OTTHYMO hydrologic model and HEC RAS hydraulic models of Barrie's major drainage systems citywide. The models were used to identify the deficiencies in the minor/major drainage systems and allow for the evaluation of proposed infrastructure improvements under a variety of actual and predicted storm events and future watershed conditions.

As part of this Drainage Master Plan project, we updated the minor and major drainage system models. The model updates, results and drainage system deficiencies are further described in the Hydrologic & Hydraulic Modelling Technical Memorandum enclosed in Appendix B.

1.2.4 Kidd's Creek Master Drainage Plan (2001, 2005)

In 2001, Oliver, Mangione, McCalla & Associates prepared the *Kidd's Creek Master Drainage Plan Class Environmental Assessment Report* identifying alternative drainage solutions to address the drainage deficiencies in the Kidd's Creek watershed. In 2005, Trow Consulting Engineers issued an Addendum to the *Kidd's Creek Master Drainage Plan Class Environmental Assessment Report* identifying the preferred alternative solution after evaluating the alternatives and public consultation. The preferred alternative solution includes the following improvements:

Conveyance Improvements – Regional Conveyance

- Regional floodway capacity improvements from the Boardwalk at Kempenfelt Bay to Toronto Street; and
- Lower the parking lot at Barrie Central Collegiate Institute to improve Regional conveyance capacity.

Conveyance Improvements – 100 Year Conveyance

- Toronto Street, Donald Street, Ross Street/Wellington Street, and Cundles Road West culvert improvements;
- Watercourse improvements from Toronto Street to Simcoe Street, from Dunlop Street to Eccles Street, upstream of Eccles Street for approximately 40 m, upstream of Eccles Street North for approximately 80 m;
- Culvert capacity improvements from Simcoe Street to Dunlop Street; and
- Culvert capacity improvements 40 m upstream of Eccles Street.



Watershed Spill Containment

- Raise Bradford Street 0.15 m south of Kidd's Creek;
- Raise Ross Street 0.30 m east of Kidd's Creek; and
- Regional conveyance capacity improvements at Highway 400.

A figure illustrating the recommendations under the preferred alternative solution for Kidd's Creek is included in Appendix C for reference.

Since the publication of the Kidd's Creek Master Drainage Plan Updated in 2005, the Toronto Street culvert, the Donald Street culvert, the floodway improvements from the boardwalk at Kempenfelt Bay to Toronto Street, the culvert improvements upstream of Toronto Street to Simcoe Street, and the Ross Street/Wellington Street culvert improvements have been constructed. In addition, Ross Street and Bradford Street were raised as part of road renewal projects. However, the remaining improvements have not been implemented.

1.2.5 Bunkers Creek Master Drainage Plan Update (2001)

On April 9, 2001, the City of Barrie adopted the *Bunkers Creek Master Drainage Plan Update* prepared by Giffels Associates Limited (March 2001). The preferred alternative solution selected following the evaluation of alternatives and public consultation was Alternative 5 – Full Infrastructure Upgrades, Implementation of Stormwater Detention Pond.

In 2004, an update to the *Bunkers Creek Master Drainage Plan Update* was completed to revise the Bunkers Creek hydrologic and hydraulic models as per recommendations of the Lake Simcoe Region Conservation Authority (LSRCA) and provide an implementation strategy for the preferred alternative solution. Also, the preferred alternative solution was refined to include the following improvements:

Stormwater Management Facilities

- Construct a stormwater management facility south of Edgehill Drive within the City's R.A. Archer Operations Centre and construct a storm sewer diversion from Edgehill Drive into the SMWF.

Capacity Improvement – 100 Year Conveyance

- Lakeshore Drive, Bradford Street, Innisfil Street, and Highway 400 culvert (3) improvements;
- Construct a storm sewer from Anne Street to Highway 400 via Dunlop Street; and



- Construct a storm sewer along the northeast branch of the watercourse between Wellington Street and Milligan's Pond via Boys Street, Dunlop Street, an easement through the Wellington Street Plaza and an easement between 125 Wellington Street and 135 Wellington.

Enhancement of Natural Areas

- Enhance the natural watercourse from Kempenfelt Bay to approximately 100 m upstream of Bradford Street; and
- Enhance the Milligan's Pond outlet structure, construct a sediment forebay in the pond and re-vegetate the pond.

A figure illustrating the recommendations under the preferred alternative solution for Bunkers Creek is included in Appendix C for reference.

Since the publication of the *Bunkers Creek Master Drainage Plan Update* in 2004, the Lakeshore Drive culvert has been improved, the SWMF has been constructed in the R.A. Archer Operation Centre, the storm sewer diversion has been constructed from Edgehill Drive into the SWMF, and the storm sewer along the northeast branch of the watercourse between Wellington Street and Milligan's Pond has been constructed. However, the remaining improvements have not been implemented.

1.2.6 Dyments Creek Master Drainage Plan Update (2006)

The City of Barrie updated the *Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment* in 2006. The preferred alternative solution selected following the evaluation of alternatives and public consultation is as follows:

- "Storage Upstream of Dunlop Street West, Victoria Street and Anne Street with 100 Year Conveyance Upgrades at all Crossings (except Highway 400, Bradford Street and Lakeshore Drive which are Regional Storm Conveyance Upgrades)."

The individual projects recommended for implementation under the preferred alternative solution are as follows:

Capacity Improvements – Regional Conveyance

- Floodway from future Lakeshore Drive to Kempenfelt Bay;
- Lakeshore Drive, Hart Drive and Highway 400 culvert improvements;
- Floodway from Bradford Street, approximately 50 m downstream; and
- Floodway from approximately 30 m upstream of Bradford Street to Bradford Street.



Capacity Improvements – 100 Year Conveyance

- Sanford Street, Innisfil Street, Anne Street and John Street, Victoria Street, George Street, Sarjeant Street, Ferndale Drive North, and Dunlop Street West culvert improvements;
- Stormwater Management Facility west of Anne Street, west of Victoria Street and north of Dunlop Street and west of Ferndale Industrial Drive (Pond 1); and
- Floodway from Ferndale Drive North to Sarjeant Drive, Dunlop Street West to Ferndale Drive North, Pond 1 to Dunlop Street, and from Sproule Drive to Pond 1.

Watercourse Sediment Removal and Re-Shaping

- Watercourse sediment removal and re-shaping downstream of Edgehill Drive to Kempenfelt Bay.

A figure illustrating the recommendations under the preferred alternative solution for Dyments Creek is included in Appendix C for reference.

Since the publication of the Dyments Creek Master Drainage Plan Update in 2006, the floodway from Lakeshore Drive to Kempenfelt Bay, the floodway from Lakeshore Drive to Bradford Street, and the culvert improvements under Lakeshore Drive have been constructed. However, the remaining improvements have not been implemented.

1.2.7 Hotchkiss Creek Master Drainage Plan Update (2000)

In 2000, R.G. Robinson and Associates Ltd. published the *Hotchkiss Creek Master Drainage Plan Update Environmental Assessment Document*. The Master Drainage Plan was amended by R.G. Robinson and Associates Ltd. In 2007. The preferred alternative solution selected following the evaluation of alternatives and public consultation was Alternative 4a – Implementation of stormwater management facilities within the creek corridor including increased hydraulic capacity of culverts and channels and discharge major system flow directly to Kempenfelt Bay.

In 2012, an update to the *Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment* was completed by C.C. Tatham & Associates Ltd. and the preferred alternative solution was refined. The individual projects recommended for implementation under the preferred alternative solution are as follows:

Stormwater Management Facilities

- Pond 1 – between Wood Street and Highway 400;
- Pond 2 – upstream of BC Railway (west of Alfred Street);
- Pond 3 – upstream of Innisfil Street; and



- Pond 4 – upstream of Bradford Street.

Capacity Improvements – 100 Year Conveyance

- Outlet channel to Kempenfelt Bay;
- Lakeshore Drive, Bradford Street, Innisfil Street, Anne Street, Tiffin Street, BC Railway, Wood Street, Highway 400 and Morrow Road culvert improvements;
- Channel through WwTF; and
- Construct a trunk storm sewer north on Essa Road from Anne Street South to Gowan Street, then east on Gowan Street to Kempenfelt Bay.

A figure illustrating the recommendations under the preferred alternative solution for Hotchkiss Creek is included in Appendix C for reference. It's noted that a Notice of Study completion was never filed for the 2012 Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment.

Since the publication of the Hotchkiss Creek Master Drainage Plan Update in 2000, the outlet channel to Kempenfelt Bay, the Lakeshore Drive culvert improvements, the channel adjacent to the WwTF, the Bradford Street culvert improvements, the trunk storm sewer on Gowan Street to Kempenfelt Bay, and Pond 4 (upstream of Bradford Street) have been constructed. However, the remaining improvements have not been implemented.

1.2.8 Whiskey Creek Master Drainage Plan Update (2009)

The Whiskey Creek Master Drainage Plan Update Environmental Assessment Document prepared by Aecom (October 2009) was adopted by the City of Barrie in October 2009. The preferred alternative solution selected following the evaluation of alternatives and public consultation was Alternative 5 – Increase hydraulic capacity to 1:100-year storm conveyance for creek channel and culvert crossings with specific locations for Regional storm conveyance (Bryne Drive, Harvie Road and Highway 400) and 25 year storm conveyance (Yonge Street and Tollendal Mill Road). The individual projects recommended for implementation under the preferred alternative solution are as follows:

Stormwater Management Facilities

- Designate the natural storage areas upstream of Yonge Street and Tollendal Mill Road as SWMF's.



Capacity Improvements

- Bryne Drive, Harvie Road (2), Highway 400 (2), Harvie Road (west of Bryne Drive), Yonge Street, Tollendal Mill Road, Fairview Road, BC railway (west of Bayview Drive), Bayview Drive (north of Big Bay Point Road), Bayview Drive (north of Mollard Court), McConkey Place, BR railway (west of Huronia Road), Huronia Road, Little Avenue, The Boulevard, and Brennan Avenue culvert improvements;
- Watercourse improvements around 279 Bayview Drive, downstream of Huronia Road, between Little Avenue and Yonge Street and between The Boulevard and Brennan Avenue; and
- Outlet channel improvements downstream of Brennan Avenue.

A figure illustrating the recommendations under the preferred alternative solution for Whiskey Creek is included in Appendix C for reference.

Since the publication of the Whiskey Creek Master Drainage Plan Update in 2000, none of the recommended improvements have been implemented.

1.2.9 Hydrologic & Hydraulic Modeling and Drainage Study for the Nelson and Johnson Drainage Areas (2009)

Greenland International Consulting published the *Hydrologic & Hydraulic Modeling and Drainage Study for the Nelson & Johnson Drainage Areas* in 2009. The study was completed to establish existing drainage conditions and deficiencies in the drainage areas and develop solutions to address the drainage issues. Drainage issues were identified in seven (7) areas in the Nelson and Johnson drainage areas and conceptual designs were developed/recommended to contain stormwater within the municipal road allowance preventing flooding of private property. However, a preferred alternative solution was not identified.

1.2.10 City of Barrie Comprehensive Stormwater Management Master Plan (2016)

The City of Barrie in collaboration with the Lake Simcoe Region Conservation Authority developed the Comprehensive Stormwater Management Master Plan (CSWM-MP) for the City in accordance with the Policies of the Lake Simcoe Protection Plan following Schedule B of the Municipal Class Environmental Assessment process. The CSWM-MP was prepared as a directive for the City to improve stormwater management with a focus on reducing the discharge of nutrients and pollutants into Lake Simcoe and to fulfill Policy 4.5-SA of the Lake Simcoe Protection Plan.



The CSWM-MP was undertaken in two stages. Stage 1 of the CSWM-MP was primarily a desktop exercise summarizing the information available in the background studies previously completed and identifying data gaps to be addressed as part of Stage 2 of the project. Stage 1 of the CSWM-MP is a compilation of information and data available in the previously completed Master Drainage Plans, stormwater management reports, SWMF retrofit studies, etc. In addition, Stage 1 of the CSWM-MP includes recommendations regarding the implementation of stormwater management (SWM) improvement and retrofit opportunities, inspections and maintenance guidelines, and stormwater management funding mechanisms.

Stage 2 of the CSWM-MP addresses the data gaps identified as part of Stage 1 works and fulfills the outstanding requirements of the governing guidelines, LSPP and Municipal Class Environmental Assessment planning process unable to be completed as part of Stage 1. Specifically, recommended approaches for stormwater management were established for the City and implementation plans were developed for the recommended approaches.

The approach to stormwater management recommended through the CSWM-MP consists of a combination of traditional end-of-pipe SWMFs, LID stormwater measures and stream restoration works. The approach to stormwater management is recommended differently to new greenfield development, re-development and existing development areas as follows:

- For new greenfield development, a combination of conventional end-of-pipe SWMFs and LID practices are recommended to maintain pre-development infiltration volumes, provide volume control as per LSRCA and NVCA requirements, provide enhanced water quality control resulting in no net increase in phosphorus loads, and provide erosion and water quantity (flood) control;
- For re-development, intensification and infill development, LID measures or other best management practices are recommended to improve the water balance (infiltrate a minimum of 5 mm of rainfall), provide volume control as per LSRCA and NVCA requirements, provide enhanced water quality control resulting in no net increase in phosphorus loads, provide water quantity control in the form of post to pre-development peak flow matching for the 1:2-year through 1:100-year design storms; and
- For development in existing urban areas, SWMF retrofits, implementation of LIDs in existing roadways and stream restoration works are the recommended approach to stormwater management.

1.2.11 Storm Water Management Facilities (SWMF) Asset Management Plan (2012)

The asset management plan assessed the stormwater management facilities owned and operated by the City of Barrie to understand the costs and risk associated with providing the level of service that best meets the needs of the City. The asset management plan identified



the existing SWMF's that fail to provide sufficient water quantity control, water quality treatment and other deficiencies such as insufficient access and security. The asset management plan also prioritized the SWMF's based on the severity of the consequences and probability of the consequence resulting from the SWMF deficiency. The asset management plan specified recommendations specific to the City's stormwater management facilities including renewal/enhancement and inspection/maintenance. These recommendations are presented in the following tables:

Table 2: SWMF Asset Management Plan – SWMF Renewal/Enhancement

SWMF ID					
LV20	LV21	LV22	HW04	LV18	HW01
LT05	DY04	BR08A	BR10	HW05	HW09
LT02	LV19	DY07	WK17	BY03	LT06
KD02	KD06	LT01	LV05	SP01	DY02
BR13	LV02	LV03	BR03	HT03A	GR04

Table 3: SWMF Asset Management Plan – SWMF Inspection and Maintenance Program

SWMF ID					
BR16	GR01	KD01	LV07	KD04	KD05
GR02	LV12	SP02	SP03	HT08	LV06
LV10	HW08	LV28	LV49	WK04	HT06

1.2.12 Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (2013)

This assessment was completed as a component of the Drainage and Stormwater Management Master Plan (DSWMMP) to identify and prioritize stormwater management retrofit opportunities within the City of Barrie with the primary goal of reducing phosphorus discharges. The product of the assessment is a prioritized list of stormwater management retrofits (including new SWMF construction) for the City's Stormwater Retrofit Program, a framework for funding the proposed retrofits and a maintenance and repair program. The recommended SWMF retrofits are illustrating on Figures included in Appendix C and are summarized in the following table:



Table 4: DSWMMP - SWMF Retrofit Summary

SWMF ID (RETROFIT NO.)					
SP03 (8)	LV01 (68)	KD03 (13)	LV18 (24)	LV03 (31)	LV12 (32)
LV10 (37)	LV07 (65)	HT06 (3)	DY02 (11)	HR01 (28)	WK01 (25)
WK04 (20)	LV13 (21)	LV05 (45)	SP01 (4)	KD01 (14)	GR01 (75)
BR13 (69)	LT01 (77)	BR08 (61)			

In addition to the recommended SWMF retrofit opportunities, the assessment provided recommendations for new SWMF's to improve water quality treatment and peak flow attenuation. The new SWMF's recommended for construction are summarized in the following table.

Table 5: DSWMMP - New SWMF Summary

RETROFIT NO.	WATERSHED	LOCATION
67	Lovers Creek	Drainage easement south of Ellis Dr.
27	Hewitts Creek	Southeast corner of Walnut Cres.
44	Hotchkiss Creek	Between Morrow Rd. and Highway 400 north of Essa Rd.
17	Kidds Creek	Southwest of Bayfield St. between Coulter St. and Highway 400
39	Hotchkiss Creek	Between Patterson Rd. and Highway 400 east of Philips St.
26	Whiskey Creek	North of Big Bay Point Rd. between Huronia Rd. and Pickett Cres.
42	Whiskey Creek	Southeast corner of Montserrand St. and Beacon Rd.
38	Hotchkiss Creek	West of Patterson Rd. between Tiffin St. and Philips St.
55	Hotchkiss Creek	North of Ardagh Road
40	Whiskey Creek	Northeast corner of Chieftan Cres.
60	Bear Creek	North side of Loughheed Park, east of Bear Creek



1.2.13 Barrie Creeks, Lovers Creek, and Hewitts Creek Subwatershed Plan (2012)

The Subwatershed Plan published in 2012 under the direction of the Lake Simcoe Protection Plan (LSPP) provides detailed guidance for area-specific hydrologic and natural heritage resource planning and management. The recommendations of the Subwatershed Plan included the following:

- Continued implementation of on-the-ground stewardship projects to improve water quality and aquatic habitat, promote infiltration of precipitation, and broaden the extent of natural features;
- Promoting and supporting water conservation and re-use initiatives;
- Improved land use planning practices to minimize the impacts of development;
- Educating members of the public and targeted industries on topics including the dangers of using invasive species in horticulture, the importance of maintaining groundwater recharge areas, and good practices for the use of road salt to minimize environmental impacts;
- Studying potential impacts of climate change and developing plans to limit its impacts;
- Researching and using new and innovative solutions to address uncontrolled stormwater;
- Evaluating monitoring activities, and adjusting programs as necessary; and
- Striving to ensure that natural features lost through development are re-established in other parts of the watershed.

1.3 PROJECT TEAM

The project team responsible for input and preparation of this report and the supporting documentation is comprised of the following:

- City of Barrie (City);
- Tatham Engineering Limited (Tatham) - Engineering;
- Lake Simcoe Region Conservation Authority (LSRCA);
- Nottawasaga Valley Conservation Authority (NVCA);
- Azimuth Environmental Consulting, Inc. (AEC) - Natural Heritage;
- Archeoworks Inc. (AW) - Archeological;
- ERA Architects Inc. (ERA) - Cultural Heritage;
- Peto MacCallum Ltd. (Peto) - Geotechnical;



- Rudy Mak Surveying Ltd. (RMS) – Legal Survey; and
- Water's Edge Consulting (WEO) – Fluvial Geomorphology.

A Technical Advisory Committee (TAC) has been established for this project. The TAC is in place to ensure the City's, LSRCA and NVCA interests are maintained and the objectives of the study are achieved. The TAC is also responsible for the technical review of the Drainage Master Plan, specifically the evaluation of the alternative improvement options. The TAC is comprised of the City, LSRCA and NVCA.

1.4 MASTER PLANNING PROCESS – APPROACH #2

Approach #2 of the Master Planning process involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The Master Plan document is to be made available to the public and interested stakeholders for review and comment prior to adoption by the City. Following Approach #2, the Master Plan satisfies the Municipal Class EA requirements for Schedule B projects allowing these projects to proceed directly to Phase 5 of the EA process and detailed design by way of a Notice of Study completion.

The Master Plan is a broad level assessment thereby requiring more detailed investigations at the project specific level for Schedule C projects recommended in the study in order to fulfil the requirements of the Municipal Class EA. As such, the Master Plan document becomes the basis for, and is used in support of, future detailed investigations for the specific Schedule C projects. After the completion of the Master Plan, Schedule C projects are required to fulfil Phases 3 and 4 prior to completing the Environmental Study Report (ESR) for public review.

Master Plans are long-range plans that integrate infrastructure requirements for existing and future land uses with environmental assessment planning processes. Master Plans consider all aspects of the environment: physical, natural, social, cultural and economic, and involves consultation with the public, affected parties and review agencies throughout the process.

This Master Drainage Plan for the City of Barrie is proceeding through Phases 1 and 2 of the Class EA process (provided overleaf) as follows:

Phase 1: Identify the Problem.

Phase 2: Identify and assess, at a strategic level, alternative solutions to the identified problem, then recommend the preferred master plan that can be implemented as separate subsequent projects.



The Master Drainage Plan will be finalized upon the conclusion of Phases 1 and 2 of the Class EA process and made available for public comment prior to being approved and adopted by the City.

1.5 EXISTING POLICIES

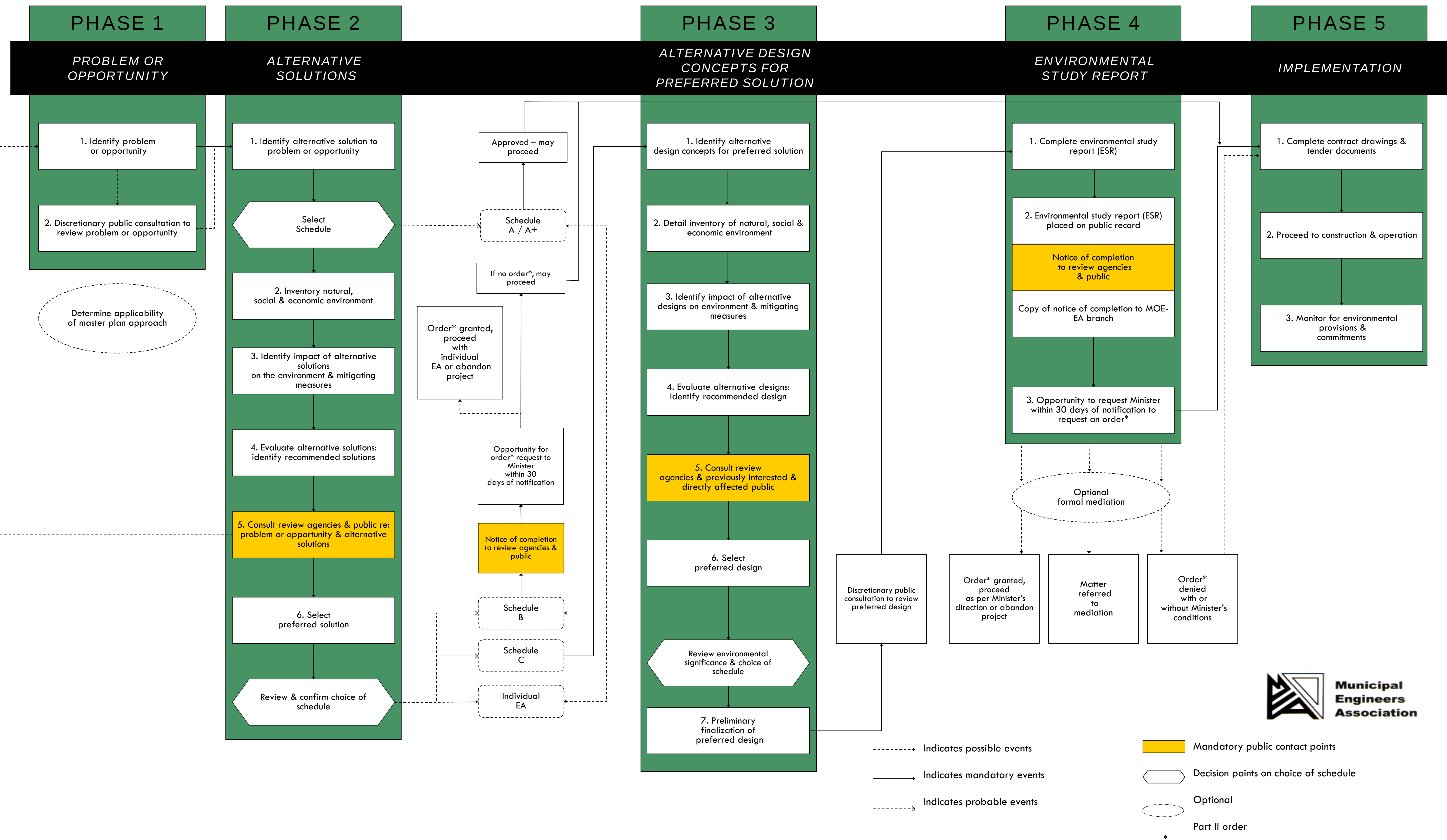
There are several policies, regulations and guidelines which are to be adhered to as part of the proposed improvement alternatives within the study area. The most recent versions of these documents include the following:

1.5.1 Storm Drainage and Stormwater Management Policies and Design Guidelines (2017)

The City of Barrie *Storm Drainage and Stormwater Management Policies and Design Guidelines* provide direction for the effective management of stormwater in the City. The Policies and Guidelines provide uniform minimum standards and policies for the planning process and stormwater infrastructure design. The document includes the City's policies and guidelines regarding environmental protection (water quality, water quantity, water balance, etc.), natural



Municipal Class EA Process



hazards (flood and erosion hazards), stormwater management facility design, and urban design concepts including traditional concepts and low impact development (LID) techniques. Generally, these guidelines include the mandates of the other policies, regulations and guidelines discussed in this section. As such, these guidelines act as the basis for the development of the improvement alternatives in the study area.

As per the City's guidelines, the minor drainage system (storm sewer) shall be designed to convey the 1:5-year (minimum) design storm peak flow. Watercourses and channels shall be capable of conveying the Regulatory storm peak flow without flooding adjacent private property. Flooding of existing buildings and/or property shall be eliminated where feasible. Road culvert crossings and road elevations shall be designed to satisfy the following design criteria:

Table 6: Flow Design Guidelines for Road Crossings

ROAD CLASSIFICATION	DESIGN FLOOD FREQUENCY
Arterial	1:100 Year Regional (Hurricane Hazel/Timmins) - if directed by the City
Collector	1:50 Year
Urban Local	1:50 Year
Rural Local	1:25 Year
Temporary Detour	1:10 Year
Driveway	1:10 Year

Generally, all new development is restricted to areas outside the Regulatory floodplain unless, in the opinion of the City, and the Nottawasaga Valley Conservation Authority or the Lake Simcoe Region Conservation Authority, the control and extent of flooding will not be affected by the development. If permission is granted by the City and NVCA/LSRCA to develop or redevelop in the floodplain, the minimum opening elevations of all buildings must be 500 mm greater than the Regulatory flood elevation.

1.5.2 By-Law 90-92: To Prohibit Obstruction of Drains & Watercourses (1990)

By-Law 90-92 specifies the City's responsibility in continuing to undertake SWM related projects, operate and maintain existing conveyance systems and progressively acquire land or easements for drains, watercourses and storage areas crossing or upon private lands, where it is considered to be in the City's interest to do so.



1.5.3 LSRCA Watershed Development Policies and LSRCA Technical Guidelines for Stormwater Management Submissions (2016)

The principal mandate of the Lake Simcoe Region Conservation Authority is to protect public health and safety, prevent property damage and prevent social disruption caused by natural hazards while conserving, protecting and managing natural resources within the Lake Simcoe watershed. Complementing the Planning Act, the LSRCA administers the *Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation (Ontario Regulation 179/06)* under Section 28 of the *Conservation Authorities Act*. Development within the LSRCA Regulation Limits is subject to LSRCA review and approvals allowing the LSRCA to ensure development proposals have regard for the existing natural hazards.

The *LSRCA Watershed Development Policies* outline the stormwater management and watershed development policies aimed to protect the environmental integrity of the Lake Simcoe watershed. The Policies provide direction on land use and development considering natural hazards, natural heritage features, and the natural environment to protect public health and safety, prevent property damage and social disruption.

Similar to the Ministry of the Environment, Conservation and Parks (MECP) *Stormwater Management Planning and Design Manual* and City of Barrie *Storm Drainage and Stormwater Management Policies and Design Guidelines*, the *LSRCA Technical Guidelines for Stormwater Management* provide planning and design direction for the effective management of stormwater in the Lake Simcoe Watershed.

As per the *LSRCA Technical Guidelines*, road reconstruction projects are subject to stormwater volume control requirements, specifically linear development volume control. Linear development is to retain and treat the larger of the following:

1. The runoff from the 12.5 mm event from the total reconstructed impervious surface; or
2. The runoff from a 25 mm event from the net increase in impervious surface.

As part of road reconstruction projects, attempts are to be made to fully comply with the linear development volume control criteria. If compliance is not achievable due to soil/groundwater conditions or site constraints, flexible treatment alternatives shall be applied. Given the restrictions to implementing LID techniques in the study area, specifically existing groundwater and soil conditions, a majority of the study area is subject to the LSRCA's flexible treatment alternative for sites with restrictions criteria. The flexible treatment alternatives are described as follows:

- Alternative 1 - Retain the runoff from the 12.5 mm event from the total reconstructed impervious surface;



- Alternative 2 – Achieve runoff volume reduction to the maximum extent possible (minimum 5 mm from all impervious surfaces); or
- Alternative 3 – Off-site control of the runoff from a 25 mm event from the net increase in impervious surface.

1.5.4 NVCA Planning and Regulation Guidelines (2009), Stormwater Technical Guide (2013) and Natural Hazards Technical Guide (2013)

The mission statement for the Nottawasaga Valley Conservation Authority (NVCA) is “*working together to value, protect, enhance, and restore our watershed resources, for a healthy sustainable future*”. Complementing the Planning Act, the NVCA administers the *Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation (Ontario Regulation 179/06)* under Section 28 of the *Conservation Authorities Act*. Development within the NVCA Regulation Limits is subject to NVCA review and approvals allowing the NVCA to ensure development proposals have regard for the existing natural hazards.

The *NVCA Planning and Regulation Guidelines* outline the stormwater management and watershed development policies aimed to protect the environmental integrity of the NVCA watershed. The Policies provide direction on land use and development considering natural hazards, natural heritage features, and the natural environment to protect public health and safety, prevent property damage and social disruption.

Similar to the MECP *Stormwater Management Planning and Design Manual* and City of Barrie *Storm Drainage and Stormwater Management Policies and Design Guidelines*, the *NVCA Stormwater Technical Guide* provides planning and design direction for the effective management of stormwater in the NVCA Watershed. The *NVCA Natural Hazards Technical Guide* provides guidance in the development of natural hazard studies, especially guidance regarding methodology, computation methods, and parametrization. The natural hazards regulated by the NVCA are flood, erosion, hazardous soils, karst, and dynamic beach.

1.5.5 Lake Simcoe Protection Plan (2009)

The Lake Simcoe Protection Plan’s priority is to protect and restore the long-term ecological health of the Lake Simcoe watershed. Short term focus includes restoring the health of aquatic life, improving water quality, maintaining water quantity, protecting and rehabilitating shorelines and natural heritage features, and addressing impacts of invasive species, climate change, and recreational activities. The strategies outlined in the LSPP will evolve over time based on scientific research and experience to ensure the objectives are satisfied. The objectives of the Plan as set out in the *Lake Simcoe Protection Plan* (2009) are to:



- Protect, improve or restore the elements that contribute to the ecological health of the Lake Simcoe watershed, including water quality, hydrology, key natural heritage features and their functions, and key hydrologic features and their functions;
- Restore a self-sustaining coldwater fish community in Lake Simcoe;
- Reduce phosphorus loadings and other nutrients of concern to Lake Simcoe and its tributaries;
- Reduce the discharge of pollutants to Lake Simcoe and its tributaries;
- Respond to adverse effects related to invasive species and, where possible, to prevent invasive species from entering the Lake Simcoe watershed;
- Improve the Lake Simcoe watershed's capacity to adapt to climate change;
- Provide ongoing scientific research and monitoring related to the ecological health of the Lake Simcoe watershed;
- Improve conditions for environmentally sustainable recreation activities related to Lake Simcoe and to promote those activities;
- Promote environmentally sustainable land and water uses, activities and development practices;
- Build on the protections for the Lake Simcoe watershed that are provided by provincial plans that apply in all or part of the Lake Simcoe watershed, including the Oak Ridges Moraine Conservation Plan and the Greenbelt Plan, and provincial legislation, including the Clean Water Act, 2006, the Conservation Authorities Act, the Ontario Water Resources Act, and the Planning Act; and
- Pursue any other objectives set out in the Lake Simcoe Protection Plan.

The Barrie Creeks drainage study area and Lovers Creek, Hewitts Creek and Sandy Cove Drainage Study Area are located in the Lake Simcoe watershed and fall under the general authority of the *Lake Simcoe Protection Plan* (LSPP). Policy 4.5 – SA of the LSPP establishes requirements for SWM Master Plans prepared in accordance with the Municipal Class Environmental Assessment process. Accordingly, the LSPP has been used as a guidance document for this study.

The City is committed to meet all of the requirements of Policy 4.5 of the LSPP including determining the effectiveness of the existing drainage infrastructure at reducing the negative impacts of stormwater on the environment and identifying additional stormwater management retrofit opportunities or improvements to existing storm infrastructure that could improve



stormwater treatment. Any retrofit opportunities would be implemented on a site specific basis with the improvements carried through to downstream areas.

1.5.6 Stormwater Management Planning and Design Manual (2003)

The *Stormwater Management Planning and Design Manual* evolved from the MECP *Stormwater Quality Best Management Practices* manual (June 1991) in response to evolving stormwater management practices to provide an integrated approach to effective stormwater management planning and design focused on water quality, water quantity and erosion control. The Planning and Design Manual is a tool, not a rulebook, providing practical guidance for the effective design of lot level, conveyance, and end-of-pipe stormwater practices. The objectives of the Planning and Design Manual are to apply an integrated treatment train approach to manage stormwater to maintain the hydrologic cycle, protect water quality and prevent increased erosion and flooding.

In accordance with the City's guidelines and *Ontario Regulation 219/09*, all new development and SWMF's shall provide as a minimum Enhanced Level water quality control as specified in the *Stormwater Management Planning and Design Manual* unless it can be demonstrated to the satisfaction of the Director (MECP) that it is impractical to achieve this level of protection.

1.5.7 The City of Barrie Official Plan (2014)

The Official Plan (OP) outlines the goals, objectives and policies for land use and development within the City of Barrie. The OP provides the City direction for controlling growth, implementing by-laws and making public and private development decisions as a means of ensuring a healthy community. The OP provides guidance for land use changes, municipal initiatives and the provision of public works. As such, the OP provides policies for the effective management of stormwater.

The stormwater management goals of the OP as set out in 2011 are:

- To protect and enhance the water quality and environmental, aesthetic and recreational potential of the City's watercourses, Little Lake, Kempenfelt Bay and Lake Simcoe.
- To encourage effective stormwater management in order to control flooding, erosion, sedimentation and maintain and enhance water quality in the receiving watercourses and water bodies.
- To promote the incorporation of natural waterways, valleys, and ponds into continuous green corridors for wildlife habitat, open space, and parkland.



- To ensure stormwater management policies minimize stormwater peak flows, contaminant loads including phosphorus, and maintain or increase the extent of vegetative and pervious surfaces.

The alternatives for this project, especially as they relate to the environment and future growth and development, will consider these goals, objectives and policies.

1.5.8 Provincial Policy Statement (2005)

The 2005 *Provincial Policy Statement* was developed as a regulatory policy for land use planning and development. The 2005 *Provincial Policy Statement* supports the protection of public health and safety, the natural environment and the resources of provincial interest while providing for appropriate development. The policy identifies the natural and built features to be protected and the areas where development and site alteration are restricted. Key requirements of this policy are as follows:

- Development and site alteration are restricted on lands adjacent to natural heritage features unless it is demonstrated that the natural features and their ecological functions are not negatively impacted.
- Development and site alteration are restricted on lands adjacent to sensitive surface water and groundwater features unless mitigative measures or alternate development approaches protect these natural features.
- Significant built heritage features are to be conserved.

1.5.9 Low Impact Development Stormwater Management Planning and Design Guide (2010)

The Credit Valley Conservation Authority (CVC) and Toronto and Region Conservation Authority (TRCA) developed the *Low Impact Development Stormwater Management Planning and Design Guide* which speaks to the importance of at source SWM controls versus typical end-of-pipe facilities. The advantages of the low impact development approach include:

- Reduction in overall runoff volume;
- Reduction in phosphorus discharge; and
- Reduced long term operation and maintenance.

As such, implementing low impact development measures in the City of Barrie where feasible will help reduce flooding and improve the overall water quality of the watershed. On this basis, all future development should evaluate the use of low impact development principles as part of the stormwater management design.



1.5.10 Natural Heritage Strategy (2013)

As a requirement of the *Official Plan*, the *Natural Heritage Strategy* has been developed to identify the natural resources within the City and to provide a system of linkages between these resources and the waterfront within the existing urban area. The goal of the strategy is to preserve and improve the natural heritage features, such as watercourses, wetlands and woodlots, remaining in the City over the long term. The Strategy establishes the natural heritage policies needed to ensure the preservation of these features throughout the existing urban area.

1.5.11 Natural Hazard Policies

The Natural Hazard Policies under the *Provincial Policy Statement* provide direction on land use and development in areas where there is a risk to public health and safety or a risk of property damage from flooding and/or erosion hazards. The Natural Hazard Policies aim to reduce the long-term risk to public health and safety or property damage through land management and by directing development outside hazardous lands. The natural hazard features in the study area have been estimated by the LSRCA and refined through detailed studies. In the study area, the natural hazard policies are administered by the LSRCA under Section 28 of the *Conservation Authorities Act* through *Ontario Regulation 179/06*.

1.5.12 Growth Plan (2005)

Under the *Places to Grow Act*, 2005 the *Growth Plan* for the Greater Golden Horseshoe is a framework for building stronger, prosperous communities by implementing Ontario's vision for managed growth in the region. The Plan provides direction for planning, housing, natural heritage, environmental protection, infrastructure and transportation decisions considering the region as a whole while recognizing the unique characteristics, strengths and economy of each individual community.

1.5.13 Phosphorus Reduction Strategy (2010)

The *Lake Simcoe Phosphorus Reduction Strategy* was produced to satisfy Policy 4.24-SA of the LSPP. The Phosphorus Reduction Strategy presents a series of actions designed to achieve long term continual reductions in phosphorus loads discharged into Lake Simcoe. The Strategy identifies specific goals and potential opportunities to achieve the long-term objective of reducing the phosphorus load in Lake Simcoe to 44 tonnes per year. The Strategy is a living document and will be reassessed every five years to ensure the proper actions are recommended to achieve the desired phosphorus reductions.



1.5.14 Phosphorus Offsetting Policy (2017)

As part of the LSRCA Strategic Plan, the LSRCA has initiated the Lake Simcoe Phosphorus Offsetting Program (LSPOP) to improve and protect the water quality in Lake Simcoe and its tributaries. The LSPOP requires that all new development, including redevelopment and intensification, control 100% of the phosphorus leaving the development lands. The phosphorus control is referred to as the Zero Export Target. As such, phosphorus budgets must be prepared for all new developments demonstrating that the phosphorus load leaving the development is zero. If the Zero Export Target cannot be achieved within the development lands, the developer is required to provide compensation through the phosphorus offsetting program at a ratio of 2.5:1 and value of \$35,000/kg/year. The revenue generated by the LSPOP will be used to reduce phosphorus loads elsewhere in the watershed by funding SWMF retrofits, the construction of LID measures or other best management practices.

1.5.15 Lakes and Rivers Improvements Act (LRIA)

The Lakes and Rivers Improvements Act is administered by the Ministry of Natural Resources (MNRF) and Forestry for the purpose of managing, protecting, and preserving the use of the waters of the lakes and rivers of Ontario and the land under them. The purpose of the Lakes and Rivers Improvement Acts is also to provide for:

1. The protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario;
2. The protection of the interests of riparian owners;
3. The management, perpetuation and use of the fish, wildlife, and other natural resources dependent on the lakes and rivers;
4. The protection of the natural amenities of the lakes and rivers and their shores and banks; and
5. The protection of persons and of property by ensuring that dams are suitably located, constructed, operated and maintained and are of an appropriate nature with regard to the purposes of clauses A to E.

Approvals must be obtained from the MNRF under the Lakes and Rivers Improvements act for the following:

- Dams;
- Watercourse crossings (bridges, culverts and causeways) where the drainage area for the watershed upstream of the crossing is greater than 5 km² unless construction is being undertaken by a Provincial Ministry or municipality, or contractors employed by a



Provincial Ministry or municipality on lands owned by the Crown or the municipality undertaking the construction;

- River channels (channelization of rivers, including dredging, diverting or enclosing a channel except for the installation or maintenance of a drain subject to the Drainage Act) where channelization of a river or stream may harmfully alter fish habitat, or impede the movement of fish in a river, stream or lake. Where the potential impact of channelization work on fish habitat and/or fish movement is unknown, such impacts must be confirmed with Department of Fisheries and Oceans (DFO) or their delegate in consultation with the MNRF. Where it is determined that proposed work will adversely affect fish habitat and/or impede the movement of fish an LRIA approval is required;
- Enclosures (river or stream enclosures) that enclose a length of watercourse greater than 20 m and may harmfully alter fish habitat or impede fish movement;
- Buried pipelines and cables where they hold back, forward or divert water; and
- Municipal and other drains.

1.5.16 Habitat Protection Provisions of the Fisheries Act

The habitat protection provisions are in place to address threats to fish from habitat loss/degradation and changes to natural flow regimes. The habitat protection provisions prohibit the carrying on of a work, undertaking or activity that results in serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery. Serious harm to fish is considered the death of fish or the permanent alteration to, or destruction of, fish habitat including spawning grounds and any other area, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes. The habitat protection provisions are administered by the DFO under the Fisheries Act.

Proposals that cause serious harm to fish are subject to review and approval by the DFO under the Fisheries Act. The DFO requires the proponent of projects near water to undertake a self-assessment to determine if a DFO review is required. For those projects that cannot avoid serious harm to fish or is likely to contravene one of the Species at Risk Act prohibitions with respect to aquatic species, and does not satisfy the DFO exemption criteria, then a DFO review is required.

Waterbodies that do not require a DFO review are as follows:

- Approved marine disposal or dumping sites;



- Artificial waterbodies that are not connected to a waterbody that contains fish at any time during any given year, such as private ponds, commercial ponds, stormwater management facilities, irrigation ponds or channels, agricultural drains and drainage ditches, roadside drainage ditches, quarries and aggregate pits; and
- Any other waterbody that does not contain fish at any time during any given year and is not connected to a waterbody that contains fish at any time during any given year.

For this Drainage Master Plan, projects that may require a DFO review are bridge, culvert and causeway projects; watercourse channelization/realignment, bank stabilization, dykes, berms and storm outfalls that do not satisfy the DFO exemption criteria and measures to avoid and mitigate harm.

1.5.17 Ministry of Transportation

Highway 400 is a provincial highway owned and maintained by the Ontario Ministry of Transportation (MTO). As such, the MTO is responsible for the major drainage system culvert crossings under Highway 400. The MTO is proposing Highway 400 improvements from approximately Highway 89 to Highway 11 including the stretch through the City of Barrie. The improvements include widening Highway 400 to 10 lanes, interchange improvements, centre median improvements to a standard concrete centre barrier, and drainage improvements including culvert upgrades.

The proposed Highway 400 improvements are outlined in the Transportation Environmental Study Report (TESR) Addendum Class Environmental Assessment and Preliminary Design Study Update (Aecom, 2017). The proposed culvert improvements are further outlined in the Drainage and Hydrology Report (Aecom, 2017) prepared in support of the Highway 400 improvements.

Through the City of Barrie, Highway 400 acts as a barrier to flow on several creeks. A number of the existing culverts do not have capacity to convey the expected flows under Highway 400 causing backwater conditions upstream. Flooding upstream can result in overtopping of Highway 400 during major storm events and interwatershed spills between Kidd's Creek, Bunkers Creek and Dyments Creek and Whiskey Creek and Hotchkiss Creek.

As part of the proposed Highway 400 improvements, the MTO proposes to replace the existing culverts that do not satisfy their *Highway Drainage Design Standards* (2008). Highway 400 has been designated as a Freeway by the MTO and according to their designs standards the culverts/bridges are to be designed in accordance with the following flood hazard criteria:

- 1:50-year design storm peak flow for spans less than 6 m; and
- 1:100-year design storm peak flow for spans greater than 6 m.



It is understood that the culverts proposed within the limits of the City are less than 6 m in span and will be designed to convey the 1:50 year design storm peak flow, except for the Dyments Creek crossing. The Dyments Creek culvert is being designed to convey the 1:100-year design storm peak flow.

The MTO has been consulted as part of this Drainage Master Plan to discuss their proposed Highway 400 drainage improvements. The MTO have indicated that they will consider upsizing the proposed culvert crossings to satisfy stricter flood hazard criteria if recommended by the City. However, the MTO expects the City to contribute a portion, if not all, of the additional construction costs associated with the additional culvert upsizing.

The installation of a standard concrete centre barrier was also discussed as the barrier will impeded flow overtopping Highway 400 resulting in additional flooding upstream and increased interwatershed spills. The MTO has indicated that alternative barrier designs will be considered at locations identified by the City to allow surface runoff to overtop the highway without impediment.



2 Problem/Opportunity Statement

The previously completed Master Drainage Plans as well as the updated minor and major drainage system models were reviewed in detail to clearly identify the outstanding drainage issues/deficiencies in the study area which need to be addressed. The Problem and Opportunity Statements for this Master Drainage Plan are provided in the following sections and remain generally consistent with the background Master Drainage Plans.

2.1 PROBLEM STATEMENT

Currently, portions of the City experience flooding during both minor and major storm events. Frequent flooding of private and municipal property during minor and major storm events has been documented throughout the City along much of the watercourses due to insufficient culvert and channel capacities. The flooding has caused historic damage to both private and municipal property and causes concern for public safety. Also, there is significant erosion along a number of the channel reaches in the City that threaten both private and municipal property and also causes concern for public safety.

In addition to flooding, the existing storm infrastructure is reaching its service life expectancy and deteriorating. A majority of the aging storm sewers are undersized considering historic rainfall data and current climate models predict future increases in rainfall intensities and volumes. In some locations, municipal storm infrastructure is located on private property outside the municipal right-of-way making it difficult to access and maintain. Also, there are areas absent of minor drainage systems and stretches of deficient overland flow routes across the City. Development, intensification, urbanization and growth in the City have also adversely impacted the stormwater quality and ecological health of the various creeks and Lake Simcoe. The culmination of the above noted factors results in a storm system that does not meet the City's engineering and development standards.

2.2 WATERSHED/DRAINAGE AREA SPECIFIC PROBLEMS

Several existing problem areas have been identified through our review of the available background information and consultation with City staff. The background reports divided the drainage deficiencies into several categories including minor/major deficiencies, road crossing deficiencies, flooding of buildings and private property, erosion and sedimentation and water quality. The problem areas are summarized next using the same division of issues as the background reports. The background reports also identified interwatershed spills that we have summarized in the sections that follow. The background reports should be referenced if additional information/details are required regarding the drainage issues.



2.2.1 City Wide Issues

- Erosion and sedimentation in the creeks resulting in localized active erosions sites and sedimentation causing obstruction to culverts; reducing their capacity to convey flow and increased maintenance; and
- Degraded water quality, specifically elevated phosphorus concentrations, resulting from urbanization and lack of stormwater quality controls.

2.2.2 Kidd's Creek

- Road crossing deficiencies at Cundles Road West, Highway 400, Thomson Street, Eccles Street, Wellington Street, Parkview Gardens, Donald Street, Dunlop Street and Eccles Street;
- Minor/major drainage system deficiencies between Simcoe Street and Dunlop Street West resulting in surcharged storm sewers, frequent flooding and excessive flood depths;
- Flooding of buildings and private property resulting from insufficient channel, culvert and overland flow route capacities that has the potential to damage property and public safety concerns; and
- Flood spill from Kidd's Creek to Bunkers Creek at Highway 400 during the Regulatory storm event.

2.2.3 Bunkers Creek

- Road crossing deficiencies at Innisfil Street, a Commercial Plaza entrance (80 Bradford Street), Dunlop Street and Bradford Street;
- Undersized storm infrastructure and lack of a continuous overland flow route downstream of Wellington Street along the north branch of Bunkers Creek resulting in frequent flooding;
- Flooding of buildings and private property resulting from insufficient channel, culvert and overland flow route capacities that has the potential to damage property and cause public safety concerns;
- Flood spill from Kidd's Creek into Bunkers Creek at Highway 400 during the Regulatory storm event; and
- Flood spill from Bunkers Creek to Dyments Creek at Highway 400 during major storm events (1:10 year storm and less frequent storm events).



2.2.4 Dyments Creek

- Road crossing deficiencies at Sproule Drive, Dunlop Street West, Ferndale Drive North, Sarjeant Drive, Dunlop Street/Highway 400 on-ramp, Highway 400, Hart Drive, George Street, Victoria Street, John Street, Innisfil Street, Sanford Street, Bradford Street and the Ferndale Landfill access road;
- Flood spill from Bunkers Creek into the Dyments Creek watershed at Highway 400 during major storm events; and
- Flooding of buildings and private property resulting from insufficient channel, culvert and overland flow route capacities and backwater conditions that has the potential to damage property and cause public safety concerns.

2.2.5 Hotchkiss Creek

- Road crossing deficiencies at Mayfair Drive, Ardagh Road, Morrow Road, Essa Road, Highway 400, Wood Street, Tiffin Street, Anne Street South, and Innisfil Street;
- Railway crossing deficiency south of Tiffin Street;
- Minor/major drainage deficiencies resulting in significant flooding and flood depths on Essa Road in the vicinity Gowan Street;
- Flooding of buildings and private property on Bradford Street, Anne Street S., Fraser Court, Wood Street, Alfred Street, Tiffin Street, Innisfil Street and Sanford Street due to undersized culverts and hydraulic deficiencies in the creek itself; and
- Flood spill from Whiskey Creek into Hotchkiss Creek during the Regulatory storm event.

2.2.6 Whiskey Creek

- Road crossing deficiencies at Harvie Road, Highway 400, Fairview Road, Bayview Drive, McConkey Place, Huronia Road, Little Avenue, Yonge Street, Hurst Drive, The Boulevard, and Brennan Avenue;
- Railway crossing deficiencies (2);
- Flooding of buildings and private property, particularly downstream of Brennan Drive and Little Avenue, due to undersized culverts and hydraulic deficiencies in the creek itself; and
- Flood spill from Whiskey Creek to Hotchkiss Creek during the Regulatory storm event.



2.2.7 Lovers Creek

- Road crossing deficiencies at Bayview Drive, Lockhart Road (2), Huronia Road (2), Welham Road (2), Mapleview Drive East, Ellis Drive, Tollendal Mill Road and BCRY rail crossings (2); and
- Flooding of buildings and private property, particularly downstream of Mapleview Drive East along Loon Avenue, Country Lane, Chalmers Drive, Grace Crescent, Barre Drive and Cox Mill Road, due to undersized culverts and hydraulic deficiencies in the creek itself.

2.2.8 Hewitts Creek

- Road crossing deficiencies at Mapleview Drive East; and
- Flooding of buildings and private property, due to undersized culverts and hydraulic deficiencies in the creek itself.

2.2.9 Bear Creek

- Road crossing deficiencies at County Road 27 (2) and 300 Mapleview Drive West; and
- Flooding of buildings and private property, due to undersized culverts and hydraulic deficiencies in the creek itself.

2.2.10 Little Lake

- Minor/major drainage deficiencies resulting in flooding in the vicinity of Livian Herman Way and St. Vincent Street.

2.2.11 Georgian Creek

- Road crossing deficiencies at Penetanguishene Road;
- Minor/major drainage deficiencies resulting in flooding on Hickling Trail and Penetanguishene Road; and
- Flooding of buildings and private property, due to undersized culverts and hydraulic deficiencies in the creek itself.

2.2.12 Drainage Areas

- Minor/major drainage deficiencies resulting in flooding in the Johnson, Nelson, Rodney, St. Vincent, Minets, Royal Oak, Gray Lane, Williams, Holgate, Huronia, and Bayshore drainage areas.



2.3 OPPORTUNITY STATEMENT

The City is planning to mitigate the drainage deficiencies and replace the aging and deteriorating storm infrastructure throughout the study area as part of future works. Opportunity exists to improve the drainage system level of service to a level that conforms with current drainage policies and design guidelines, improves water quality and water balance conditions, reduces flooding and erosion, improves maintenance opportunities and eliminates public safety hazards. As such, the City has initiated this Master Drainage Plan to identify and evaluate drainage improvements based on their impacts to the physical, natural, social, cultural and economic environments. A set of preferred improvement alternatives having the greatest positive impact and a recommended approach for implementing the alternatives will be the end product of the study.



3 Project Environment

This section provides a description of the existing physical, natural, social, cultural and economic environments within the study area. The detailed description of the project environment has been developed from a review of the available background information as well as recent field investigations.

3.1 PHYSICAL ENVIRONMENT

3.1.1 Private Property

Within the study area there is a mix of residential, commercial, institutional, industrial, and open space land uses. The existing land uses across the City are illustrated on Figure 4 - Existing Land Use Plan provided in Appendix A.

As discussed, the existing drainage systems are located on both municipal and private property in the study area. Also, flooding of private land historically has occurred along the creeks throughout the City during minor and major storm events.

The improvement alternatives proposed aim to prevent/reduce flooding on private property. However, the evaluation of the improvement options must also consider the purchase of these properties or acquiring interest therein (easements) to eliminate flooding of private property as per Watercourse By-Law 90-92. The private properties identified within the existing floodplain are presented in Appendix D and summarized in Table 7.



Table 7: Summary of Private Properties within the Regulatory Floodplain

WATERSHED / DRAINAGE AREA	NUMBER OF PROPERTIES	ASSESSED VALUE
Barrie Creeks Drainage Study Area		
Kidd's Creek	110	\$53,378,500
Bunkers Creek	16	\$11,791,200
Dyments Creek	63	\$47,618,250
Hotchkiss Creek	39	\$27,487,492
Whiskey Creek	105	\$52,192,001
Minets	26	\$9,874,500
Sub Total	359	\$202,341,943
Lovers Creek, Hewitts Creek and Sandy Cove Drainage Study Area		
Lovers Creek	97	\$81,265,501
Hewitts Creek	45	\$19,416,750
Sub Total	142	\$100,682,251
NVCA Study Area		
Bear Creek	48	\$31,704,425
Little Lake	0	0
Georgian Creek	2	\$13,830,250
Sub Total	50	\$46,534,675
Total	551	\$349,558,869

Note: Property Value – 2018 Assessed Value (MPAC)

3.1.2 Storm Sewer

Within the study area, the drainage systems consist of storm sewers, culverts, ditches, and open channels. The existing drainage infrastructure is illustrated on Figure 5 – Existing Stormwater Management Infrastructure Plan provided in Appendix A.

As per the City's guidelines, the minor drainage system (storm sewer) shall be designed to convey the 1:5-year (minimum) design storm peak flow. Watercourses and channels shall be capable of conveying the Regulatory storm peak flow without flooding adjacent private



property. Flooding of existing buildings and/or property shall be eliminated where feasible. Road culvert crossings and road elevations shall be designed to satisfy the design flood frequency criteria for the corresponding road classification. In the Study Area, the roads are classified as arterial, major/minor collectors, and urban local roads. The design flood frequency criteria for each road classification is provided in Table 7 in section 3.1.1.

Existing storm infrastructure in the City is reaching its service life expectancy and deteriorating. A majority of the aging storm sewers are undersized considering historic rainfall data and current climate models predict future increases in rainfall intensities and volumes. In some locations, municipal storm infrastructure is located on private property outside the municipal right-of-way making it difficult to access and maintain. Frequent nuisance flooding during minor storm events, potential public safety hazards, and access/maintenance issues are common throughout the study area. For these reasons, the replacement of storm infrastructure throughout the City is required.

The extent/locations of the existing minor and major drainage system deficiencies are described further in the Hydrologic & Hydraulic Modelling Technical Memorandum enclosed in Appendix B.

It is recommended that consideration be given to upsizing the local storm sewers to satisfy current design standards be considered as part of future road reconstruction projects. Similarly, relocating storm sewer to the municipal road allowance should also be considered. Also, it is recommended that consideration be given to service the streets absent of a minor drainage system throughout the study area. The areas/streets absent of minor drainage systems are illustrated on Figures 1A through 5A – Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

3.1.3 Existing Infrastructure (Sanitary, Water and Utilities)

Utilities including sanitary sewers, water main, gas, hydro and other overhead and buried utilities have been identified in the study area from the available record drawings. Conflicts with existing utilities will be reviewed for each improvement alternative proposed and potential conflicts and resolutions will be identified. Minor utility relocations and lowering of existing sanitary sewer and water main may be required to accommodate the improvement alternatives being evaluated.



3.1.4 Transportation System

In the Study Area, the roads are classified as arterial, major/minor collectors, and urban local roads. The road classifications are summarized in the following table and illustrated on the Schedule D Roads Plan provided overleaf.



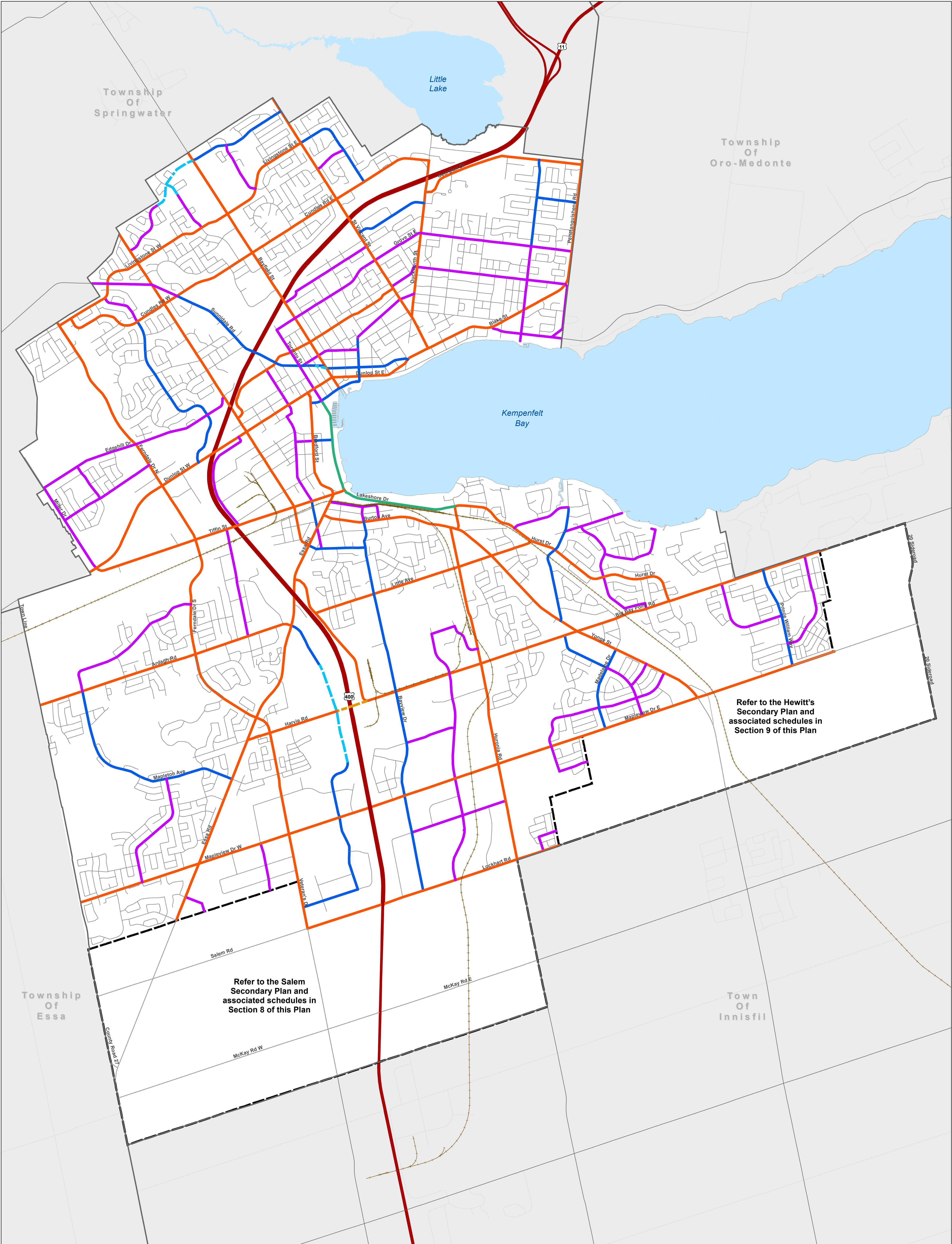
Table 8: Road Classification Summary

STREET					
Road Classification: Arterial			Flood Frequency Criteria: 1:100 Year		
St. Vincent Street	Yonge Street	Blake Street	Big Bay Point Rd	Burton Avenue	Yonge Street
Wellington Street	Duckworth Street	Georgian Drive	Mapleview Drive	Veterans Drive	Lockhart Road
Dunlop Street	Livingstone Street	Bradford Street	Huron Road	Anne Street	Minets Point Road
Bayfield Street	Ferndale Drive	Tiffin Street	Little Avenue	Hurst Drive	Harvie Road
Cundles Road	Essa Road	Ardagh Road	Big Bay Point Rd	Burton Avenue	Penetanguishene Rd
Road Classification: Major Collector			Flood Frequency Criteria: 1:50 Year		
Sunnidale Road	Innisfil Street	Cheltenham Road	Johnson Street	Anne Street	Baldwin Lane
Simcoe Street	Bayview Drive	Bell Farm Road	Livingstone Street	Bryne Drive	Commerce Park Drive
Mulcaster Street	Prince William Way	Hanmer Street	Leacock Drive	Cox Mill Road	Dean Avenue
Collier Street	Madelaine Drive	Mapleton Avenue	Victoria Street		
Road Classification: Minor Collector			Flood Frequency Criteria: 1:50 Year		
Rose Street	Patterson Road	Shanty Bay Road	Summerset Drive	Eccles Street	Gowan Street
Grove Street	Milburn Street	Wellington Street	Bayview Drive	Johnson Street	Marsellus Drive
Sophia Street	Dunn Street	Crestwood Drive	Reid Drive	Stanley Street	Churchill Drive
Toronto Street	Welham Road	Penetanguishene Rd	Hamilton Road	Edgehill Drive	Truman Road
Penetang Street	Saunders Road	McDonald Street	Tollendal Mill Road	Kozlov Street	Dock Road
Steel Street	Golden Meadow Rd	Crimson Ridge Road	Hanmer Street	Sunnidale Rd	Grand Forest Drive



STREET					
Road Classification: Minor Collector			Flood Frequency Criteria: 1:50 Year		
Pringle Drive	Esther Drive	Sproule Drive	Country Lane	Hart Drive	Stunden Lane
Leacock Drive	Sandringham Drive	Osprey Ridge Road	The Queensway	Miller Drive	Dean Ave
Dyment Road	Finsbury Street	Innisfil Street	Fenchurch Manor	Victoria Street	
Road Classification: Provincial Highway			Flood Frequency Criteria: 1:50 Year (MTO)		
Highway 400					
All other roads are classified as Urban Local Roads					
Source: The City of Barrie Official Plan – Schedule D Roads Plan					





OFFICIAL PLAN

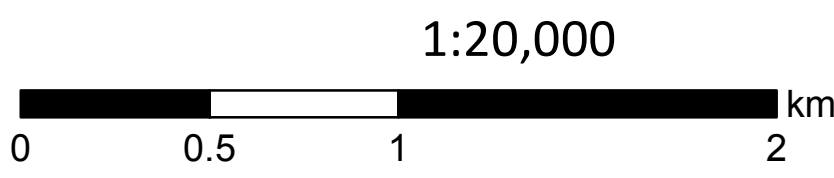
Schedule D

Roads Plan

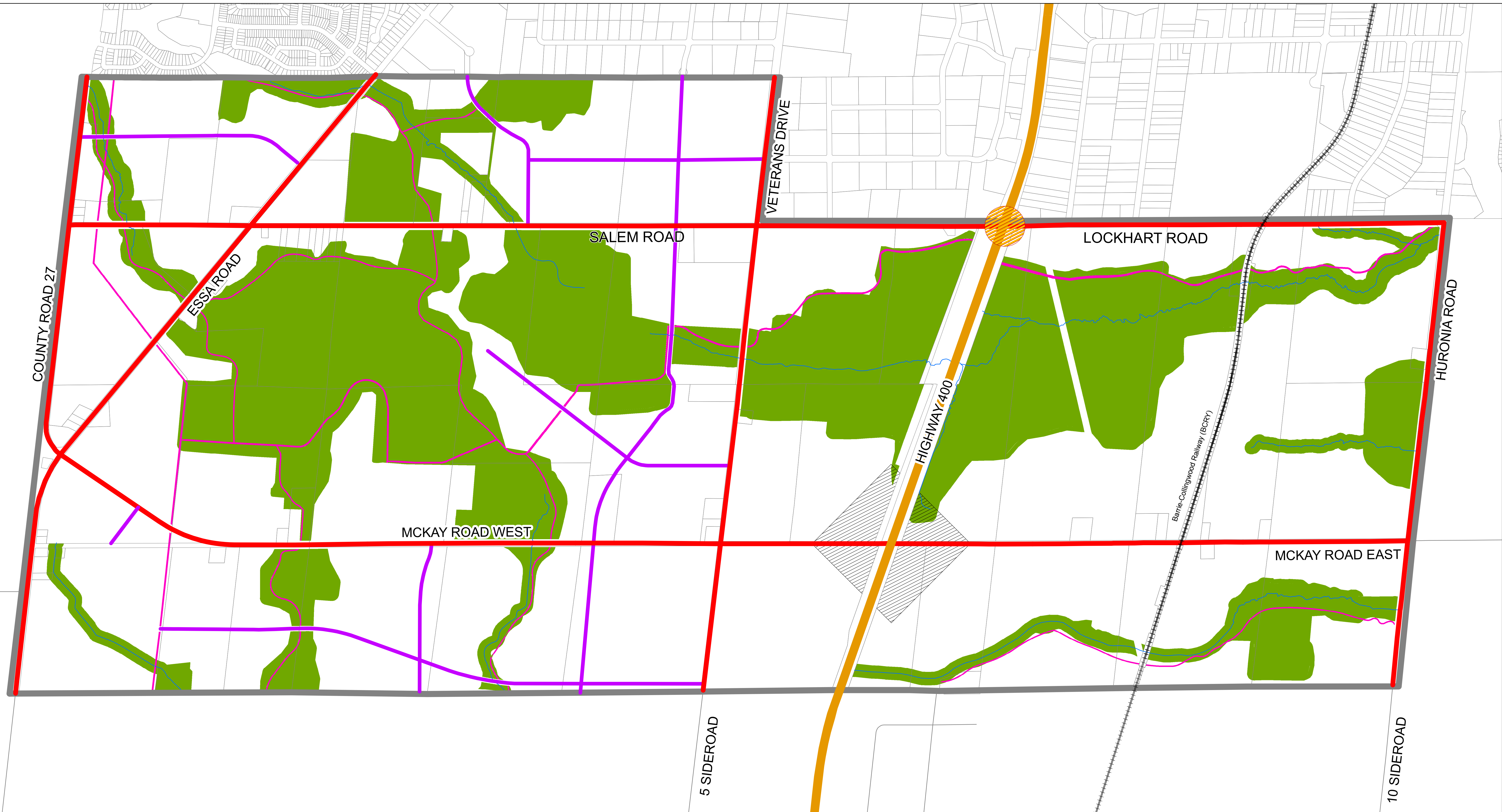
March 2017

Provincial Highway	Minor Collector	Future Arterial
Arterial	Parkway	Future Collector
Major Collector	Local	Railway

The City of
BARRIE

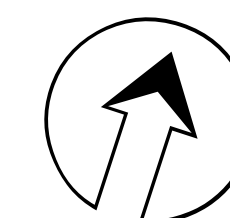


The City of Barrie does not warrant the accuracy, completeness, content, or currency of the information provided.
This is not a legal Plan of Survey
Copyright ©City of Barrie 2017
Produced (in part) under license from:
© Queens Printer, Ontario Ministry of Natural Resources. All rights reserved;
© Her Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved;
© Members of the Ontario Geospatial Data Exchange. All rights reserved.
For information please contact Service Barrie at 705-726-4242 or ServiceBarrie@barrie.ca



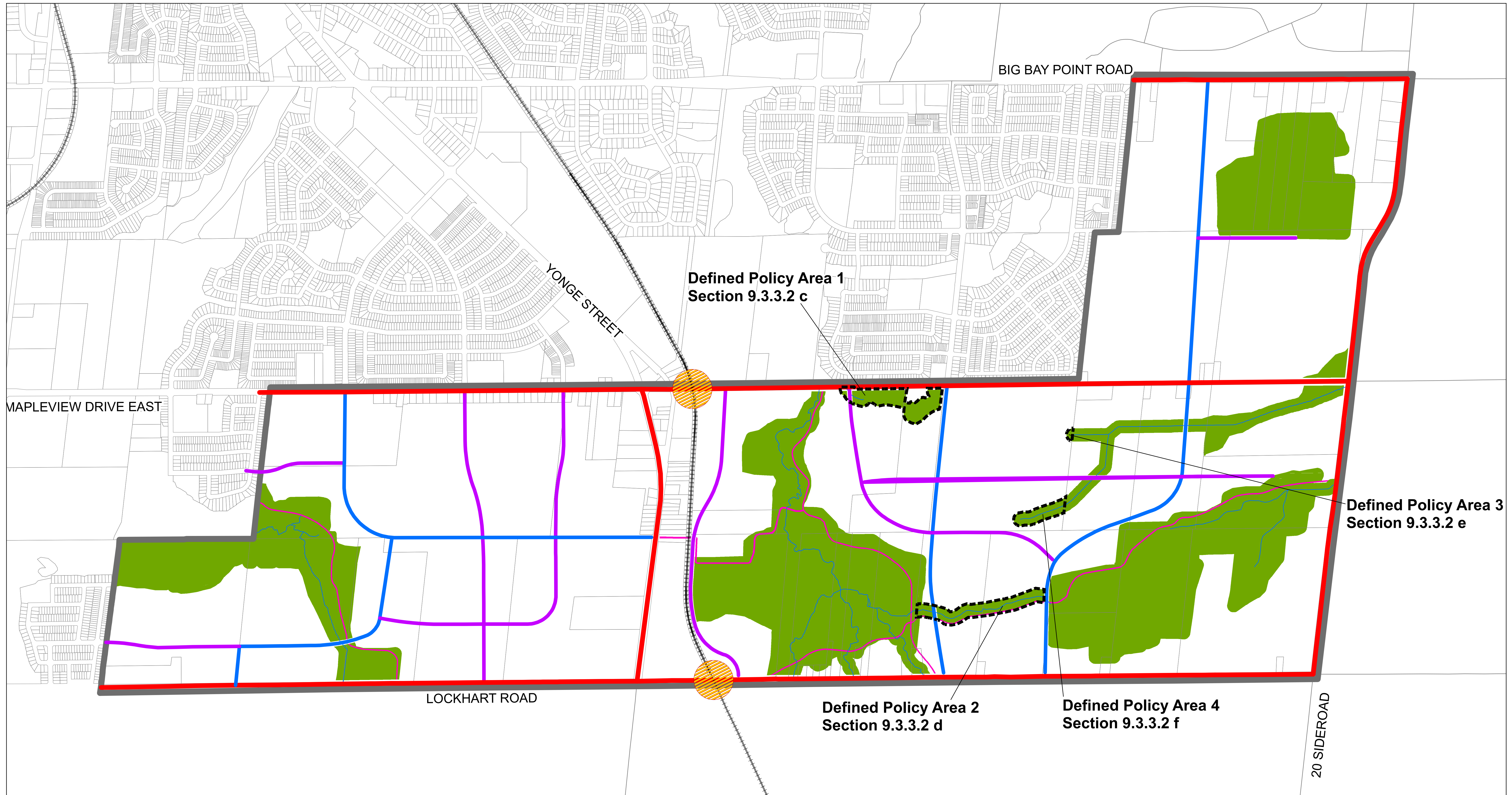
	Secondary Plan Boundary		Provincial Highway		Future Interchange		Natural Heritage System
	Existing Parcel Fabric		Arterial		Potential Grade Separation		
	Railway		Major Collector				
	Stream		Minor Collector				
			Pathway System				

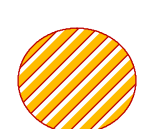
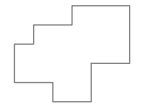
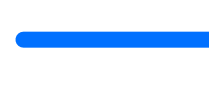
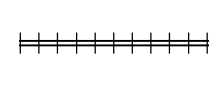
0 0.25 0.5 1 km



Schedule 8D-1
Transportation Plan
 City of Barrie
 Salem Secondary Plan

May 2016

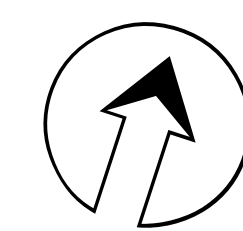
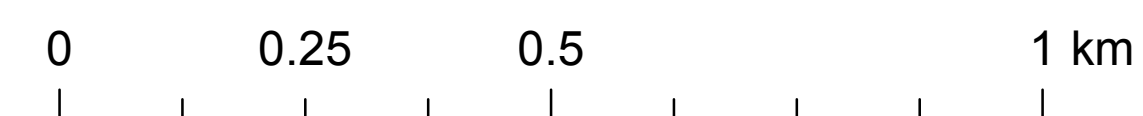


 Secondary Plan Boundary	 Arterial	 Potential Grade Separation	 Natural Heritage System
 Existing Parcel Fabric	 Major Collector	 Defined Policy Area	
 Railway	 Minor Collector		
 Stream	 Pathway System		

Schedule 9D-1
Transportation Plan

City of Barrie
Hewitt's Secondary Plan

May 2016



As part of the Transportation Master Plan being undertaken by the City, the existing road classifications are being reviewed and updated. The Multi-Modal Active Transportation Master Plan (MMATMP) is being undertaken to assess the future transportation needs of the City to support growth to the planning horizon of 2041. The purpose of the study is to assess existing conditions, identify transportation improvements including road widenings to accommodate growth and develop a long-range implementation plan.

The proposed improvement alternatives include construction within the roadway to replace culverts and construct trunk storm sewers. These improvements will result in isolated disturbances to the existing transportation systems; temporary disturbance during construction. However, construction of a trunk storm sewer and culvert replacements will create a temporary disturbance on the existing transportation system during construction, particularly if works occur on arterial and/or collector roads. As such, the impact each improvement alternative has on the transportation systems is an important consideration for this study.

3.1.5 Floodplain

The floodplain along the creeks throughout the City was originally developed through the previous Master Drainage Plans. The existing floodplain associated with each creek in the City is illustrated on Figure 6 - Natural Hazards Plan provided in Appendix A.

Existing flooding is an important consideration for this study. The flooding has caused historic damage to both private and municipal property and causes concern for public safety. *By-Law 90-92* specifies the City's obligation to progressively acquire land or easements for drains, watercourses and storage areas crossing or upon private lands, where it is considered to be in the City's interest to do so. This includes lands located in the floodplain.

The delineation of the existing floodplain through the study area is further described in the Hydrologic & Hydraulic Modelling Technical Memorandum enclosed in Appendix B. As discussed, the private properties identified within the existing floodplain are presented in Appendix D.

Although updated hydrologic and hydraulic models were prepared in support of this Drainage Master Plan, updating the existing floodplain mapping was not part of the scope of work.

3.1.6 Fluvial Geomorphology

The City's OP lists one of its goals as "to protect people and property and to minimize social disruption within the City from natural hazards including flooding and erosion". Keeping this in mind, a Fluvial Geomorphologic & Erosion Threshold Assessment was completed by Water's



Edge to identify the areas of active erosion and determine erosions thresholds to aid in the development and evaluation of the alternative drainage solutions. The assessment highlights the active erosion sites on each watercourse and provides recommendations for mitigation. Erosion is an important consideration for this study. The Fluvial Geomorphologic & Erosion Threshold Assessment is included in Appendix E for reference.

3.1.7 Source Water Protection

The South Georgian Bay Lake Simcoe Source Protection Plan has been developed to protect existing and future drinking water sources from significant drinking water threats. A number of potential significant drinking water threats have been identified in the Source Protection Plan. The City of Barrie uses both surface and groundwater resources for its potable drinking water supply. The applications of pesticides, fertilizers and road salts are significant drinking water threats that impact stormwater runoff and can be transferred to creeks and groundwater sources. As such, a Source Water Protection Technical Memorandum has been prepared as part of this study to provide additional considerations for the development and evaluation to the Alternative Drainage Solutions. The Source Water Protection Technical Memorandum has been prepared by Azimuth Environmental and is enclosed in Appendix F for reference.

3.1.8 Parkland

The existing parks are an important consideration within the study area. The parks provide a green space amenity within the City for pedestrian connectivity and community use. The parks are features enjoyed by not only surrounding residents but residents throughout the City. The maintenance of the parks is an important consideration as it relates to the City of Barrie Master Park and Leisure planning policies.

Parkland has been identified for its potential inclusion of low impact development measures and/or stormwater management facilities. Low impact development measures can be constructed in existing parklands to reduce minor drainage system peak flows, enhance water quality treatment, improve the water balance and reduce erosion all while maintaining the existing function/use of the parkland. SWMF's may provide the added benefit of reducing major drainage system peak flows, however at a cost of disturbing the surface features, function and use of the parkland or a portion of it.

3.2 NATURAL ENVIRONMENT

As part of the development of the background studies, the natural heritage features throughout the city have been mapped. The natural heritage features are illustrated on Figure 7 - Natural Heritage Plan provided in Appendix A.



Azimuth Environmental completed an existing natural heritage features evaluation in the summer of 2017 in support of this Drainage Master Plan. The evaluation involved general surveys of habitat types, Significant Wildlife Habitat (SWH) for Ecoregion 6E, potential habitat for SAR bats, habitat for amphibians and reptiles, fish and fish habitat, and a tree species inventory. The results of the evaluation are summarized in the following sections and detailed in the Natural Heritage Assessment Technical Memorandum enclosed in Appendix G.

3.2.1 Vegetation

No plant species designated Endangered, Threatened or Special Concern federally or provincially were observed in the areas identified for potential improvement (project footprint). None of vegetation community types are considered rare provincially, however, four Ohio Buckeye considered rare provincially were identified in the areas for potential improvement. Two Black Walnut considered rare in the Lake Simcoe watershed were observed, however, Black Walnut are common landscape trees in the City of Barrie. Of the 77 plant species identified within the project footprint, approximately 50 are considered non-native and/or invasive species. Overall, the improvement alternatives will provide opportunities to enhance native plantings.

3.2.2 Fisheries

No fish species or permanent fish habitat was observed in Georgian Creek or Little Lake Creek due to the lack of baseflow during the field investigations, perched culverts and dry channel reaches. As such in-water works activity timing windows should not be required (subject to MNRF/DFO/NVCA confirmation) and standard mitigation measures for working around water should be sufficient for the improvement alternatives.

However, fish species have been mapped in the remaining creeks and the thermal regime of each watercourse has been identified. The mapped fish species for each creek are summarized in Table 9. The mapped fish species have been identified in the overall watercourse and are not site specific or specific to the projects being considered under this Drainage Master Plan. The thermal regime and in-water works activity timing windows as summarized in Table 10. The in-water works activity timing windows presented in Table 10 are generalized based on the fish species mapped in the watercourse and are not site specific. For projects near water, the in-water works activity timing windows should be resolved through consultation with the MNRF, DFO and NVCA/LSRCA.



Table 9: Mapped Fish Species Summary

CREEK	FISH SPECIES
Kidd's Creek	Brook Trout, Northern Pike, Creek Chub, Rock Bass, Pumpkinseed, Yellow Perch
Bunkers Creek	Northern Pike, Common White Sucker, Northern Redbelly Dace, Finescale Dace, Brassy Minnow, Emerald Shiner, Spottail Shiner, Blacknose Dace, Creek Chub, Brook Stickleback, Trout-Perch, Rock Bass, Pumpkinseed, Yellow Perch
Dyments Creek	Central Mudminnow, Common White Sucker, Northern Redbelly Dace, Common Shiner, Bluntnose Minnow, Fathead Minnow, Blacknose Dace, Creek Chub, Pearl Dace, Brook Stickleback, Pumpkinseed
Hotchkiss Creek	Common White Sucker, Northern Redbelly Dace, Finescale Dace, Brassy Minnow, Hornyhead Chub, Sand Shiner, Blacknose Dace, Creek Chub, Pearl Dace, Stoneroller, Brook Stickleback, Trout-Perch, Mottled Sculpin
Whiskey Creek	Brook Trout, Rainbow Smelt, Golden Shiner, Emerald Shiner, Spottail Shiner, Bluntnose Minnow, Blacknose Dace, Longnose Dace, Creek Chub, Rock Bass, Pumpkinseed, Smallmouth Bass, Black Crappie, Iowa Darter, Logperch, Mottled Sculpin, Slimy Sculpin
Lovers Creek	Rainbow Trout, Brook Trout, Central Mudminnow, Common White Shiner, Northern Redbelly Dace, Brassy Minnow, Hornyhead Chub, River Chub, Emerald Shiner, Common Shiner, Blackchin Shiner, Blacknose Shiner, Rosyface Shiner, Bluntnose Minnow, Fathead Minnow, Blacknose Dace, Longnose Dace, Creek Chub, Pearl Dace, Silver Shiner (threatened), Brown Bullhead, Brook Stickleback, Rock Bass, Pumpkinseed, Smallmouth Bass
Hewitts Creek	Brook Trout, Common White Sucker, Northern Redbelly Dace, Finescale Dace, Brassy Minnow, Hornyhead Chub, Common Shiner, Blacknose Shiner, Bluntnose Minnow, Fathead Minnow, Blacknose Dace, Longnose Dace, Creek Chub, Pearl Dace, Brook Stickleback, Rock Bass, Pumpkinseed, Largemouth Bass, Iowa Darter, Johnny Darter/Tesselated Darter, Mottled Sculpin, Slimy Sculpin
Sandy Cove Creek	Sand Shiner, Northern Redbelly Dace, Fathead Minnow, Eastern Blacknose Dace, Longnose Dace, Brook Trout, Creek Chub, Central Mudminnow, White Sucker, Mottled Sculpin, Brook Stickleback, Pearl Dace, Emerald Shiner
Thornton Creek	Eastern Blacknose Dace, Longnose Dace, Brook Trout, Creek Chub, Common White Sucker, Mottled Sculpin, Brook Stickleback, Pumpkinseed, Burbot, Pearl Dace, Common Shiner, Rainbow Trout, Fathead Minnow
Bear Creek	Common White Sucker, Mottled Sculpin, Brook Stickleback, Johnny Darter/Tesselated Darter, Brassy Minnow, Pearl Dace, Common Shiner, Rainbow Trout, Northern Redbelly Dace, Fathead Minnow, Eastern Blacknose Dace, Longnose Dace, Brown Trout, Brook Trout, Creek Chub
Kidd's Creek	Brook Trout, Northern Pike, Creek Chub, Rock Bass, Pumpkinseed, Yellow Perch



Source: Natural Heritage Assessment Technical Memorandum (Azimuth Environmental Consulting, Inc., October 2017); mapped fish species in watercourse (not site specific)

Table 10: Creek Thermal Regime and Fishery Timing Windows

CREEK	THERMAL REGIME	ACTIVITY TIMING WINDOW
Kidd's Creek	Coldwater	October 1 – May 31
Bunkers Creek	Coldwater	March 15 – July 15
Dyments Creek (upstream of Hwy 400)	Coldwater	March 15 – July 15
Dyments Creek (downstream of Hwy 400)	Warmwater	March 15 – July 15
Hotchkiss Creek	Coldwater	March 15 – July 15
Whiskey Creek	Coldwater	October 1 – July 15
Lovers Creek	Coldwater	October 1 – July 15
Hewitts Creek	Coldwater	October 1 – July 15
Sandy Cove Creek	Coldwater	October 1 – July 15
Thornton Creek	Coldwater	October 1 – July 15
Bear Creek	Coldwater	October 1 – July 15

Note: Activity timing windows subject to MNRF, DFO, and NVCA/LSCRA confirmation

3.2.3 Terrestrial Wildlife

No species-specific surveys were conducted as part of this study. However, general field surveys, inventories and background data/mapping reviews were completed to identify habitat for threatened and endangered species and significant wildlife habitat. The significant natural heritage features/functions identified are summarized as follows:

- Habitat of Threatened and Endangered Species;
 - Bank Swallow (threatened);
 - Barn Swallow (threatened);
 - Blanding's Turtle (threatened);
 - King Rail (endangered);
 - Least Bittern (threatened);
 - Little Brown Myotis (endangered);
 - Northern Myotis (endangered);



- Tri-coloured Bat (endangered); and
- Silver Shiner (threatened).
- Provincially Significant Wetlands;
- Significant Wildlife Habitat;
 - Waterfowl stopover and staging areas (terrestrial);
 - Waterfowl stopover and staging areas (aquatic);
 - Bat maternity colonies;
 - Colonially-nesting bird breeding habitat (bank and cliff);
 - Waterfowl nesting area;
 - Bald eagle and osprey nesting, foraging and perching habitat;
 - Turtle nesting areas;
 - Amphibian breeding habitat (wetlands);
 - Woodland area-sensitive bird breeding habitat;
 - Terrestrial crayfish; and
 - Special concern and rare wildlife species;
 - Bald eagle (SC);
 - Black Tern (SC);
 - Eastern Ribbonsnake (SC);
 - Eastern Wood-pewee (SC);
 - Peregrine Falcon (SC);
 - Red-headed Woodpecker (SC);
 - Snapping turtle (SC);
 - Yellow rail (SC); and
 - Monarch butterfly (SC).

The proposed alternative drainage options discussed in subsequent sections of this report will be evaluated based on their impact on terrestrial wildlife.



3.2.4 Water Quality

The watersheds and drainage areas in the Barrie Creek drainage study area and in the Little Lake and Georgian Creek watershed are predominately developed and accordingly the current development within the study area is not considered as potential new sources of water quality degradation. However, many of the existing developments do not have water quality controls thus, where feasible, opportunities to improve water quality should be considered including the following:

1. Low Impact Development measures;
2. SWMF retrofits;
3. Watercourse daylighting; and
4. Vegetative buffers along the watercourse.

In the other watersheds, there is opportunity for new growth and development. New development in the study area is subject to the policies and regulations outlined in section 1.5 of this report. As such, all new development shall provide as a minimum Enhanced Level water quality control as specified in the *Stormwater Management Planning and Design Manual* unless it can be demonstrated to the satisfaction of the Director (MECP) that it is impractical to achieve this level of protection.

3.3 SOCIAL ENVIRONMENT

3.3.1 Property Value

Existing flooding and the presence of municipal infrastructure on private property can negatively impact property values and the City's ability to improve existing drainage infrastructure. As such, any improvement alternative that will prevent/reduce flooding on private property and relocate municipal infrastructure into municipally owned lands would be a positive improvement. The assessed property values of the private properties identified within the floodplain are summarized in Table 7 and provided in Appendix D.

3.3.2 Public Safety

The existing drainage systems throughout the study area operate at levels below current City design standards resulting in flooding on municipal and private property. The flooding presents a potential for public safety concerns. The conveyance of both minor and major storm flows and compliance with the Provincial Policy Statement in this regard is an important consideration in the review of improvement alternatives.



In addition to flooding, the lack of safety grates on storm sewers and culvert inlets/outlets, lack of signage around SWMF's describing the potential hazards, and the lack of pedestrian barricades at fall hazards pose a threat to public safety. As such, the installation of safety grates, signage and pedestrian barricades is highly recommended.

3.4 CULTURAL/ARCHEOLOGICAL ENVIRONMENT

Archeoworks Inc. completed a *Stage 1 Archeological Assessment* in the summer of 2017 in support of this Drainage Master Plan. The assessment concluded that the study area has undergone significant changes since 1954 through urban development, roadway construction, infrastructure installation and grading/landscaping. These activities contribute to the removal of archeological resources. As such, disturbed areas confirmed through on-site property inspection may be classified as "no archeological potential" and may be exempt from Stage 2 test pit surveys.

Any construction activity in lands that are deemed undisturbed during an on-site property inspection require a Stage 2 test pit survey. Similarly, the historic Town of Barrie retains elevated archeological potential for the presence of deeply buried archeological resources. As such, a Stage 2 test pit survey is required within the historic Town of Barrie. Lands classified as uncertain archeological potential or archeological potential require a Stage 2 test pit survey within the footprint of the improvement alternatives. The conclusions and recommendations of the archeological assessment are detailed in the *Stage 1 Archeological Assessment Technical Memorandum* enclosed in Appendix H for reference.

It is noted that no construction activities shall take place within the study area prior to the Ministry of Tourism, Culture and Sport (MTCS-Archaeology Program Unit) confirming in writing that all archaeological licensing and technical review requirements have been satisfied.

ERA Architects prepared a Cultural Heritage Review to identify all cultural heritage properties that may be impacted by the alternative solutions developed as part of the Drainage Master Plan. ERA identified 22 projects that overlap with one or more heritage properties. Nine projects necessitate an easement or purchase of one or more heritage properties. The remaining projects are located adjacent to or near heritage properties.

The recommendations of the Cultural heritage Review are as follows:

1. All newly identified prospective heritage properties should be studied further to determine whether the properties should be inventoried, listed or designated;
2. Any project necessitating the demolition of a building on a heritage property should be avoided; and



3. A Heritage Impact Assessment should be prepared for any non-demolition project located on, adjacent to or near a heritage property.

3.5 ECONOMIC ENVIRONMENT

3.5.1 Drainage System Maintenance Costs

Throughout the study area, the City incurs costs to maintain their existing drainage systems on both municipal and private property. Clearing obstructions, repairing erosion and removing accumulated sediment are routine maintenance activities the City coordinates to complete. Unfortunately, as existing storm infrastructure reaches its service life expectancy and deteriorates, the maintenance costs increase. Limited access for City Operations staff to drainage infrastructure on both private and municipal lands also increases maintenance costs and risk of failure.

The improvement alternatives being considered aim to attenuate peak flows, improve water quality, increase conveyance capacities and prevent/reduce the flooding on private property. As such, the maintenance costs throughout the City is expected to be reduced. However, annual periodic maintenance will be required to maintain the function of stormwater management facilities (SWMF) and Low Impact Development (LID) measures. Improvement alternatives proposing SWMF's or LID measures will require routine maintenance.

3.5.2 Property Acquisition Costs

By-Law 90-92 provides direction to the City to acquire lands or interests therein (easements) adjacent to the watercourse where it is in the City's interest to do so. As per the By-Law, if the City does not acquire the lands or interest therein (easements), the owner of the lands upon which a watercourse is located is fully responsible to maintain the watercourse on their lands. Future development lands may be dedicated to the City through the Subdivision Agreement or Site Plan Conditions. Existing properties, or portions of the properties, may be acquired through negotiations with the land owner or under the worst case scenario through expropriation.

Currently, extensive flooding of private property occurs throughout the study area during major storm events. As part of the previous MDP's and recent updates to the major drainage system models, the private properties subject to flooding during major storm events were identified (Appendix D). The improvement alternatives proposed aim to prevent/reduce the flooding on private property. However, to implement several of the improvement alternatives, acquisition of private property by the City is required. The cost to acquire these lands will be included in project cost estimates prepared for each alternative.



3.5.3 Construction Costs

Each improvement alternative has a capital cost to construct. Project cost estimates will be prepared for each improvement alternative considered to aid in the evaluation of the economic impacts to implement each alternative. Consideration will be given to implementing the alternative improvement options as part of future renewal projects to reduce costs. For those projects recommended to occur as part of future renewal projects, the cost to construct the improvement will be compared against the cost to replace the existing infrastructure.



4 Existing Condition System Analysis

As discussed, CCTA was retained in 2015 by the City of Barrie to develop minor and major drainage system models of the City's storm infrastructure across the entire City of Barrie. CCTA prepared, calibrated, and verified a PCSWMM hydrologic/hydraulic model of Barrie's minor drainage systems citywide. Similarly, CCTA prepared a Visual OTTHYMO hydrologic model and HEC RAS hydraulic models of Barrie's major drainage systems citywide. The models were used to identify the deficiencies in the minor/major drainage systems and allow for the evaluation of proposed infrastructure improvements under a variety of actual and predicted storm events and future watershed conditions.

4.1 MODEL UPDATES

As part of this Drainage Master Plan project, we updated the minor and major drainage system models. The following model updates were completed:

1. The Visual OTTHYMO hydrologic model input parameters (CN numbers, percent impervious, percent directly connected impervious, etc.) were reviewed and updated. The Visual OTTHYMO hydrologic model input parameters were updated using the 2016 Impervious GIS layers. The Visual OTTHYMO hydrologic model was updated with the new input parameters and used to generate new peak flows for the various 4 hour Chicago and 6, 12 and 24 hour SCS type II design storms, and the Hurricane Hazel and the Timmins storm events for each watershed and drainage area.
2. The PCSWMM hydrologic input parameters (percent impervious and percent routed) were updated using the 2016 impervious GIS layers provided by the City. After updating the input parameters, the PCSWMM minor drainage system models were recalibrated and validated using the approach developed in the City Wide Model Development Project. After completing the calibration/validation, the models were used to generate new peak flows for the 2, 5 and 10-year 4 hour Chicago and 6, 12 and 24 hour SCS type II design storms.
3. The SWMF stage-storage-discharge tables were reviewed and updated using the background information available and field investigations/survey.
4. As a requirement of the LSRCA, the Hurricane Hazel storm peak flows are to be generated under AMCIII conditions with storage facilities removed. Similarly, the NVCA requires the Timmins peak flows be generated under AMCII conditions with the storage facilities removed. As such, separate Visual OTTHYMO scenarios were created for each study area and the CN numbers were adjusted to reflect the appropriate AMC conditions and the



existing SWMF's within each watershed/drainage area were removed from the model scenarios. New Hurricane Hazel and Timmins storm peak flows were generated from the updated model.

The existing condition major drainage system hydrologic model results are summarized in Table 11. The model updates and results are further described in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.



Table 11: Existing Conditions Hydrologic Modelling Results Summary

WATERSHED/ DRAINAGE AREA	DRAINAGE AREA (ha)	REGULATORY STORM EVENT	PEAK FLOW AT OUTLET (m ³ /s)
Kidd's Creek	488	Hurricane Hazel	54.0
Bunkers Creek	361	Hurricane Hazel	42.6
Dyments Creek	580	Hurricane Hazel	62.6
Hotchkiss Creek	483	1:100 Year SCS (6 Hour)	66.3
Whiskey Creek	638	Hurricane Hazel	70.0
Johnson	83	1:100 Year SCS (6 Hour)	17.3
Nelson	62	1:100 Year SCS (6 Hour)	12.6
Rodney	29	1:100 Year SCS (6 Hour)	4.6
St. Vincent	36	1:100 Year SCS (6 Hour)	5.4
Williams	69	1:100 Year SCS (6 Hour)	10.8
Holgate	15	1:100 Year SCS (6 Hour)	2.8
Huronia	93	Hurricane Hazel	11.8
Minets	6	Hurricane Hazel	0.2
Little Lake	445	1:100 Year SCS (6 Hour)	47.8
Bear Creek	1,700	Timmins	72.2
Georgian Creek	270	1:100 Year SCS (6 Hour)	35.9
Lovers Creek	2,538	Hurricane Hazel	342.1
Hewitts Creek	762	Hurricane Hazel	130.1
Bayshore	50	1:100 Year SCS (24 Hour)	5.7
Gray Lane	19	1:100 Year SCS (6 Hour)	2.2
Royal Oak	14	1:100 Year SCS (6 Hour)	2.4

The updated existing conditions PCSWMM minor drainage system model was used to establish the existing deficiencies in the minor drainage system across the study area. For the purpose of this study, the deficiencies were identified for the 1:5-year 6 hour SCS design storms. The minor drainage system deficiencies are illustrated on Figures 1A through 5A – Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum*



enclosed in Appendix B. For this study, the storm sewer has been characterized as follows based on conveyance capacity:

1. **Peak Flow/Storm Sewer Full Flow Capacity ($Q_{max}/Q_{fullflow}$) < 85%** - storm sewer capacity exceeds design storm peak flow (storm sewer has adequate capacity) by greater than 15% and satisfies the current municipal conveyance criteria.
2. **85% < Peak Flow/Storm Sewer Full Flow Capacity ($Q_{max}/Q_{fullflow}$) < 100%** - storm sewer capacity exceeds design storm peak flow (storm sewer has adequate capacity) by less than 15%. As such, the peak flow is approaching full flow capacity.
3. **101% < Peak Flow/Storm Sewer Full Flow Capacity ($Q_{max}/Q_{fullflow}$) < 115%** - design storm peak flow exceeds storm sewer capacity (deficient conveyance capacity) by up to 15% - moderate exceedance.
4. **Peak Flow/Storm Sewer Full Flow Capacity ($Q_{max}/Q_{fullflow}$) > 115%** - design storm peak flow exceeds storm sewer capacity (deficient conveyance capacity) by greater than 15% - severe exceedance.

The areas/streets absent of a minor drainage system are also illustrated on Figures 1 through 5 – Minor Drainage System Deficiencies. The streets absent of storm sewer were highlighted due to the length of road missing a minor drainage system. The City of Barrie *Storm Drainage and Stormwater Management Policies and Design Guidelines* specify a maximum catch basin spacing of 90 m. As such, any road longer than 90 m absent of existing storm sewer was identified.

The updated existing condition HEC RAS hydraulic models of the creeks have been used to establish the existing capacities of the major road culvert crossings, and consequently the level of service provided. The existing capacities of the road crossing culverts are summarized in *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B. The major drainage system deficiencies and the Regulatory floodplain are illustrated on Figure 1B through 5B included in the *Hydrologic & Hydraulic Modelling Technical Memorandum*.

The existing conditions PCSWMM minor drainage system model was also used to establish the existing deficiencies in the overland flow routes throughout the study area. For the purpose of this study, deficiencies were defined by the NVCA/LSCRA safe access/egress criteria as follows:

1. Depth of flow exceeds 0.30 m;
2. Velocity of flow exceeds 1.7 m/s; or
3. Depth velocity product exceeds 0.4 m²/s.



The results for the PCSWMM dual drainage system corresponding to the 1:100-year 6 Hour SCS design storm were evaluated against the safe access/egress criteria. The overland flow routes that do not satisfy the aforementioned criteria are deficient. The deficient overland flow routes are illustrated on Figures 1B through 5B included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

For this study, the major overland deficiencies have been evaluated using the dual drainage system in PCSWMM and standardized road cross-sections between storm structures. The cross-sections do not necessarily match existing conditions, however, they do provide an estimate of the overland flow depths and velocities along a typical roadway during major storm events. As such, it is recommended that solutions to address the major overland deficiencies be evaluated as part of future road reconstruction projects and improvements be made where feasible.

4.2 INTERWATERSHED SPILLS ANALYSIS

The background documents identified interwatershed spills between Kidd's Creek, Bunkers Creek and Dyments Creek and Whiskey Creek and Hotchkiss Creek. As such, an existing conditions spill analysis was completed using the existing HEC RAS models to quantify the existing interwatershed spills and the Regulatory peak flows downstream within the existing Highway 400 culverts, road profile and cross-section in place. The existing HEC RAS models were updated to include lateral structures at each spill location to quantify each spill and the resultant floodplain impacts downstream. A 2D hydraulic analysis was also completed in PCSWMM to verify the results of the HEC RAS spills analysis. The results of the flood spill analysis are summarized in the following sections. The flood spill analysis and results are further described in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

4.2.1 Kidd's Creek – Bunkers Creek Interwatershed Flood Spill

The spills analysis predicts a spill from Kidd's Creek during the Regulatory storm. During the Hurricane Hazel storm, stormwater will overtop Highway 400 and flow south via the roadway. Approximately 5.4 m³/s will flow south underneath Sunnidale Road. A majority of the spill (4.8 m³/s) will drain east off of Highway 400 into a tributary of Kidd's Creek; ultimately draining back into the main branch of Kidd's Creek downstream. However, approximately 0.6 m³/s will spill into Bunkers Creek. There is no spill predicted from Kidd's Creek under the 1:2-year to 1:100-year design storms as the existing Highway 400 culvert crossing has adequate capacity to convey the 1:100-year design storm peak flow.



4.2.2 Bunkers Creek – Dyments Creek Interwatershed Flood Spill

The spills analysis predicts spills between the branches of Bunkers Creek (north branch, central branch, and south branch) upstream of Highway 400 during the 1:2-year through 1:100-year design storms and Regional (Hurricane Hazel) storm event. The spills occur when the capacity of the culverts under Highway 400 are exceeded. The excess surface runoff spills south through the west ditch of Highway 400 to the south branch. The south branch has sufficient capacity to convey the 1:5-year design storm peak flow plus spill downstream.

During the 1:10-year design storm and less frequent storm events, Bunkers Creek spills into Dyments Creek. The spill occurs along the west ditch of Highway 400, where surface runoff flows south to Dunlop Street and Dyments Creek. The interwatershed spills under the various design storm and Regional (Hurricane Hazel) storm event are summarized in the following table:

Table 12: Dyments Creek Flow Summary (Existing Conditions)

STORM	PEAK FLOW (NO SPILL)	PEAK FLOW (WITH SPILL)	SPILL
1:10 Year	13.8	14.4	0.6
1:25 Year	18.1	21.5	3.4
1:50 Year	21.4	26.7	5.3
1:100 Year	24.7	32.4	7.7
Regional	49.9	54.9	5.0

Note: Units – m³/s

4.2.3 Whiskey Creek – Hotchkiss Creek Interwatershed Flood Spill

The spills analysis predicts spills between the main branch of Whiskey Creek and a tributary of Whiskey Creek at Highway 400 during the Regional (Hurricane Hazel) storm event. The spill occurs when the capacity of the culverts under Highway 400 are exceeded. The excess surface runoff spills north along the roadway and through the east and west ditch of Highway 400 to the tributary.

During the Regional storm event, the tributary does not have sufficient capacity to convey the Regional storm event peak flow plus spill downstream and surface runoff spills north to Hotchkiss Creek. A spill of approximately 3.9 m³/s will occur from Whiskey Creek to Hotchkiss Creek during the Regional (Hurricane Hazel) storm. There is no spill predicted from Whiskey Creek under the 1:2-year to 1:100-year design storms as the existing Highway 400 culvert crossing has adequate capacity to convey the 1:100-year design storm peak flow.



4.2.4 Watershed Peak Flows

In the past, the LSRCA has delineated the floodplains of each creek under their jurisdiction assuming no interwatershed spills. In the case of Whiskey Creek, this is a conservative assumption. However, as the flood spill analysis demonstrates, the peak flows downstream of Highway 400 increase in Dyments Creek and Hotchkiss Creek when spills are considered. A summary of the peak flows with and without spills is provided in the following table.

Table 13: Existing Condition Peak Flows for Barrie Creeks Drainage Study Area

WATERSHED/ DRAINAGE AREA	STORM EVENT	PEAK FLOW (m³/s)	
		No Spill	With Spill
Kidd's Creek			
Main Branch	Hurricane Hazel	47.5	42.1
Tributary	Hurricane Hazel	0.8	5.6
Bunkers Creek			
North Branch	Hurricane Hazel	8.8	4.8
Central Branch	1:100 Year SCS	7.7	4.2
South Branch	Hurricane Hazel	14.1	15.9
Dyments Creek	Hurricane Hazel	49.9	54.9
Hotchkiss Creek	Hurricane Hazel	25.6	29.5
Whiskey Creek			
Main Branch	Hurricane Hazel	21.2	16.8
Tributary	Hurricane Hazel	2.4	3.3

Note: 6 hour SCS design storm governs

In consultation with the LSRCA and NVCA, it was decided that the worst case peak flows for each creek considering no spill and spill would be used for this study moving forward. In the case of Whiskey Creek there is no change to the peak flows as the worst case scenario excludes the spill out of the watershed. As such, the floodplain delineation for the creek is still valid. However, for Dyments Creek and Hotchkiss Creek, the most conservative approach includes the addition of spill from the adjacent watersheds to their peak flows downstream of Highway 400. A summary of the updated Regulatory peak flows for the Barrie Creeks study area is provided in the following table.



Table 14: Existing Condition Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area

WATERSHED/ DRAINAGE AREA	REGULATORY STORM EVENT	PEAK FLOW DOWNSTREAM OF HIGHWAY 400 (m ³ /s)
Kidd's Creek		
Main Branch	Hurricane Hazel	47.5
Tributary	Hurricane Hazel	5.6
Bunkers Creek		
North Branch	Hurricane Hazel	8.8
Central Branch	1:100 Year SCS	7.7
South Branch	Hurricane Hazel	15.9
Dyments Creek	Hurricane Hazel	54.9
Hotchkiss Creek	Hurricane Hazel	29.5
Whiskey Creek		
Main Branch	Hurricane Hazel	21.2
Tributary	Hurricane Hazel	3.3

Note: 6 hour SCS design storm governs.



5 Future Peak Flow Spill Analysis

For this study, the existing condition peak flows were increased by 20% to account for future development and/or intensification, climate change and as a safety factor (for partial culvert obstruction, storm sewer sizing, etc.). For the major drainage system Visual OTTHYMO model, the existing condition peak flows were simply increased by 20%. However, as PCSWMM is a dynamic unsteady state model, the peak flows could not simply be increased by 20%. To account for potential development, intensification and climate change as well as apply a safety factor, the rainfall data used in the PCSWMM model to generate peak flows was increased by 20%.

The future peak flow major drainage system hydrologic model results are summarized in Table 15 provided overleaf. The model updates and results are further described in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

The updated future peak flow PCSWMM minor drainage system model was used to establish the future deficiencies in the existing minor drainage system across the study area. For the purpose of this study, the deficiencies were identified for the 1:5-year 6 hour SCS design storms. The minor drainage system deficiencies are illustrated on Figures 6A through 10A - Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B. For this study, the storm sewer has been characterized based on the conveyance capacities outlined in Section 4 of this report.

Future peak flow HEC RAS hydraulic models of the creeks have been used to establish the future capacities of the existing major road culvert crossings, and consequently the level of service provided. The future capacities of the road crossing culverts are summarized in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B. The major drainage system deficiencies and the Regulatory floodplain are illustrated on Figure 6B through 10B included in the *Hydrologic & Hydraulic Modelling Technical Memorandum*.

The future peak flow PCSWMM minor drainage system model was also used to establish the future deficiencies in the existing overland flow routes throughout the study area. The results of the PCSWMM dual drainage system corresponding to the 1:100-year 6 Hour SCS design storm were evaluated against the safe access/egress criteria presented in Section 4. The overland flow routes that do not satisfy the aforementioned criteria are deficient. The deficient overland flow routes are illustrated on Figures 6B through 10B included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.



Table 15: Future Conditions Hydrologic Modelling Results Summary

WATERSHED/ DRAINAGE AREA	DRAINAGE AREA (ha)	REGULATORY STORM EVENT	PEAK FLOW AT OUTLET (m ³ /s)
Kidd's Creek	488	Hurricane Hazel	54.0
Bunkers Creek	361	Hurricane Hazel	42.6
Dyments Creek	616	Hurricane Hazel	62.6
Hotchkiss Creek	484	1:100 Year SCS (6 Hour)	79.5
Whiskey Creek	651	Hurricane Hazel	70.0
Johnson	83	1:100 Year SCS (6 Hour)	20.8
Nelson	62	1:100 Year SCS (6 Hour)	15.0
Rodney	29	1:100 Year SCS (6 Hour)	5.6
St. Vincent	36	1:100 Year SCS (6 Hour)	6.5
Williams	60	1:100 Year SCS (6 Hour)	12.9
Holgate	16	1:100 Year SCS (6 Hour)	3.4
Huronia	93	Hurricane Hazel	11.8
Minets	6	Hurricane Hazel	0.1
Little Lake	445	1:100 Year SCS (6 Hour)	47.3
Bear Creek	1,710	Timmins	63.3
Georgian Creek	270	1:100 Year SCS (6 Hour)	26.4
Lovers Creek	2,538	Hurricane Hazel	342.9
Hewitts Creek	762	Hurricane Hazel	130.1
Bayshore	50	1:100 Year SCS (24 Hour)	7.9
Gray Lane	19	1:100 Year SCS (6 Hour)	3.9
Royal Oak	14	1:100 Year SCS (6 Hour)	2.9

Note: The 20% future flow increase was applied to design storms only, not the Regional (Hurricane Hazel and Timmins) storm events.

5.1 INTERWATERSHED SPILLS ANALYSIS

The existing conditions spills analysis was updated to include the future peak flows to quantify the future peak flow spills between watersheds and the Regulatory peak flows downstream. The results of the future peak flows flood spill analysis are summarized in the following



sections. The flood spill analysis and results are further described in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

5.1.1 Kidd's Creek – Bunkers Creek Interwatershed Flood Spill

The spills analysis predicts a spill from Kidd's Creek during the Regulatory storm as described in Section 4.2.1. There is no spill predicted from Kidd's Creek under the 1:2-year to 1:100-year design storms as the existing Highway 400 culvert crossing has adequate capacity to convey the future 1:100-year design storm peak flow.

5.1.2 Bunkers Creek – Dyments Creek Interwatershed Flood Spill

The spills analysis predicts spills between the branches of Bunkers Creek (north branch, central branch, and south branch) upstream of Highway 400 during the 1:2-year through 1:100-year design storms and Regional (Hurricane Hazel) storm event. The spills occur when the capacity of the culverts under Highway 400 are exceeded. The excess surface runoff spills south through the west ditch of Highway 400 to the south branch. The south branch has sufficient capacity to convey the 1:5-year design storm peak flow plus spill downstream.

During the 1:10-year design storm and less frequent storm events, Bunkers Creek spills into Dyments Creek. The spill occurs along the west ditch of Highway 400, when surface runoff flows south to Dunlop Street and Dyments Creek. The interwatershed spills under the various design storm and Regional (Hurricane Hazel) storm event are summarized in the following table:

Table 16: Dyments Creek Flow Summary (Future Conditions)

STORM	PEAK FLOW (NO SPILL)	PEAK FLOW (WITH SPILL)	SPILL
1:10 Year	16.5	18.4	1.9
1:25 Year	21.8	26.7	4.9
1:50 Year	25.6	33.7	8.1
1:100 Year	29.6	39.6	10.0
Regional	49.9	54.9	5.0

Note: Units – m³/s

5.1.3 Whiskey Creek – Hotchkiss Creek Interwatershed Flood Spill

The spills analysis predicts spills between the main branch of Whiskey Creek and a tributary of Whiskey Creek at Highway 400 during the Regional (Hurricane Hazel) storm event as described in Section 4.2.3.



There is no spill predicted from Whiskey Creek under the 1:2-year to 1:100-year design storms as the existing Highway 400 culvert crossing has adequate capacity to convey the future conditions 1:100-year design storm peak flow.

5.1.4 Watershed Peak Flows

The worst case peak flows for each creek considering no spill and spill will be used for this study moving forward. A summary of the future peak flows with and without spills and the Regulatory peak flows for the Barrie Creeks study area is provided in the following tables.

Table 17: Future Condition Peak Flows for Barrie Creeks Drainage Study Area

WATERSHED/ DRAINAGE AREA	STORM EVENT	PEAK FLOW (m³/s)	
		No Spill	With Spill
Kidd's Creek			
Main Branch	Hurricane Hazel	47.5	42.1
Tributary	Hurricane Hazel	0.8	5.6
Bunkers Creek			
North Branch	Hurricane Hazel	8.8	4.8
Central Branch	1:100 Year SCS	9.2	5.3
South Branch	Hurricane Hazel	14.1	15.9
Dyments Creek	Hurricane Hazel	49.9	54.9
Hotchkiss Creek	Hurricane Hazel	25.6	29.5
Whiskey Creek			
Main Branch	Hurricane Hazel	21.2	16.8
Tributary	Hurricane Hazel	2.4	3.3

Note: 6 hour SCS design storm governs.



Table 18: Future Condition Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area

WATERSHED/ DRAINAGE AREA	REGULATORY STORM EVENT	PEAK FLOW DOWNSTREAM OF HIGHWAY 400 (m ³ /s)
Kidd's Creek		
Main Branch	Hurricane Hazel	47.5
Tributary		5.6
Bunkers Creek		
North Branch	Hurricane Hazel	8.8
Central Branch	1:100 Year SCS	9.2
South Branch	Hurricane Hazel	15.9
Dyments Creek	Hurricane Hazel	54.9
Hotchkiss Creek	Hurricane Hazel	29.5
Whiskey Creek		
Main Branch	Hurricane Hazel	21.2
Tributary		3.3

Note: 6 hour SCS design storm governs.



6 Spill Analysis with MTO's Proposed Highway 400 Improvements

As part of the proposed Highway 400 improvements, the MTO proposes to replace the existing culverts that do not satisfy their *Highway Drainage Design Standards* (2008). Highway 400 has been designated as a Freeway by the MTO and according to their designs standards the culverts/bridges are to be designed in accordance with the following flood hazard criteria:

- 1:50-year design storm peak flow for spans less than 6 m; and
- 1:100-year design storm peak flow for spans greater than 6 m.

It is understood that the culverts proposed within the limits of the City are less than 6 m in span and will be designed to convey the 1:50-year design storm peak flow, except for the Dyments Creek crossing. The Dyments Creek culvert is being designed to convey the 1:100-year design storm peak flow. The proposed culvert improvements from the MTO are as follows:

- Kidd's Creek (culvert 14) – existing culvert to remain;
- Bunkers Creek North Branch (culvert 143) – 2400 mm × 1830 mm conc. box culvert;
- Bunkers Creek Central Branch (culvert 142) – 4200 mm × 1500 mm conc. box culvert;
- Bunkers Creek South Branch (culvert 141) – Twin 1800 mm × 1200 mm conc. box culverts;
- Dyments Creek (culvert 33) – 9000 mm × 2000 mm conc. box culvert;
- Hotchkiss Creek main branch (culvert 46) – 1800 mm Dia. CSP lined with 1070 mm Dia. liner and new 2100 mm Dia. CSP; and
- Whiskey Creek main branch (culvert 55) – 2250 mm Dia. Conc. Culvert
- The improvements also include widening Highway 400 to 10 lanes, interchange improvements, centre median improvements to a standard concrete centre barrier, and drainage improvements including storm sewer.

As discussed, Highway 400 acts as a barrier to flow on several creeks through the City of Barrie. A number of the existing culverts do not have capacity to convey the expected flows under Highway 400 causing backwater conditions upstream. Flooding upstream can result in overtopping of Highway 400 during major storm events and interwatershed spills between Kidd's Creek, Bunkers Creek and Dyments Creek and Whiskey Creek and Hotchkiss Creek.

To assess the impact the proposed Highway 400 improvements have on the interwatershed spills, the existing conditions spill analysis was updated to include the proposed road cross-



section, road profile and culvert improvements. This analysis was completed to quantify the proposed interwatershed spills and the Regulatory peak flows downstream. The existing HEC RAS models were updated to include lateral structures at each spill location to quantify each spill and the resultant floodplain impacts downstream. A 2D hydraulic analysis was also completed in PCSWMM to verify the results of the HEC RAS spills analysis. The results of the flood spill analysis are summarized in the following sections. The flood spill analysis and results are further described in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

6.1.1 Watershed Peak Flows

Improving the existing culvert crossing at Whiskey Creek eliminates the interwatershed flood spill between Whiskey Creek and Hotchkiss Creek. The proposed culvert crossing (2250 mm Dia. concrete culvert) has adequate capacity to convey the Regional storm peak flow.

In the past, the LSRCA has delineated the floodplain of each creek under their jurisdiction assuming no interwatershed spills. In the case of Kidd's Creek, this is a conservative assumption. However, as the flood spill analysis demonstrates, the peak flows downstream of Highway 400 increase in Dyments Creek when spills are considered. A summary of the peak flows with and without spills under existing and future conditions with the proposed Highway 400 improvements in place is provided in the following tables.



Table 19: Existing Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements)

WATERSHED/ DRAINAGE AREA	STORM EVENT	PEAK FLOW (m³/s)	
		No Spill	With Spill
Kidd's Creek			
Main Branch	Hurricane Hazel	47.5	36.6
	1:100 Year SCS	6.0	6.0
Tributary	Hurricane Hazel	0.8	2.6
	1:100 Year SCS	1.6	1.6
Bunkers Creek			
North Branch	Hurricane Hazel	8.8	11.0
	1:100 Year SCS	8.2	7.6
Central Branch	Hurricane Hazel	6.9	5.3
	1:100 Year SCS	7.7	5.5
South Branch	Hurricane Hazel	14.1	13.3
	1:100 Year SCS	9.7	11.7
Dyments Creek			
	Hurricane Hazel	49.9	58.8
	1:100 Year SCS	24.7	25.7

Note: 6 hour SCS design storm governs.



Table 20: Future Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements)

WATERSHED/ DRAINAGE AREA	STORM EVENT	PEAK FLOW (m³/s)	
		No Spill	With Spill
Kidd's Creek			
Main Branch	Hurricane Hazel	47.5	36.6
	1:100 Year SCS	7.3	7.3
Tributary	Hurricane Hazel	0.8	2.6
	1:100 Year SCS	1.9	1.9
Bunkers Creek			
North Branch	Hurricane Hazel	8.8	11.0
	1:100 Year SCS	9.8	8.7
Central Branch	Hurricane Hazel	7.8	5.3
	1:100 Year SCS	9.2	6.4
South Branch	Hurricane Hazel	14.1	13.3
	1:100 Year SCS	11.6	12.4
Dyments Creek			
	Hurricane Hazel	49.9	58.8
	1:100 Year SCS	29.6	33.0

Note: 6 hour SCS design storm governs.

In consultation with the LSRCA and NVCA, it was decided that the worst case peak flows for each creek considering no spill and spill would be used for this study moving forward. In the case of Kidd's Creek there is no change to the peak flows as the worst case scenario excludes the spill out of the watershed. As such, the floodplain delineation for the creek is still valid. However, for Dyments Creek, the most conservative approach includes the addition of the spill from the adjacent watersheds to their peak flows downstream of Highway 400. A summary of the updated Regulatory peak flows for the Barrie Creeks study area under existing and future conditions is provided in the following tables.



Table 21: Existing Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements)

WATERSHED/ DRAINAGE AREA	REGULATORY STORM EVENT	PEAK FLOW DOWNSTREAM OF HIGHWAY 400 (m ³ /s)
Kidd's Creek		
Main Branch	Hurricane Hazel	47.5
Tributary	Hurricane Hazel	2.6
Bunkers Creek		
North Branch	Hurricane Hazel	11.0
Central Branch	1:100 Year SCS	7.7
South Branch	Hurricane Hazel	14.1
Dyments Creek	Hurricane Hazel	58.8

Note: 6 hour SCS design storm governs.

Table 22: Future Governing Regulatory Peak Flows for Barrie Creeks Drainage Study Area (with Highway 400 Improvements)

WATERSHED/ DRAINAGE AREA	REGULATORY STORM EVENT	PEAK FLOW DOWNSTREAM OF HIGHWAY 400 (m ³ /s)
Kidd's Creek		
Main Branch	Hurricane Hazel	47.5
Tributary	Hurricane Hazel	2.6
Bunkers Creek		
North Branch	Hurricane Hazel	11.0
Central Branch	1:100 Year SCS	9.2
South Branch	Hurricane Hazel	14.1
Dyments Creek	Hurricane Hazel	58.8

Note: 6 hour SCS design storm governs.



7 Screening of Improvement Options

For this study, a number of improvement options are being considered to address the problem statement and correct the noted deficiencies. The following improvement options were pre-screened:

7.1 FLOW REDUCTION/WATER QUALITY IMPROVEMENT OPTIONS

1. SWMF Retrofit/Expansion/Creation
2. Low Impact Development (LIDs)

7.2 CONVEYANCE CAPACITY IMPROVEMENT OPTIONS

1. Culvert Improvements
2. Watercourse Improvements
3. Minor Drainage System Improvements
4. Major Drainage System Improvements

The improvement options were reviewed and pre-screened based on their physical, natural, social, cultural and economic impacts to narrow the options into improvement alternatives that would be further evaluated, eliminating those options that produced negative impacts on the environment or the least positive impact compared against the other options providing the same function. The improvement options were divided into water quality/flow reduction improvement options and conveyance capacity improvement options as described in the following sections.

7.3 FLOW REDUCTION/WATER QUALITY IMPROVEMENT OPTIONS

Opportunities exist in the study area to implement SWM measures to attenuate flows, improve water quality and divert flows around areas susceptible to flooding. These opportunities include retrofitting, expanding and creating SWM detention facilities and implementing Low Impact Development (LID) measures. The water quality/flow reduction improvement options screened as part of this study are described in the following sections.

7.3.1 SWMF Retrofit/Expansion/Creation

As part of the *Storm Water Management Facilities (SWMF) Asset Management Plan and Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum*, SWMF retrofit, expansion and creation opportunities were evaluated,



recommended and prioritized. Similarly, the previously completed Master Drainage Plans also included recommendations for SWMF retrofit, expansion and creation. As part of this Drainage Master Plan, the previous studies and evaluations were reviewed and alternative SWMF retrofits, expansions and creations were considered.

From our review of the available background documents, an initial list of potential retrofit, expansion and creation opportunities was developed. The list was expanded to include SWMF's downstream of existing storm sewer outfalls where constructing a SWMF is feasible, beneficial and appropriate. A pre-screening evaluation was then completed for the SWMF's listed to establish those suitable to move forward as an alternative drainage solution. The list of SWMF's included in the pre-screening evaluation is provided in the following tables and their location is illustrated on Figure 8 - SWMF Retrofit/Creation Opportunities (Pre-Screening Evaluation) included in Appendix A.

Table 23: SWMF (Existing and Proposed Ponds) Pre-Screening Summary

EXISTING SWMF ID (RETROFIT NO.)					
BR07 (63)	KD03 (13)	HT06 (3)	KD06 (11)	DY02 (15)	HR01 (28)
WK01 (25)	WK04 (20)	BR05 (62)	HT13 (48)	DY01 (79)	BK03 (10)
JH01 (6)	DY03 (9)	KD02 (12)	KD05 (18)	HR02 (33)	HT03a (46)
HT03b (47)	LV01 (68)	LV18 (24)	LV03 (31)	LV05 (45)	LV02 (30)
LV06 (35)	LV09 (43)	LV08 (49)	LV12 (32)	GR01 (75)	BR13 (69)
LT01 (77)	BR08 (61)	GR04 (76)	BR01 (58)	LT06 (88)	LT05 (89)
LT03 (93)	LT04 (91)	LTGM (83)	HR03 (85)	LV10 (37)	BR14 (90)
WK05 (92)	LV16 (86)	LV17 (87)	LV07 (65)		

CREATION NO.	WATERSHED	LOCATION
44	Hotchkiss Creek	Between Morrow Rd. and Highway 400 north of Essa Rd.
17	Kidds Creek	Southwest of Bayfield St. between Coulter St. and Highway 400, in southeast corner of Sunnidale Park
39	Hotchkiss Creek	Between Patterson Rd. and Highway 400 east of Philips St.
26	Whiskey Creek	North of Big Bay Point Rd. and between Huronia Rd. and Pickett Crescent



CREATION NO.	WATERSHED	LOCATION
42	Whiskey Creek	Southeast corner of Montserrand St. and Beacon Rd.
38	Hotchkiss Creek	West of Patterson Rd. between Tiffin St. and Phillips St.
55	Hotchkiss Creek	North of Ardagh Rd.
40	Whiskey Creek	South of Chieftain Crescent
78	Dyments Creek	North of Dunlop St. West and west of Ferndale Industrial Dr.
81	Hotchkiss Creek	Upstream of Wood Street and BCR tracks (50 Wood St.)
80	Bunkers Creek	South of Shirley Ave. in Hwy 400 ROW along NE creek branch
82	Whiskey Creek	North of Harvie Road, upstream of Highway 400
34	Whiskey Creek	Southeast of Wilson Crt.
1	Bunkers Creek	Northeast corner of Vespra St. and Ellen St.
16	Kidds Creek	West of Coulter St. and northeast of Highway 400
19	Kidds Creek	Lillian Crescent southeast of Sinclair Crt.
41	Whiskey Creek	South of Chieftan Crescent and northeast of Fairview Rd.
51	Bunkers Creek	Between Vine Cres. And Shirley Ave.
52	Whiskey Creek	East of Bayview Dr.
56	Kidds Creek	South of Cundles Rd. W.
70	Hotchkiss Creek	South of Essa Road at Highway 400
71	Hotchkiss Creek	North corner of Essa Road and Highway 400 Interchange
73	Bunkers Creek	Southwest corner of Anne St. and Edgehill Dr
72	Bunkers Creek	Highway 400 and Dunlop St.
67	Lovers Creek	Drainage easement south of Ellis Drive
27	Hewitts Creek	Southeast corner of Walnut Crescent
22	Lovers Creek	West of Maclaren Ave. and South of Little Ave.
36	Lovers Creek	Between Peck St. and Cox Mill Rd.
66	Lovers Creek	Highway 400 and Maplevue Dr. W inside SE ramp loop
60	Bear Creek	North side of Loughheed Park, east of Bear Creek



CREATION NO.	WATERSHED	LOCATION
59	Bear Creek	Southern end of Girdwood Drive
14	Kidd's Creek	Northeast corner of Sunnidale Road and Highway 400
94	Bunkers Creek	Highway 400 and Dunlop Street
96	Hotchkiss Creek	Between Wood St. and BCRY tracks (50 Wood St.)

The pre-screening evaluation included a review of each stormwater management facility (SWMF) retrofit/expansion/creation opportunities impact on natural heritage features and natural hazards. The SWMF retrofit/expansion/creation opportunities were also pre-screened based on their impacts on water quality, phosphorus removal, flooding, erosion, safety and costs. The SWMF's were pre-screened and eliminated from further evaluation due to natural heritage constraints, steep slopes, erosion, limited drainage areas, potential flood impacts, property acquisition, and safety concerns. The SWMF's eliminated from further evaluation through the pre-screening process are summarized in the following table.

Table 24: SWMF's (Existing and Proposed Ponds) Eliminated from Further Evaluation

SWMF ID / CREATION NO.	JUSTIFICATION	SWMF ID / CREATION NO.	JUSTIFICATION
BR07 (63)	Online SWMF within Regulated Area	JH01 (6)	No SWMF present
DY03 (9)	Steep slopes with limited expansion opportunities	KD02 (12)	Removed – reconstruction not permitted online
HR02 (33)	Limited potential expansion opportunities, flood impacts	HT03a (46)	Limited drainage area
HT03b (47)	Limited drainage area	LV18 (24)	Retrofit would extend SWMF into Regulated Area
LV06 (35)	Greater retrofit opportunity upstream (LV07)	LV09 (43)	Underground storage on private property
LV08 (49)	Greater retrofit opportunity upstream (LV16 and LV17)	BR01 (58)	Online SWMF with limited opportunities for expansion
LT06 (88)	Existing wet pond providing normal treatment	LT03 (93)	Existing wet pond providing enhanced treatment
82	Conflicts with proposed Harvie Road improvements	34	Located within Regulated Area



SWMF ID / CREATION NO.	JUSTIFICATION	SWMF ID / CREATION NO.	JUSTIFICATION
1	Relative location to Kempenfelt Bay	16	Located within Regulated Area
19	Insufficient area to provide measurable impact	41	Online SWMF not permitted by LSRCA
51	Steep slopes, online SWMF not permitted by the LSRCA	52	Property acquisition, steep slopes.
56	Online SWMF not permitted by the LSRCA	70	Located within limits of future Hwy 400 widening
71	Located within limits of future Hwy 400 widening	73	Insufficient area to provide measurable impact
67	Online SWMF not permitted by LSRCA	22	Property acquisition, upstream of existing SWMF
36	Located in Regulated Area	66	Located within limits of future Hwy 400 widening
60	Located on school property	59	Online SWMF not permitted by NVCA
14	Steeps slopes, immediately upstream of SWMF KD01	39	Backwater condition, located in Regulated Area
38	Insufficient outlet	55	Steep slopes, Natural Heritage Feature
80	Located within limits of future Hwy 400 widening		

The remaining SWMF retrofit/creation opportunities are recommended for further evaluation as an alternative drainage solution and are being carried forward in this study. A list of the SWMF's recommended for further evaluation as an alternative drainage solution is provided in the following tables and are identified on Figure 9 - SWMF Retrofit/Creation Opportunities (To Be Evaluated) provided in Appendix A.



Table 25: SWMF's (Existing and Proposed Ponds) Recommended for Further Evaluation

EXISTING SWMF ID (RETROFIT NO.)					
WK01 (25)	LV03 (31)	LV05 (45)	GR01 (75)	BR13 (69)	LT01 (77)
GR04 (76)	LT05 (89)	LTGM (83)	LT04 (91)	KD05 (18)	BK03 (10)
BR14 (90)	BR05 (62)	LV16 (86)	LV17 (87)	LV07 (65)	LV12 (32)
LV10 (37)	HR03 (85)	HT13 (48)	LV02 (30)	WK05 (92)	LV01 (68)
KD03 (13)	HT06 (3)	KD06 (11)	DY02 (15)	HR01 (28)	DY01 (79)
WK04 (20)	BR08 (61)				

CREATION NO.	WATERSHED	LOCATION
44	Hotchkiss Creek	Between Morrow Rd. and Highway 400 north of Essa Rd.
17	Kidd's Creek	Southwest of Bayfield St. between Coulter St. and Highway 400, in southeast corner of Sunnisdale Park
26	Whiskey Creek	North of Big Bay Point Rd. and between Huronia Rd. and Pickett Crescent 1229
42	Whiskey Creek	Southeast corner of Montserrand St. and Beacon Rd.
40	Whiskey Creek	Northeast corner of Chieftan Crescent
78	Dyments Creek	North of Dunlop St. W and west of Ferndale Industrial Dr.
27	Hewitts Creek	Southeast corner of Walnut Crescent
94	Bunkers Creek	Highway 400 and Dunlop St.
81	Hotchkiss Creek	Upstream of Wood Street and BCRY tracks (50 Wood St.)
96	Hotchkiss Creek	Between Wood St. and BCRY tracks (50 Wood St.)
72	Bunkers Creek	Highway 400 and Dunlop St.

7.3.2 Low Impact Development (LID) Measures

From a review of the available background reports, specifically the *Evaluation of Low Impact Development Stormwater Technologies for the Uncontrolled Urban Areas in the Lake Simcoe Region* (Ryerson University, March 2010), the implementation of Low Impact Development (LID) measures is feasible in the study area, including infiltration trenches, perforated pipe systems, bioretention facilities, rain water harvesting and porous pavement. The



implementation of wide scale and extensive LID measures is limited by the existing groundwater and soil conditions in the study area. The implementation of Low Impact Development (LID) measures is also constrained by the known wellhead protection areas, intake protection zones and groundwater recharge areas in the City. The known wellhead protection areas (WHPA), intake protection areas, groundwater recharge areas and soils groups across the City are illustrated on Figures 10 through 12 provided in Appendix A.

For this study, the implementation of LID measures involving infiltration was not recommended in WHPA-A and WHPA-B. This is consistent with the recommendations of the *Low Impact Development Stormwater Management Planning and Design Guide* (2010). However, implementing infiltration LID measures throughout the remainder of the study area was considered. Within WHPA-A and WHPA-B, perforated pipe systems wrapped in an impervious liner to prevent infiltration was considered. The wrapped perforated pipe systems will intercept runoff and provide peak flow attenuation, however there is no water quality or water balance benefits. Opportunities exist to construct LID measures as follows:

1. Underground within existing parkland (centralized LIDs);
2. As part of road reconstruction (linear LIDs);
3. Future development; and
4. Lot level LIDs (rainwater harvesting and soakaway pits).

The implementation of linear LIDs within the municipal road allowance is recommended for local roads only. This is consistent with the recommendations of the *Low Impact Development Stormwater Management Planning and Design Guide* (2010).

For centralized LIDs, all of the parks within the City were considered. The list of parks was reduced through an initial review of the background data based on the parks location, programs, land availability, drainage area, etc. through consultation with the City. After the initial review, a list of parks was created for further consideration as part of our pre-screening evaluation. The list of 38 parks included in the pre-screening evaluation is provided in the following table and their location is illustrated on Figure 13 - Centralized LID Opportunities (Pre-Screening Evaluation) provided in Appendix A.

As part of the pre-screening evaluation of the centralized LIDs, the elevation of the bottom of the underground infiltration chamber system proposed in each park was determined based on available record drawings for the storm sewer that could be directed to the parks. The parks with underground infiltration chamber system bottoms greater than 6 m below existing grade were eliminated from further evaluation.



Table 26: Centralized LIDs - Pre-Screening Evaluation

PARK		
Victoria Woods Park	Shear Park	Shoreview Park
Leacock Park	Greenfield Park	Blair Park
Assikinack Park	Pringle Park	Montserrand Park
Elizabeth Park	Harvie Park	Mapleton Park
Sunnidale Park	Gibbon Park	Cloughley Park
Allandale Heights Park	Bear Creek Park	Cheltenham Park
Batteaux Park	Lougheed Park	East Bayfield Park
Ferndale Park	Dunsmore Park	Marsellus Park
Wessenger Park	Strabane Park	Cartwright Park
Emms Park	Golden Meadow Park	Queensway/Hyde Park
Sandringham Park	Shalom Park	Bayshore Park
D'Ambrosio Park	Madelaine Park	Catherine Park
Kuzmich Park	Carter Park	

For the remaining parks, the available soils information and groundwater levels were reviewed to determine if the bottom of the proposed underground infiltration chamber system is above the estimated groundwater levels. The parks with underground infiltration chamber system bottoms below the estimated groundwater level were eliminated from further evaluation. The parks eliminated from further evaluation through the pre-screening process are summarized in the following table:



Table 27: Centralized LIDs Eliminated from Further Evaluation

PARK	JUSTIFICATION
Victoria Woods Park	Depth of infiltration system greater than 6 m
Leacock Park	High groundwater
Shear Park	High groundwater
Elizabeth Park	High groundwater
Pringle Park	High groundwater
Blair Park	High groundwater
Batteaux Park	High groundwater
Ferndale Park	High groundwater
Shalom Park	High groundwater
Emms Park	Depth of infiltration system greater than 6 m
Cheltenham Park	Depth of infiltration system greater than 6 m
D'Ambrosio Park	High groundwater
Bayshore Park	Depth of infiltration system greater than 6 m
Catherine Park	High groundwater
East Bayfield Park	High groundwater
Marsellus Park	Depth of infiltration system greater than 6 m

The remaining parks are recommended for further evaluation as an alternative drainage solution and are being carried forward in this study. A list of the 22 parks recommended for further evaluation as an alternative drainage solution is provided in the following table and their locations are illustrated on Figure 13 – Centralized LID Opportunities (Pre-Screening Evaluation) provided in Appendix A.



Table 28: Centralized LIDs Recommended for Further Evaluation

PARK		
Carter Park	Madelaine Park	Shoreview Park
Kuzmich Park	Greenfield Park	Sandringham Park
Assikinack Park	Queensway/Hyde Park	Montserrand Park
Cartwright Park	Harvie Park	Mapleton Park
Sunnidale Park	Gibbon Park	Cloughley Park
Allandale Heights Park	Bear Creek Park	Golden Meadow Park
Wessenger Park	Lougheed Park	Starbane Park
Dunsmore Park		

The hydrologic analysis was updated to consider the inclusion of the LID measures given the assumptions described above and to evaluate the effectiveness of the LID measures to attenuate peak flows in the study area. The results of the analysis indicate that LID measures could reduce the major storm peak flows by 2% to 7% throughout the study area, with an average reduction of 3%. As such, while beneficial from a water quality and water balance perspective the benefit from a quantity control and major drainage system storm infrastructure perspective is limited. The results of the hydrologic analysis including the LID measures are summarized in the *Hydrologic & Hydraulic Modelling Technical Memorandum* included in Appendix B.

Although the LID measures do not significantly reduce major system flows, they do attenuate peak flows from the more frequent storm events, potentially reducing frequent nuisance flooding. The LID measures also effectively treat stormwater and improve the water balance at a relatively low capital cost without changing the existing land use/surface features.

The LID measures considered result in a positive impact on the environment, however they do not provide the quantity control that the SWM detention facilities option does. LID measures may be implemented as capital improvement projects proceed (i.e. road reconstruction projects, intensification corridor redevelopment, and in the available parkland) where feasible under each improvement alternative considered. Lot level controls (soakaway pits, infiltration trenches, and downspout disconnection) and rainwater harvesting should also be encouraged throughout the study area.



Given the restrictions to implementing LID techniques in the study area, calculations have been performed to establish realistic objectives for the LID measures listed above. The results are presented in the evaluation of this alternative solution in subsequent sections.

7.4 CONVEYANCE CAPACITY IMPROVEMENTS OPTIONS

As described in the previous MDP's and background documents, there are opportunities in the study area to implement conveyance capacity improvements to reduce flooding on both private and municipal property. These opportunities include culvert improvements, watercourse improvements, major drainage system improvements and minor drainage system improvements. The conveyance capacity improvement options presented as part of this study are described in the following sections

7.4.1 Culvert Improvements

As part of the previous MDP's and background reports, culvert improvements were recommended as outlined in Section 1.2 of this report. It was recommended that local road and collector/arterial road culvert crossings be designed with differing design flood frequency criteria in each watershed. The City has updated design standards (*Storm Drainage and Stormwater Management Policies and Design Guidelines*, 2009) stipulating generally stricter design flood frequency criteria and rainfall data adjusted to account for climate change.

The updated existing condition HEC RAS hydraulic models of the creeks have been used to establish the existing capacities of the major road culvert crossings, and consequently the level of service provided. The deficient road crossing culverts are summarized in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B. The culvert crossing deficiencies are illustrated on Figure 1B through 5B included in the *Hydrologic & Hydraulic Modelling Technical Memorandum*.

The culvert improvements identified are considered to each be of benefit and are being carried forward for further analysis in combination with the watercourse improvements discussed below.

7.4.2 Watercourse Improvements

Similar to the culvert improvements, the previous MDP's and background studies recommended watercourse improvements as outlined in Section 1.2 of this report. With the changes in the City's design standards and the need to improve maintenance access along each watercourse and improve water quality throughout the study area, the previously recommended watercourse improvements have been considered along with several new watercourse improvements that are being evaluated as part of this study.



The watercourse improvements are being carried forward for further analysis in combination with the culvert improvements discussed previously.

7.4.3 Major Drainage System Improvements

As identified in the background reports and models, runoff from minor and major storm events can surcharge the storm sewers in the City and flood private and municipal property. The flooding has caused historic damage to both private and municipal property and causes concern for public safety. Opportunities exist to construct trunk storm sewers within the municipal road allowance to supplement the existing storm sewer or replace the existing storm sewer with larger sewer capable of conveying the peak flows from major storm events.

The trunk storm sewer improvement options are being carried forward for further analysis in combination with the culvert and watercourse improvements previously discussed.

For this study, the major overland flow conveyance deficiencies have been evaluated using the dual drainage system in PCSWMM and standardized road cross-sections between storm structures. The cross-sections do not necessarily match existing conditions, however, they do provide a reasonable estimate of the overland flow depths and velocities along the roadway during major storm events. The results provide a good indication of where major overland flow deficiencies exist, however, it is recommended that solutions to address the major overland deficiencies be evaluated in more detail as part of future road reconstruction projects and improvements be made where feasible.

A number of the deficiencies will be addressed through the implementation of the alternative drainage solutions. For those that remain outstanding, consideration should be given to oversizing the storm sewers and/or adjusting the road profile/cross-sections as part of road reconstruction projects. A list of the major overland deficiencies is provided in the *Hydrologic & Hydraulic Modelling Technical Memorandum* included in Appendix B. The list includes the overland flow depths and velocities and identifies the exceedance in the safe access/egress criteria used to identify major overland flow route deficiencies.

7.4.4 Minor Drainage System Improvements

The existing storm infrastructure in the study area is reaching its service life expectancy and deteriorating. A majority of the aging storm sewers are undersized considering historic rainfall data and current climate models predict future increases in rainfall intensities and volumes. In some locations, municipal storm infrastructure is located on private property outside the municipal right-of-way making it difficult to access and maintain. For these reasons, replacement of storm infrastructure throughout the City is strongly suggested. As such, as a general requirement for all capital projects, it is recommended that consideration of upsizing



the local storm sewers to satisfy current design standards be considered as part of future road reconstruction projects. Included with this study is the minor system PCSWMM storm model that includes the current sizing and estimated capacities of the local system. This modeling should be consulted when evaluating replacement alternatives. The minor drainage system deficiencies are illustrated on Figures 1A through 5A - Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.

Similarly, relocating storm sewer onto municipal property and specifically the road allowance should also be considered. There are areas in the City of Barrie where storm sewer is located on private property making it difficult to access and maintain. Relocating the storm sewer to the municipal road allowance as part of future road reconstruction projects should be considered.

Through our review of the drainage systems, we have identified several areas and streets in the study area that are absent of minor drainage systems. After reviewing these areas, it was determined that appropriate outlets are available to allow minor drainage systems to be built that would service these areas. As such, it is recommended that consideration be given to service these areas with storm sewer as part of future road reconstruction projects. The areas/streets absent of minor drainage systems are illustrated on Figures 1A through 5A - Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B.



8 Description of Overall Improvement Alternatives

Integral to the planning process is the consideration and evaluation of alternatives to address the problem statement and where possible correct the noted deficiencies. The improvement alternatives developed as part of this study are described in the following sections.

8.1 EXISTING CONDITIONS

8.1.1 Alternative 1A – “Do Nothing” Minor Drainage Systems

The “Do Nothing” alternative allows for the consideration of not implementing any changes to the existing minor drainage system infrastructure within the study area. This alternative is being considered to provide a benchmark to gauge the physical, natural, social, cultural, and economic implications of the other alternatives.

8.1.2 Alternative 1B – “Do Nothing” Major Drainage Systems

The “Do Nothing” alternative allows for the consideration of not implementing any changes to the existing major drainage system infrastructure within the study area. This alternative is being considered to provide a benchmark to gauge the physical, natural, social, cultural, and economic implications of the other alternatives. If this alternative were selected, consideration should be given by the City to acquiring the private properties or interests therein (easements) that are impacted by flooding to comply with the City of Barrie Drainage Policies.

8.2 FLOW REDUCTION/WATER QUALITY IMPROVEMENTS

8.2.1 Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control

An opportunity exists to retrofit and expand existing stormwater management facilities and construct new stormwater management facilities within the City of Barrie to improve water quantity control, attenuate peak flows and reduce downstream flooding. Opportunities exist to expand existing SWMF’s to increase the available storage and decrease release rates into the downstream creeks and drainage systems. Similarly, end-of-pipe and on-line SWMF’s may be constructed at locations absent of any water quantity controls. Also, the SWMF retrofits and new SWMF’s can be designed to improve watershed water quality, promote infiltration and improve the water balance to meet the objective of Alternative 2B. The implementation of specific SWMF retrofits and creation of new SWMF’s in some cases will require the purchase of private property or acquiring interest therein (easements) to accommodate the improvements,



attenuate peak flows, reduce downstream flooding, improve water quality and provide for maintenance access.

8.2.2 Alternative 2B – Retrofit/New Stormwater Management Facilities for Quality Control

An opportunity exists to retrofit existing stormwater management facilities and construct new stormwater management facilities within the City of Barrie to improve watershed water quality, promote infiltration and improve the water balance. Opportunities exist to retrofit existing dry ponds to include an LID component or convert them into wet ponds or wetlands. Similarly, end-of-pipe SWMF's may be constructed at locations absent of any water quality controls upstream of the existing creeks. The implementation of specific SWMF retrofits and creation of new SWMF's will in some cases require the purchase of private property or acquiring interest therein (easements) to accommodate the improvements, improve water quality and provide for maintenance access.

8.2.3 Alternative 2C – Lot Level Low Impact Development

An opportunity exists to promote the use of lot level Low Impact Development measures on private property across the City to promote infiltration, improve the water balance and watershed water quality. Opportunities exist to promote the use of rain barrels and implementation of soakaway pits by residents and property owners in the City of Barrie.

8.2.4 Alternative 2D – Linear Low Impact Development

An opportunity exists to implement linear Low Impact Development measures to attenuate peak flows, promote infiltration, and improve the water balance and watershed water quality throughout the City. Opportunities exist to implement perforated pipe systems or infiltration systems as part of local road reconstruction projects and intensification in the City of Barrie.

8.2.5 Alternative 2E – Centralized Low Impact Development

An opportunity exists to implement centralized Low Impact Development measures throughout the City to attenuate peak flows, promote infiltration, and improve the water balance and watershed water quality. Opportunities exist to implement bio-retention facilities and infiltration galleries within existing parkland and at locations absent of any water quantity or quality controls in the City of Barrie.



8.3 CONVEYANCE CAPACITY IMPROVEMENTS

8.3.1 Alternative 3A – Culvert/Watercourse/Major Drainage System Improvements (MDP Recommended Design Flood Frequency Criteria)

Culvert and watercourse improvements can be implemented along the main channels of the various Creeks in the study area in accordance with the recommendations of the original MDPs. The culvert improvements would satisfy the 1:25 year design storm peak flow as a minimum. The watercourse improvements would reduce flooding of existing buildings and/or property where feasible for storms less than and equal to the design flood frequency criteria applied. In some cases, the implementation of specific culvert and watercourse improvements will require the purchase of private properties or acquiring interest therein (easements) to accommodate the improvements, reduce flooding of existing buildings, and provide for maintenance access.

8.3.2 Alternative 3B – Culvert/Watercourse/Major Drainage System Improvements (City Design Flood Frequency Criteria)

Under this alternative, the same culvert and watercourse improvements can be implemented along the various Creeks as described under Alternative 3A. However, the culvert improvements would satisfy the City's design flood frequency criteria as a minimum. As the roads in the study area are generally classified as local urban/collector and arterial roads, the design flood frequency criteria are the 1:50-and 1:100-year design storm peak flows, respectively. Similarly, the watercourse improvements would reduce flooding of existing buildings and/or property where feasible. The implementation of specific culvert and watercourse improvements will require the purchase of private properties or acquiring interest therein (easements) to accommodate the improvements, reduce flooding of existing buildings, and provide for maintenance access.



9 Public Consultation – Public Information Centre (PIC#1)

For the Barrie Drainage Master Plan, public consultation was completed in accordance with the Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). The public consultation undertaken leading up to and including Public Information Centre #1 (PIC#1) for this study is outlined in the following sections.

9.1 NOTICE OF STUDY COMMENCEMENT AND PUBLIC INFORMATION CENTRE

A Public Information Centre (PIC) was held Thursday, November 2, 2017 at the Dorian Parker Center (227 Sunnidale Road) to present drainage deficiencies identified through the study, elicit input/feedback regarding any additional drainage deficiencies not identified through the study, and to present the preliminary alternative design solutions to the identified drainage issues in the study area. At the PIC, local residents, business owners and interested stakeholders were presented maps identifying the various drainage deficiencies across the City and the preliminary alternative design solutions and encouraged to provide input / feedback regarding the study. Comment sheets were provided and attendees were encouraged to identify their preferences regarding the alternative design solutions. The PIC presentation materials are enclosed in Appendix J for reference.

Prior to the PIC, a Draft Environmental Assessment document was made available for public review at the Barrie Public Library (Downtown and Painswick Branch), City of Barrie Clerk's Office and City of Barrie Engineering. The document was also made accessible via the City's webpage. Also, a notification letter was distributed October 23, 2017 to local residents and stakeholders presenting the alternative drainage solutions and notifying them of the PIC. The notification included a copy of the PIC comment sheet to provide everyone with an opportunity to provide input / comments regarding the study. The notification letter is enclosed in Appendix J for reference.

9.2 RESULTS OF PUBLIC CONSULTATION

The Discretionary Public Information Centre (PIC#1) was attended by 54 interested stakeholders and 35 written comments were provided. Of the 35 written comments provided, a number were related to lot grading and development issues outside the scope of this project. However, of the 35, 19 identified a preliminary preferred alternative solution(s). A copy of the



PIC attendance sheet as well as the comments received are available in Appendix J for reference.

9.3 IDENTIFIED DRAINAGE ISSUES

During the PIC, a number of attendees identified drainage issues they have witnessed in the City. Also, the comments received included a number of additional drainage issues throughout the study area. Of note, the following drainage issues were identified by the public and interested stakeholders:

- Flooding of Bradford St. in the Hotchkiss Creek watershed during major storm events;
- Erosion of Kidd's Creek through Donald Park;
- Erosion of Kidd's Creek between Donald St. and Henry St.;
- Erosion and ponding water at inlet of SWMF KD06;
- Flooding of White Oaks Road, The Boulevard, Brennan Avenue and private property in the Whiskey Creek Watershed during major storm events;
- Obstructed culverts causing backwater conditions and roadway overtopping;
- Sedimentation issues within reaches of several watercourses; and
- Streets absent of minor drainage systems.

9.4 PUBLIC PREFERENCE

The majority of public response preferred a combination of alternative drainage solutions to address the identified drainage issues. Implementing the flow reduction/water quality improvement options (Alternatives 2A, 2B, 2C, 2D and 2E) in combination with the culvert/watercourse/major drainage system improvements (Alternatives 3A or 3B) are the public preference.

A summary of the public and agency preferred alternative drainage solution(s) is included in the following tables:



Table 29: Public Consultation Preliminary Preferred Alternative Solution

RESPONDENT	PRELIMINARY PREFERRED ALTERNATIVE SOLUTION(S)
Respondent 2	Alternative 2A
Respondent 3	Combination of Alternative 2A, 2B, 2D, 2E, 3A and 3B
Respondent 4	Combination of Alternative 2C, 3A and 3B
Respondent 5	Combination of Alternative 2A, 2B, 2C, 2D and 3B
Respondent 6	Combination of Alternative 2A, 2E and 3B
Respondent 9	Alternative 2C
Respondent 10	Alternative 2A
Respondent 12	Combination of Alternative 2A and 3B
Respondent 14	Combination of Alternative 2C, 2D and 2E
Respondent 16	Combination of Alternative 2A, 2B, 3A and 3B
Respondent 17	Combination of Alternative 2D, 2E and 3B
Respondent 18	Combination of Alternative 2A, 3A and 3B
Respondent 22	Alternative 2C
Respondent 24	Combination of Alternative 2A, 2D, 2E, and 3A
Respondent 25	Combination of Alternative 2D, 2E and 3B
Respondent 27	Combination of Alternative 2A, 2B and 3B
Respondent 29	Combination of Alternative 2A, 2B, 2C, 2D, and 2E
Respondent 30	Combination of Alternative 2A, 2B, 2C, 2D, 2E, 3A and 3B
Respondent 33	Combination of Alternative 2B and 3A

Not every respondent identified a preferred alternative solution or combination of solutions. However, for those who did, they generally preferred a combination of alternative drainage solutions. The respondent preference is presented in the following table.



Table 30: Public Consultation Respondent Preference

ALTERNATIVE SOLUTION	RESPONDENT PREFERENCE
Alternative 2A	63%
Alternative 2B	37%
Alternative 2C	37%
Alternative 2D	42%
Alternative 2E	42%
Alternative 3A	37%
Alternative 3B	58%

9.5 PRIVATE PROPERTY DRAINAGE ISSUES

There were a number of comments received from the public related to private property drainage issues. Ultimately surface or groundwater related drainage issues on private property or between two or more private properties is the responsibility of the private property owners. Dealing with the issues raised by these comments is outside the scope of this study. However, some general comments and recommendations are presented for consideration.

The City plays a role in reducing private property drainage issues as part of the development review process and the best practice is to minimize the issues during the planning/construction phases. Current practices are to review development applications for conformance to current standards and guidelines. With the City currently beginning a period of intense development in the secondary plan areas, it is important to design those new areas with sufficient measures to prevent future local/private drainage issues. From the comments received and from experience in other locations, we provide the following general recommendations for further consideration by the City:

1. Basement floors are to be set a minimum of 0.3 meters above seasonal high groundwater levels in new developments as per the City's guidelines. However, often times the groundwater monitoring data used in design is insufficient to establish the seasonal high groundwater levels. The City should consider prescribing the duration of groundwater monitoring required to determine the seasonally high groundwater level. Where that monitoring period cannot be met, the separation between basement grades and estimated seasonally high groundwater levels should be increased. It is recommended that the City review their standards regarding separation between basement floors and seasonal high



groundwater levels and their groundwater monitoring requirements as part of its next standards update.

2. The City has provisions in the drainage guideline for construction of a third pipe system to provide a stormwater service. Given the movement to smaller lots sizes with less greenspace available for infiltration, the City should consider more wide spread application of the third pipe system in new development or intensification applications. This will prevent surface runoff from causing issues on private property or being directed illegally to the sanitary sewer system.



10 Overall Improvement Alternatives Assessment

To assess the effectiveness of the overall improvement alternatives considered, the existing conditions minor and major drainage system models of the study area have been revised to include the proposed improvement alternatives. The results of the analysis, specifically the reductions in peak flows, reduction in phosphorus loading rates, required culvert sizes, and flooding impacts under each improvement alternative are discussed in the subsequent sections. As outlined in the previous alternative screening section, the implementation of minor drainage system improvements have been carried through as a recommendation and are to be brought forward for evaluation regardless of the other alternatives suggested.

10.1 EXISTING CONDITIONS

10.1.1 Alternative 1A – “Do Nothing” Minor Drainage Systems

Alternative 1A represents the “do nothing” alternative and generally does not meet the City of Barrie design standards. Undersized storm sewer results in frequent nuisance flooding throughout the study area and safety concerns. Municipal infrastructure located on private property is difficult to access and maintain and will require increased maintenance and ultimately replacement as the infrastructure continues to age and deteriorate. Areas absent of minor drainage systems are subjected to frequent nuisance flooding, ponding water, and safety concerns. With current climate models predicting increases in the frequency and intensity of significant storm events and due to the extent of the minor drainage system deficiencies throughout the study area, the implementation of this alternative has been eliminated.

10.1.2 Alternative 1B – “Do Nothing” Major Drainage Systems

Alternative 1B represents the “do nothing” alternative and generally does not meet the City of Barrie design standards unless significant property acquisition is completed to remove potential flood-prone properties from the floodplain. The assessed property values of the 551 private properties identified within the floodplain total \$349,559,000. Because the extent of flooding, particularly through the downtown core and developed areas, is extensive and currently encompasses a significant amount of residential and commercial properties, the implementation of this alternative has been eliminated as it is not practical due to economic and social implications.

Simply purchasing the private properties within the floodplain will not eliminate the drainage deficiencies across the City. The drainage deficiencies will persist. The risk to private property



will simply be removed as the flood prone properties will now be owned by the City. However, additional risks such as public safety will persist at deficient culvert crossings and along deficient overland flow routes where safe access egress is not provided. Channel erosion will continue, the water quality in the various creeks and Lake Simcoe will diminish and the maintenance requirements of the City will increase.

10.2 FLOW REDUCTION/WATER QUALITY IMPROVEMENTS

10.2.1 Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control

The Visual OTTHYMO hydrologic model of the major drainage catchments in the study area has been revised to include the contemplated SWMF retrofit/creation opportunities. The hydrologic model results and the stage-storage-discharge tables developed for the proposed SWMF's are included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference. The flow reductions in the SWMFs where retrofits were deemed to have a measurable improvement to water quantity resulting from the implementation of Improvement Alternative 2A are summarized in the following table:

Table 31: Flow Reduction Hydrologic Model Results Summary (SWMF Retrofits) – Alternative 2A

SWMF ID (RETROFIT NO.)	FLOW REDUCTION (m ³ /s / %)									
	2 Year		5 Year		25 Year		100 Year		Regional	
BK03 (10)	0.81	50.2%	0.88	33.7%	1.04	23.6%	1.03	16.9%	0.48	11.8%
KD06 (11)	0.86	35.6%	0.77	19.5%	0.38	5.5%	0.24	2.5%	1.81	29.7%
RO#26 (WK)	1.35	70.7%	1.39	44.6%	0.85	16.2%	0.70	9.6%	0.03	0.8%
RO#40 (WK)	0.26	72.1%	0.46	75.4%	0.68	63.1%	0.60	39.7%	-0.57	39.5%
RO#42 (WK)	0.78	90.7%	1.29	87.2%	1.30	50.0%	1.18	32.1%	0.01	0.6%
RO#44 (HT)	1.15	45.6%	1.06	26.2%	0.61	9.2%	0.04	0.4%	0.01	0.2%
HT13 (48)	0.14	1.1%	0.31	1.7%	0.67	2.6%	1.24	3.9%	0.24	0.7%
LT01 (77)	1.24	43.6%	2.16	45.3%	3.54	42.8%	4.39	39.4%	0.41	6.8%
RO#78 (DY)	0.00	0.0%	0.65	19.9%	1.91	37.2%	3.88	49.6%	9.38	58.3%
DY01 (79)	0.91	12.2%	2.73	23.3%	5.61	27.7%	6.61	23.7%	0.81	2.1%
RO#81 (HT)	0.20	2.9%	2.29	18.0%	10.17	44.8%	18.76	57.8%	1.72	7.2%
RO#84 (HT)	0.00	0.0%	0.65	5.7%	1.71	11.9%	2.53	15.7%	0.33	1.4%
HR03 (85)	1.94	93.2%	1.56	56.0%	1.67	40.5%	1.93	36.2%	0.01	0.4%
RO#94 (BK)	0.60	31.6%	0.64	19.9%	1.10	20.0%	2.28	29.0%	-0.77	-14.3%



The analysis demonstrates that the proposed SWMF's considered under Alternative 2A result in a measurable reduction in peak flow immediately downstream of each SWMF, with the exception of SWMF HT13.

Although the primary objective of Alternative 2A is to provide peak flow attenuation and reduce downstream peak flows, secondary benefits are provided. The water quantity control SWMF's listed above may provide additional water quality treatment and phosphorus reduction. To evaluate the potential water quality improvements resulting from each proposed SWMF retrofit/creation, calculations were performed to determine the level of treatment provided in accordance with the MECP design guidelines. To establish the potential reduction in phosphorus loading for each proposed SWMF retrofit/creation, the NVCA and MECP P-Tools were updated to include the proposed SWMF's. The results of the analysis are summarized in the following table and included in the Assessment of Stormwater Management Facilities and Low Impact Development Measures to Reduce Phosphorus Discharges Technical Memorandum enclosed in Appendix K for reference.

Table 32: Water Quality Treatment / Phosphorus Reduction Summary – Alternative 2A

SWMF ID (RETROFIT NO.)	LEVEL OF TREATMENT		PHOSPHORUS REDUCTION (kg/year)		
	Existing	Proposed	Existing	Proposed	Δ
BK03 (10)	< 60%	80%	5.0	35.4	+30.4
KD06 (11)	< 60%	80%	7.8	67.7	+59.9
RO#26 (WK)	N/A	80%	0.0	30.1	+30.1
RO#40 (WK)	N/A	80%	0.0	33.6	+33.6
RO#42 (WK)	N/A	80%	0.0	30.0	+30.0
RO#44 (HT)	N/A	80%	0.0	69.8	+69.8
HT13 (48)	N/A	< 60%	0.0	0.0	0.0
LT01 (77)	< 60%	80%	12.2	77.0	64.8
RO#78 (DY)	N/A	60%	0.0	0.0	0.0
DY01 (79)	< 60%	70%	184.1	184.1	0.0
RO#81 (HT)	N/A	60%	0.0	0.0	0.0
RO#96 (HT)	N/A	< 60%	0.0	0.0	0.0
HR03 (85)	< 60%	80%	1.2	7.8	+6.6
RO#94 (BK)	N/A	60%	0.0	8.3	8.3
Total					333.5



The analysis demonstrates that the proposed SWMF's retrofits considered under Alternative 2A result in a total additional phosphorus reduction of 333.5 kg/year.

Project cost estimates have been prepared for Improvement Alternative 2A. The project cost estimates are included in Appendix L and summarized in the following table:

Table 33: Project Cost Estimates – Alternative 2A

SWMF	PROJECT COST	SWMF	PROJECT COST
BK03 (10)	\$2,918,000	LT01 (77)	\$7,041,000
KD06 (11)	\$3,971,000	RO#78 (DY)	\$5,360,000
RO#26 (WK)	\$1,993,000	DY01 (79)	\$10,201,000
RO#40 (WK)	\$1,118,000	RO#81 (HT)	\$11,126,000
RO#42 (WK)	\$3,606,000	RO#96 (HT)	\$1,012,000
RO#44 (HT)	\$7,356,000	HR03 (85)	\$3,211,000
HT13 (48)	\$3,869,000	RO#94 (BK)	\$5,297,000
Total			\$68,079,000

Note: Excludes property acquisition costs of properties within floodplain (\$349,599,000); Property Value – 2018 Assessed Value (MPAC)

10.2.2 Alternative 2B – Retrofit/New Stormwater Management Facilities for Quality Control

Alternative 2B focused on the SWMF retrofits and new ponds being created for the primary purpose of water quality improvement. To evaluate the potential water quality improvements resulting from each proposed SWMF retrofit/creation, calculations were performed to determine the level of treatment provided in accordance with the MECP design guidelines. To establish the potential reduction in phosphorus loading for each proposed SWMF retrofit/creation, the NVCA and MECP P-Tools were updated to include the proposed SWMF retrofits and creations. The results of the analysis are summarized in the following table and included in the Assessment of Stormwater Management Facilities and Low Impact Development Measures to Reduce Phosphorus Discharges Technical Memorandum enclosed in Appendix K for reference.



Table 34: Water Quality Treatment / Phosphorus Reduction Summary – Alternative 2B

SWMF ID (RETROFIT NO.)	LEVEL OF TREATMENT		PHOSPHORUS REDUCTION (kg/year)		
	EXISTING	PROPOSED	EXISTING	PROPOSED	Δ
HT06 (03)	60%	80%	4.4	38.4	+34.0
KD03 (13)	< 60%	80%	4.0	34.4	+30.4
DY02 (15)	60%	80%	2.5	21.6	+19.1
RO#17 (KD)	N/A	80%	0.0	100.5	+100.5
KD05 (18)	60%	80%	3.1	26.5	+23.4
WK04 (20)	80%	80%	12.8	12.8	0.0
WK01 (25)	< 60%	80%	10.1	17.4	+7.3
RO#27 (HW)	N/A	80%	0.0	29.2	+29.2
HR01 (28)	60%	70%	4.0	25.0	+21.0
LV02 (30)	< 60%	60%	26.9	169.3	+142.4
LV03 (31)	60%	80%	1.4	8.6	+7.2
LV12 (32)	<60%	80%	4.0	34.9	+30.9
LV10 (37)	60%	80%	2.5	21.5	+19.0
LV05 (45)	<60%	60%	11.1	11.1	0.0
BR08b (61)	<60%	80%	7.5	47.4	+39.9
BR05 (62)	< 60%	70%	3.7	23.1	+19.4
LV07 (65)	60%	80%	11.7	101.8	+90.1
LV01 (68)	60%	80%	62.7	62.7	0.0
BR13 (69)	< 60%	80%	5.3	33.4	+28.1
GR01 (75)	< 60%	60%	6.7	42.3	+35.6
GR04 (76)	< 60%	70%	14.2	89.3	+75.1
LTGM (83)	80%	80%	37.0	37.0	0.0
LV16 (86)	60%	80%	0.5	3.7	+3.2
LV17 (87)	60%	80%	4.0	30.9	+26.9



SWMF ID (RETROFIT NO.)	LEVEL OF TREATMENT		PHOSPHORUS REDUCTION (kg/year)		
	EXISTING	PROPOSED	EXISTING	PROPOSED	Δ
LT05 (89)	< 60%	80%	25.3	25.3	0.0
BR14 (90)	60%	80%	54.8	54.8	0.0
LT04 (91)	60%	80%	66.1	66.1	0.0
WK05 (92)	60%	80%	88.5	133.8	+45.3
BK04 (95)	80%	80%	31.3	31.3	0.0
Total					828

The analysis demonstrates that the proposed SWMF's considered under Alternative 2B result in a total additional phosphorus reduction of 828 kg/year.

Although the primary objective of Alternative 2B is to provide improved water quality control and reduce downstream phosphorus loading, secondary benefits are provided. The water quality treatment SWMF's may provide water quantity control benefits. To evaluate the potential flow reduction provided under Alternative 2B, the Visual OTTHYMO hydrologic model of the major drainage catchments in the study area has been revised to include the contemplated SWMF retrofit/creation opportunities. The hydrologic model results and the stage-storage-discharge tables developed for the proposed SWMF's are included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference. The flow reductions resulting from the implementation of Improvement Alternative 2B are summarized in the following table:

Table 35: Flow Reduction Hydrologic Model Results Summary – Alternative 2B

SWMF ID (RETROFIT NO.)	FLOW REDUCTION (m ³ /s / %)									
	2 YEAR		5 YEAR		25 YEAR		100 YEAR		REGIONAL	
KD03 (13)	0.02	1.3%	0.05	2.3%	0.10	2.5%	0.19	3.5%	0.00	0.0%
DY02 (15)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
RO#17 (KD)	1.23	36.9%	0.9	17.5%	0.98	12.1%	0.94	8.8%	0.04	0.9%
KD05 (18)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
WK04 (20)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
WK01 (25)	0.93	10.8%	0.68	5.2%	3.37	16.8%	3.54	10.3%	7.04	13.7%



SWMF ID (RETROFIT NO.)	FLOW REDUCTION (m ³ /s / %)									
	2 YEAR		5 YEAR		25 YEAR		100 YEAR		REGIONAL	
RO#27 (HW)	0.91	91.7%	1.40	79.0%	1.94	59.1%	2.07	42.6%	0.02	0.5%
HR01 (28)	0.32	9.0%	0.31	6.0%	0.17	2.1%	0.43	3.9%	0.00	0.0%
LV02 (30)	0.03	0.4%	0.05	0.3%	0.05	0.2%	0.36	1.2%	0.06	0.2%
LV03 (31)	0.36	71.2%	0.54	70.9%	0.61	47.4%	0.47	27.1%	0.01	1.4%
LV12 (32)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LV10 (37)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LV05 (45)	0.37	12.7%	0.34	7.2%	0.71	8.6%	0.55	4.7%	0.02	0.2%
BR08b (61)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
BR05 (62)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LV07 (65)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LV01 (68)	0.21	7.9%	0.46	10.2%	1.43	17.5%	0.75	6.4%	0.00	0.0%
BR13 (69)	0.93	40.6%	0.80	35.2%	0.98	24.9%	1.31	23.3%	0.02	0.4%
GR01 (75)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
GR04 (76)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LTGM (83)	2.43	55.6%	1.95	29.0%	1.34	12.5%	1.23	8.5%	0.04	0.8%
LV16 (86)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LV17 (87)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LT05 (89)	0.42	41.8%	0.48	28.9%	0.25	8.6%	0.05	1.3%	0.01	0.4%
BR14 (90)	0.35	14.0%	0.75	19.1%	1.15	17.4%	1.74	19.2%	0.18	2.6%
LT04 (91)	0.15	2.2%	0.09	0.8%	0.16	0.8%	1.17	4.5%	0.55	5.2%
WK05 (92)	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%

The analysis demonstrates that the proposed SWMF's considered under Alternative 2B result in a reduction in peak flow that generally vary between 0% and 40% immediately downstream of each SWMF. On a watershed basis, the flow reductions resulting from the implementation of Improvement Alternative 2A and 2B in combination are summarized in the following table:



Table 36: Flow Reduction Hydrologic Model Results Summary (Watershed) – Alternative 2A and 2B in Combination

WATERSHED / DRAINAGE AREA	FLOW REDUCTION (m ³ /s / %)									
	2 Year		5 Year		25 Year		100 Year		Regional	
Kidd's Creek	0.50	11.9%	0.54	8.4%	0.35	3.5%	0.23	1.7%	0.00	0.0%
Bunkers Creek	0.63	6.1%	0.42	2.8%	0.75	3.8%	2.24	7.1%	0.22	0.5%
Dyments Creek	0.23	6.1%	0.85	11.0%	2.73	14.5%	7.08	21.7%	-4.08	-6.5%
Hotchkiss Creek	5.44	30.7%	9.11	31.8%	20.34	42.6%	33.0	49.8%	10.28	17.1%
Whiskey Creek	0.49	7.1%	-0.86	-8.8%	-6.34	-41.4%	-8.73	-40.1%	0.00	0.0%
Little Lake	0.87	28.4%	1.61	26.6%	3.31	26.5%	6.60	33.9%	0.00	0.0%
Bear Creek	0.18	7.3%	0.30	5.6%	0.47	4.2%	0.58	3.4%	0.00	0.0%
Huronian Creek	0.28	18.1%	0.22	12.0%	0.27	11.7%	0.28	10.2%	0.00	0.0%
Georgian Creek	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Lovers Creek	0.00	0%	0.33	1.2%	0.39	0.7%	0.55	0.6%	1.74	0.7%
Hewitts Creek	-0.01	-0.1%	-0.01	-1.1%	-0.02	-0.1%	-0.03	-0.1%	-0.48	-0.5%

Note: - valve represents an increase in peak flow.

The HEC RAS hydraulic models of the various creeks throughout the study area were revised to include the reduced peak flows under Alternative 2A and 2B in combination. This was completed to evaluate the impact the reduced peak flows have on the level of service provided by the existing road culvert crossings. The analysis demonstrates that the level of service provided by the road culvert crossings considering flow reduction from Alternative 2A and 2B alone still does not generally satisfy the City's current design flood frequency criteria or the previous recommendations of the MDP. The flow reduction alone improves but does not eliminate flooding of existing buildings and/or properties along the watercourses. As such, additional improvements are required. The hydraulic model results for the culvert crossings considering Alternative 2A and 2B in combination are included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix A for reference.

Project cost estimates have been prepared for SWMF Improvement Alternative 2B. The project cost estimates are included in Appendix L and summarized in the following table:



Table 37: Project Cost Estimates – Alternative 2B

SWMF	PROJECT COST	SWMF	PROJECT COST
HT06 (03)	Project Completed	BR05 (62)	\$417,000
KD03 (13)	\$1,650,000	LV07 (65)	\$3,969,000
DY02 (15)	\$1,312,000	LV01 (68)	\$3,767,000
RO#17	\$2,936,000	BR13 (69)	\$7,041,000
KD05 (18)	\$2,189,000	GR01 (75)	\$621,000
WK04 (20)	\$259,000	GR04 (76)	\$1,252,000
WK01 (25)	\$1,118,000	LTGM (84)	\$6,768,000
RO#27	\$1,786,000	LV16 (86)	\$316,000
HR01 (28)	\$2,638,000	LV17 (87)	\$520,000
LV02 (30)	\$2,078,000	LT05 (89)	\$1,232,000
LV03 (31)	\$402,000	BR14 (90)	\$1,317,000
LV12 (32)	\$1,126,000	LT04 (91)	\$898,000
LV10 (37)	\$1,125,000	WK05 (92)	\$2,754,000
LV05 (45)	\$2,193,000	BR08b (61)	\$816,000
Total		Total	\$52,500,000

Note: Excludes property acquisition costs of properties within floodplain (\$349,599,000); Property Value – 2018 Assessed Value (MPAC)

10.2.3 Alternative 2C – Lot Level Low Impact Development

The potential impact of lot level Lot Impact Development measures was evaluated as Alternative 2C. Calculations were performed to determine the impact lot level Low Impact Development measures have on runoff volumes, peak flows and phosphorus loading throughout the City. The PCSWMM minor drainage system hydrologic/hydraulic model was updated to include lot level LIDs (soakaway pits and rain barrels) throughout the study area. The preliminary design concept for the soakaway pits utilized in the PCSWMM model are illustrated on Figure 14 provided Appendix A. The results of the analysis are summarized in the following table and included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.



Table 38: Infiltration Summary – Alternative 2C

WATERSHED / DRAINAGE AREA	Δ INFILTRATION (mm)	PEAK FLOW REDUCTION (m³/s / %) – 100 YEAR STORM		PHOSPHORUS REDUCTION (kg/year)
Kidd's Creek	0.16	0.04	0.7%	0.43
Bunkers Creek	0.10	0.11	0.6%	0.31
Dyments Creek	0.09	0.01	0.1%	0.29
Hotchkiss Creek	0.04	0.25	2.3%	0.24
Whiskey Creek	0.12	0.13	0.9%	0.37
Johnson	0.23	N/A		0.11
Nelson	0.23	N/A		0.08
Rodney	0.23	N/A		0.03
St. Vincent	0.21	N/A		0.04
Williams & Holgate	0.19	N/A		0.08
Huronia	0.17	N/A		0.07
Minets	0.26	N/A		0.01
Little Lake	0.28	0.34	3.3%	0.33
Bear Creek	0.10	0.04	0.7%	0.02
Georgian Creek	0.28	0.26	5.1%	0.39
Lovers Creek	0.12	0.38	1.9%	0.42
Hewitts Creek	0.07	0.20	3.0%	0.28
Bayshore	0.21	N/A		0.04
Gray Lane	0.05	N/A		0.03
Royal Oak	0.05	N/A		0.02
Total				3.59

It's noted that a majority of the runoff directed to the lot level LIDs is generated from roof tops and the runoff is considered clean. As such, the lot level LIDs have limited potential to reduce phosphorus loadings across the City.

10.2.4 Alternative 2D - Linear Low Impact Development

The implementation of linear LID measures was also evaluated. Calculations were performed to establish realistic objectives for linear LIDs implemented in the study area. The PCSWMM minor



drainage system hydrologic/hydraulic model was updated to include linear LIDs on all local roads throughout the study area. The preliminary design concepts for the linear LIDs utilized in the PCSWMM model are illustrated on Figure 15A and 15B provided in Appendix A. The results of the analysis are summarized in the following table and included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

Table 39: Infiltration Summary – Alternative 2D

WATERSHED / DRAINAGE AREA	DRAINAGE AREA (ha)	INCREASE IN INFILTRATION (mm)	ROAD AREA (ha)	*TARGET CONTROL VOLUME (mm)
Kidd's Creek	488.3	1.02	20.2	24
Bunkers Creek	360.4	0.91	21.1	15
Dyments Creek	579.92	0.66	16.5	23
Hotchkiss Creek	483.4	0.36	13.7	12
Whiskey Creek	638.4	0.92	21.0	25
Johnson	82.6	0.85	4.5	15
Nelson	61.7	2.31	5.3	25
Rodney	29.0	2.50	3.3	22
St. Vincent	35.9	1.07	1.6	24
Williams & Holgate	84.1	0.91	3.1	24
Huronia	93.0	1.79	6.7	24
Minets	6.3	3.32	0.7	25
Little Lake	445.1	1.44	26.4	24
Bear Creek	1699.8	0.79	64.3	21
Georgian Creek	270.4	1.77	21.0	22
Lovers Creek	1636.1	0.16	51.8	5
Hewitts Creek	516.9	0.40	30.3	7
Bayshore	50.0	0.52	4.1	6
Gray Lane	19.3	0.52	1.6	6
Royal Oak	14.1	0.61	1.4	6

* Average Infiltration of road runoff through Linear LID implementation



Linear LIDs installed as part of road reconstruction projects or in intensification corridors can generally intercept the first 5 mm to 25 mm of runoff from a storm event depending on the site conditions and constraints. This satisfies at a minimum Alternative 2 of the LSRCA's flexible treatment alternative for sites with restrictions criteria, specifically a minimum of 5 mm runoff volume reduction. As can be seen from the results, many areas can exceed the 5 mm minimum target and approach the 25 mm target.

Linear LIDs installed as part of road reconstruction projects or in the intensification corridors should be designed to intercept the target control volume listed in Table 39 from a storm event. This satisfies Alternative 2 of the LSRCA's flexible treatment alternative for sites with restrictions criteria, specifically a minimum 5 mm runoff volume reduction.

The hydrologic analysis was updated to consider the inclusion of LIDs given the assumptions described above and evaluate the effectiveness of the LIDs to attenuate peak flows in the study area. The results of the analysis are summarized in the following table and included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

Table 40: Flow Reduction Hydrologic Model Results Summary – Alternatives 2D

WATERSHED / DRAINAGE AREA	FLOW REDUCTION (m ³ /s / %)					
	25 mm Storm		5 Year Storm		100 Year Storm	
Kidd's Creek	0.06	4.3%	0.37	11.3%	0.11	1.8%
Bunkers Creek	0.26	7.3%	0.38	4.8%	0.83	4.7%
Dyments Creek	0.05	4.1%	0.08	2.5%	0.07	1.1%
Hotchkiss Creek	0.25	5.4%	0.12	1.5%	0.50	4.6%
Whiskey Creek	0.73	19.7%	0.44	5.7%	0.30	3.1%
Little Lake	0.76	34.2%	1.37	27.3%	2.07	11.7%
Bear Creek	0.00	0.0%	0.00	0.0%	0.00	0.0%
Georgian Creek	0.33	36.7%	0.11	5.1%	0.50	11.2%
Lovers Creek	0.13	8.0%	0.26	7.0%	0.97	5.0%
Hewitts Creek	0.07	17.9%	0.03	11.2%	1.1	16.2%

The results of the analysis indicate that linear LIDs could reduce the major storm peak flows by 1% to 16% throughout the study area during major storm events. As such, while beneficial from



a water quality and water balance perspective the benefit from a water quantity control and major drainage system storm infrastructure perspective is limited.

Although the linear LIDs do not significantly reduce major system flows, they do attenuate peak flows from the more frequent storm events, reducing frequent nuisance flooding. The linear LIDs also effectively treat stormwater and improve the water balance at a relatively low cost without changing the existing land use/surface features.

To establish the potential reduction in phosphorus loading from the implementation of linear LIDs in the study area, the NVCA and MECP P-Tools were updated to include the linear LIDs. The results of the analysis are summarized in the following table and included in the Assessment of Stormwater Management Facilities and Low Impact Development Measures to Reduce Phosphorus Discharges Technical Memorandum enclosed in Appendix K for reference.



Table 41: Project Cost Estimates – Alternative 2D

WATERSHED / DRAINAGE AREA	UNIT PRICE	AREA OF LOCAL ROADS (ha)	CONSTRUCTION ESTIMATE
Kidd's Creek	*\$62,800 / ha	20.2	\$1,269,000
Bunkers Creek		21.1	\$1,326,000
Dyments Creek		16.5	\$1,037,000
Hotchkiss Creek		13.7	\$861,000
Whiskey Creek		21.0	\$1,319,00
Johnson		4.5	\$283,000
Nelson		5.3	\$333,000
Rodney		3.3	\$208,000
St. Vincent		1.6	\$101,000
Williams & Holgate		3.1	\$195,000
Huronina		6.7	\$421,000
Minets		0.7	\$44,000
Little Lake		26.4	\$1,658,000
Bear Creek		64.3	\$4,039,000
Georgian Creek		21.0	\$1,319,000
Lovers Creek		51.8	\$3,254,000
Hewitts Creek		30.3	\$1,903,000
Bayshore		4.1	\$258,000
Gray Lane		1.6	\$101,000
Royal Oak		1.4	\$88,000
Total			\$20,017,000

*Source: Low Impact Development Stormwater Management Planning and Design Guide (CVC and TRCA, 2010); Unit price is per impervious hectare treated and excludes engineering fees, contract administration/inspection fees, utility relocation costs, and contingencies.

It is noted, the acquisition of private property is not required for this alternative.



10.2.5 Alternative 2E – Centralized Low Impact Development

Centralized LIDs have been recommended in several areas (parks) and calculations were performed to establish realistic objectives for centralized LIDs implemented in the study area. The PCSWMM minor drainage system hydrologic/hydraulic model was updated to include the centralized LIDs recommended for the parks identified in Table 28. The preliminary design concepts for the centralized LIDs utilized in the PCSWMM model are consistent with the City of Barrie Draft Underground Infiltration Chamber System (Drawing BSD-1502) and utilized either infiltration chambers or perforated CSP/HDPE pipe. The results of the analysis are summarized in the following table and included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.



Table 42: Infiltration Summary – Alternative 2E

PARK	DRAINAGE AREA (ha)	STORAGE VOLUME (m ³)	RUNOFF VOLUME CAPTURED (mm)	PHOSPHORUS REDUCTION (kg/year)
Carter Park	4.6	313	6.8	6.0
Kuzmich Park	1.3	116	8.9	0.9
Assikinack Park	7.3	546	7.5	9.7
Cartwright Park	3.1	209	6.7	6.1
Sunnidale Park	7.7	190	1.9	10.9
Allandale Heights Park	2.5	69	1.7	3.2
Wessenger Park	9.3	635	6.8	17.0
Dunsmore Park	16.1	928	5.8	14.7
Madelaine Park	5.6	487	8.7	7.0
Greenfield Park	27.1	1353	5.0	30.3
Queensway/Hyde Park	42.3	2242	5.3	64.5
Harvie Park	2.5	180	7.2	3.1
Gibbon Park	4.3	143	3.3	5.6
Bear Creek Park	73.0	4592	6.3	129.8
Lougheed Park	14.6	999	6.8	28.2
Shoreview Park	20.3	944	4.7	29.1
Sandringham Park	79.4	2342	3.0	100.1
Montserrand Park	12.3	959	7.8	13.5
Mapleton Park	2.1	179	8.5	2.6
Cloughley Park	1.5	105	7.0	1.9
Golden Meadow Park	34.0	2380	7.0	41.4
Starbane Park	4.9	243	5.0	8.4



The results of the analysis indicate that centralized LIDs could reduce the major storm peak flows by 1% to 5% throughout the study area. As such, while beneficial from a water quality and water balance perspective the benefit from a water quantity control perspective and the major drainage system storm infrastructure in the study area is limited.

Although the centralized LIDs do not significantly reduce major system flows, they do attenuate peak flows from the more frequent storm events, reducing frequent nuisance flooding. The centralized LIDs also effectively treat stormwater and improve the water balance at a relatively low cost without changing the existing land use/surface features.

Table 43: Flow Reduction Hydrologic Model Results Summary – Alternatives 2E

WATERSHED / DRAINAGE AREA	FLOW REDUCTION (m ³ /s / %)					
	25 mm Storm		5 Year Storm		100 Year Storm	
Kidd's Creek	0.00	0.0%	0.01	0.2%	0.00	1.5%
Bunkers Creek	0.00	0.0%	0.00	0.1%	0.00	0.1%
Dyments Creek	0.00	0.0%	0.00	0.0%	0.00	0.0%
Hotchkiss Creek	0.00	0.0%	0.00	0.1%	0.06	0.6%
Whiskey Creek	0.14	3.7%	0.10	1.3%	0.14	0.9%
Little Lake	0.01	0.2%	0.17	7.9%	0.33	3.3%
Bear Creek	0.00	0.0%	0.00	0.0%	0.00	0.0%
Georgian Creek	0.05	5.1%	0.06	2.2%	0.18	3.5%
Lovers Creek	0.05	2.9%	0.31	5.9%	2.41	3.1%
Hewitts Creek	0.00	0.0%	0.00	0.0%	0.51	0.0%

To establish the potential reduction in phosphorus loading from the implementation of centralized LIDs in the study area, the NVCA and MECP P-Tools were updated to include the centralized LIDs. The results of the analysis are summarized in the following table and included in the Assessment of Stormwater Management Facilities and Low Impact Development Measures to Reduce Phosphorus Discharges Technical Memorandum enclosed in Appendix K for reference.



Table 44: Phosphorus Reduction Summary – Alternatives 2C through 2E

WATERSHED / DRAINAGE AREA	PHOSPHORUS REDUCTION (kg/year)		
	LOT LEVEL LIDS (2C)	LINEAR LIDS (2D)	CENTRALIZED LIDS (2E)
Kidd's Creek	0.4	52.8	9.7
Bunkers Creek	0.3	47.0	4.9
Dyments Creek	0.3	40.5	1.7
Hotchkiss Creek	0.2	36.7	2.8
Whiskey Creek	0.3	25.1	26.4
Johnson	0.1	11.9	29.4
Nelson	0.1	14.7	0.0
Rodney	0.0	7.9	0.0
St. Vincent	0.0	4.2	0.0
Williams	0.01	8.0	0.0
Holgate	0.1	0.0	0.0
Huron	0.1	16.3	26.8
Minets	0.0	1.8	0.0
Little Lake	0.3	291.5	6.1
Bear Creek	0.0	594.8	155.6
Georgian Creek	0.4	217.1	23.1
Lovers Creek	0.4	85.8	55.3
Hewitts Creek	0.3	51.0	55.5
Bayshore	0.0	5.5	0.0
Gray Lane	0.0	4.2	0.0
Royal Oak	0.0	3.9	0.0
Total	3.31	1520.7	397.3



Preliminary construction cost estimates have been developed for the preliminary design concepts. The project cost estimates are summarized in the following table and are enclosed in Appendix L for reference:

Table 45: Project Cost Estimates – Alternative 2E

CENTRALIZED LID	CONSTRUCTION ESTIMATE	CENTRALIZED LID	CONSTRUCTION ESTIMATE
Allandale Heights Park	\$303,000	Golden Meadow Park	\$3,100,000
Assikinack Park	\$862,000	Kuzmich Park	\$306,000
Cloughley Park	\$516,000	Madelaine Park	\$819,000
Gibbon Park	\$378,000	Queensway/Hyde Park	\$3,167,000
Greenfield Park	\$1,855,000	Sandringham Park	\$3,361,000
Harvie Park	\$467,000	Bear Creek Park	\$9,112,000
Mapleton Park	\$331,000	Cartwright Park	\$303,000
Montserrand Park	\$1,361,000	Dunsmore Park	\$2,027,000
Shoreview Park	\$1,412,000	Lougheed Park	\$2,057,000
Sunnidale Park	\$298,000	Strabane Park	\$563,000
Carter Park	\$568,000	Wessenger Park	\$1,188,000
Total			\$34,350,000

It is noted, the acquisition of private property is not required for this alternative.

10.3 CONVEYANCE CAPACITY IMPROVEMENTS

As discussed, the level of service provided by the road culvert crossings does not generally satisfy the City's current design flood frequency criteria or the previous recommendations of the MDP even with the flow reduction from implementing Alternatives 2A through 2E. The flow reduction of 2A through 2E alone does not eliminate flooding of existing buildings and/or properties along the watercourses. As such, conveyance capacity improvements are required. To evaluate the merits of conveyance capacity improvements required under Alternative 3A and 3B, the flow reductions resulting from the proposed SWMF retrofits/creation (Alternatives 2A and 2B) were considered as being implemented.



10.3.1 Alternative 3A – Culvert/Watercourse/Major Drainage System Improvements (MDP Recommended Design Flood Frequency Criteria)

The existing condition HEC RAS hydraulic models of the various creeks were updated to include the flow reductions resulting from the proposed SWMF retrofits/creation to determine the culvert sizes and watercourse improvements required to satisfy the recommended design flood frequency criteria in the previously completed Master Drainage Plans. A summary of the required culvert sizes is presented in the following table and the detailed model results are included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

Table 46: Culvert Improvement Summary – Alternative 3A

CULVERT ID & LOCATION		SIZE	CAPACITY (m ³ /s)	LEVEL OF SERVICE
16	Thomson St.	1800 mm x 900 mm conc. box culvert	3.9	1:100 Year
18	Wellington St.	1345 mm x 855 conc. Elliptical culvert	2.5	1:100 Year
22	Innisfil St.	10.06 m open bottom span structure	28.7	1:100 Year
23	Commercial Plaza Entrance Road	Twin 7.62 m open bottom span structures	29.7	1:100 Year
30	Sarjeant Dr.	Twin 3000 mm x 1500 mm conc. box culverts	18.0	1:100 Year
31	Highway 400 E/W-S and N-E/W Ramp	9000 mm x 1500 mm conc. box culvert (MTO)	29.6	1:100 Year
32	Hart Dr.	10.67 m open bottom span structure	31.6	1:100 Year
33	Highway 400	9000 mm x 2000 mm conc. box culvert	54.0	Regional
34	George St.	Twin 3600 mm x 1800 mm conc. box culverts	32.2	1:100 Year
35	Victoria St.	Culvert crossing to be removed		
36	Anne St. S. / John St.	Extend twin 3000 mm x 2100 mm conc. box culverts	28.9	1:100 Year
37	Innisfil St.	6.71 m open bottom span structure	29.6	1:50 Year



CULVERT ID & LOCATION		SIZE	CAPACITY (m ³ /s)	LEVEL OF SERVICE
38	Sanford St.	4200 mm × 2100 mm conc. box culvert	23.6	1:50 Year
39	Bradford St.	10.67 m open bottom span structure	29.5	Regional (Controlled)
46	Highway 400	1800 mm Dia. conc. culvert (existing culverts to remain)	29.6	1:100 Year
50	Innisfil St.	3962 mm × 2134 mm conc. box culvert	37.3	1:100 Year
55	Highway 400	2250 mm dia. conc. pipe	8.0	Regional
57	Bayview Dr.	Twin 2400 mm × 900 mm conc. box culvert	8.2	1:50 Year
147	Railway Crossing	Twin 1800 mm dia. conc. culvert	29.2	1:100 Year
138	Railway Crossing	3000 mm dia. conc. culvert	37.6	1:100 Year
65	The Boulevard	10.67 m open bottom span structure	37.3	1:100 Year
66	Brennan Ave.	Twin 9.14 m open bottom span structures	37.4	1:100 Year
126	Railway Crossing	Twin 2100 mm dia. conc. culverts	26.0	Regional
123	Railway Crossing	1500 mm dia. conc. culvert	10.2	1:100 Year
134	Railway Crossing	Triple 525 mm dia. HDPE culverts	<0.1	<1:2-Year

The analysis demonstrates that the level of service provided by the improved road culvert crossings under this alternative generally satisfies or exceeds the City's current design flood frequency criteria.

The proposed watercourse conveyance improvements under this improvement alternative were also determined to be required to meet the Design Flood Frequency criteria and are summarized as follows:

1. Watercourse Improvement No. 25 – Daylight Kidd's Creek through 150 Dunlop St. W. between Eccles St. and Dunlop St. W. (Reach Ki-11);



2. Watercourse Improvements No. 26 – Daylight Kidd's Creek through 125 Dunlop St. W. between Dunlop St. W. and Bradford St. (Reach Ki-11);
3. Watercourse Improvements No. 7 – Construct watercourse from future Highway 400 E/W-N ramp to Anne St. S. to convey Bunkers Creek (central and south branch) 1:100-year peak flows;
4. Watercourse Improvements No. 27 – Natural watercourse enhancement on Bunkers Creek to increase conveyance capacity, habitat and canopy downstream of the Commercial Plaza Entrance Road to Lakeshore Drive;
5. Watercourse Improvements No. 29 – Realign Dyments Creek from Sproule Drive to Dunlop St. W.;
6. Watercourse Improvements No. 9 – Realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. (Reach Dy-2a);
7. Watercourse Improvements No. 10 – Re-grade/shape Dyments Creek from Ferndale Dr. N. to Sarjeant Dr. to increase conveyance capacity and drainage (Reach Dy-2b);
8. Watercourse Improvements No. 11 – Daylight Dyments Creek through 65 Hart Drive downstream of Hart Drive (Reach Dy-3);
9. Watercourse Improvements No. 28 – Watercourse improvements on Dyments Creek to increase conveyance capacity and decrease flooding downstream of Bradford St. to Lakeshore Drive;
10. Watercourse Improvements No. 6 – Daylight Hotchkiss Creek through 128 Anne St. S. and 134 Tiffin St. between Anne St. S. and Tiffin St. (Reach Ho-8);
11. Watercourse Improvements No. 13 – Daylight Hotchkiss Creek through 108 and 120 Tiffin St. between Anne St. S. and Innisfil St. (Reach Ho-9);
12. Watercourse Improvements No. 15 – Realign Whiskey Creek from Harvie Rd. to Highway 400 (Reach Wh-3);
13. Watercourse Improvements No. 30 – Watercourse improvements on Whiskey Creek to increase conveyance capacity and reduce flooding (Reaches Wh-4a through Wh-4c);
14. Watercourse Improvements No. 31 – Realign Whiskey Creek between Huronia Rd. And SWMF WK01;
15. Watercourse Improvements No. 32 – Watercourse improvements on Whiskey Creek to increase conveyance capacity downstream of Little Ave. (Reach Wh-9);



16. Watercourse Improvements No. 20 – Re-grade/shape Whiskey Creek between The Boulevard and Brennan Ave. to increase conveyance capacity (Reach Wh-10); and
17. Watercourse Improvements No. 21 – Re-grade/shape Whiskey Creek between Brennan Ave. and Kempenfelt Bay to increase conveyance capacity (Reach Wh-10).

In addition to the watercourse conveyance improvements, watercourse improvements to address bank erosion, scour and deposition are also recommended in the study area from the conclusions of the fluvial geomorphological and erosion threshold assessment. The additional watercourse improvements are summarized as follows:

1. Watercourse Improvement No. 1 – Watercourse improvements along Kidd's Creek to stabilize existing bank erosion between Lilian Cres. and Cundles Rd. W. (Reaches Ki-1 through Ki-2);
2. Watercourse Improvements No. 2 – Watercourse improvements along Kidd's Creek to stabilize existing bank erosion/failure between Thomson St. and Eccles St. (Reach Ki-8a);
3. Watercourse Improvements No. 3 – Watercourse Improvements along Kidd's Creek to stabilize existing bank erosion/failure between Eccles St. and Henry St. (Reaches Ki-10b through Ki-10c);
4. Watercourse Improvements No. 4 – Watercourse improvements including scour treatment and bank stabilization to remediate existing scour and bank erosion/failure on Bunkers Creek downstream of Shirley Ave. (Reach Bu-3);
5. Watercourse Improvements No. 5 – Watercourse improvements including scour treatment and bank stabilization to remediate existing scour and bank erosion/failure on Bunkers Creek downstream of Edgehill Dr. (Reach Bu-7);
6. Watercourse Improvements No. 8 – Watercourse improvements to mitigate bank scour and undercutting on Bunkers Creek between Anne St. S. and Innisfil St. (Reaches Bu-11 and Bu-15);
7. Watercourse Improvements No. 12 – Watercourse improvements to mitigate bank scour and undercutting On Dyments Creek between Anne St. S. and Innisfil St. (Reach Dy-5);
8. Watercourse Improvements No. 14 – Watercourse improvements on Hotchkiss Creek to stabilize existing bank erosion between Innisfil St. and Bradford St. (Reach Ho-9);
9. Watercourse Improvements No. 16 – Minor watercourse realignment to address long-term bank and bed erosion on Whiskey Creek (Reach Wh-4a);
10. Watercourse Improvements No. 17 – Watercourse improvements on Whiskey Creek to stabilize existing bed and bank erosion (Reach Wh-5);



11. Watercourse Improvements No. 18 – Watercourse improvements on Whiskey Creek to stabilize existing bank erosion (Reach Wh-6);
12. Watercourse Improvements No. 19 – Watercourse improvements on Whiskey Creek to stabilize existing bank erosion (Reach Wh-10);
13. Watercourse Improvements No. 22 – Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander (Reach Lo-19);
14. Watercourse Improvements No. 23 – Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander (Reach Lo-20);
15. Watercourse Improvements No. 24 – Watercourse Improvements on Little Lake Creek downstream of Livingstone St. E. to stabilize existing bank erosion (Reach Li-1);
16. Watercourse Improvements No. 33 – Watercourse Improvements on Bear Creek downstream of Ardagh Rd. to stabilize existing bed erosion (Reach Be-14); and
17. Watercourse Improvement No. 34 – Watercourse Improvements on Kidd's Creek between Cundles Rd. and Highway 400 to stabilize existing bank erosion.

In addition to culvert and watercourse improvements, trunk storm sewer improvements are proposed to divert flow and address major overland flow deficiencies. The PCSWMM hydrologic/hydraulic model was updated to analyze the trunk storm sewer improvements being evaluated. The results of the analysis are summarized in the following table and included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference. The trunk storm sewer improvements are summarized as follows:

1. Trunk Storm Sewer Improvement No. 9 – Construct a trunk storm sewer on Thomson St., Sophia St. W. and Florence St. to reduce flows and erosion through Kidd's Creek from Thomson St. to Eccles St. N.;
2. Trunk Storm Sewer Improvement No. 1 – Construct a trunk storm sewer on Anne St. N. from SWMF BK03 to Edgehill Dr. to divert flows reducing flooding and erosion in Bunkers Creek downstream;
3. Trunk Storm Sewer Improvement No. 2 – Construct a trunk storm sewer on Anne St. S. from Dunlop St. W. to Perry St. to convey the 1:100-year peak flows from Bunkers Creek (Central and south branches);
4. Trunk Storm Sewer Improvement No. 10 – Construct a trunk storm sewer on Essa Rd. from Fairview Rd. to Essa Rd. to divert flows away from Hotchkiss Creek and the WwTF;
5. Trunk Storm Sewer Improvement No. 7 – Construct a trunk storm sewer on Esther Dr. from Dean Ave. to SWMF LV19 to eliminate overland flow route deficiencies;



6. Trunk Storm Sewer Improvement No. 6 – Construct a trunk storm sewer on Princess Margaret Gate to Camelot Sq. from Loyalist Sq. to SWMF HW06 to eliminate overland flow route deficiencies;
7. Trunk Storm Sewer Improvement No. 3 – Construct a trunk storm sewer between SWMF GR04 and SWMF GR01 to convey the 1:100-year peak flow from SWMF GR04;
8. Trunk Storm Sewer Improvement No. 4 – Construct a trunk storm sewer on Harrogate Ct., Johnson St., Cheltenham Rd., Larkin Dr. and Quintan Rd. from Dunsmore Park to Penetanguishene Rd. to eliminate overland flow route deficiencies;
9. Trunk Storm Sewer Improvement No. 5 – Construct a trunk storm sewer between SWMF LT02 and SWMF LT01 to eliminate overland flow route deficiencies;
10. Trunk Storm Sewer Improvement No. 8 – Construct a trunk storm sewer on Johnson St. from Steel St. to Kempenfelt Bay to eliminate overland flow route deficiencies;
11. Trunk Storm Sewer Improvement No. 11 – Extend trunk storm upstream of Bradford St.; and
12. Trunk Storm Sewer Improvement No. 12 – construct a trunk storm sewer on Blake St. to eliminate overland flow route deficiencies.

Project cost estimates have been developed for the preliminary design concepts. The project cost estimates are summarized in the following tables:



Table 47: Project Cost Estimates – Alternative 3A (Culvert Improvements)

CULVERT IMPROVEMENT	PROJECT COST	CULVERT IMPROVEMENT	PROJECT COST
No. 16	\$1,453,000	No. 46	\$932,000
No. 18	\$179,000	No. 50	\$1,815,000
No. 22	\$3,130,000	No. 55	\$5,522,000
No. 23	\$3,572,000	No. 57	\$1,694,000
No. 30	\$8,295,000	No. 147	\$703,000
No. 31	\$2,254,000 (MTO)	No. 138	\$1,110,000
No. 32	\$1,542,000	No. 65	\$1,497,000
No. 33	\$5,852,000 (MTO)	No. 66	\$2,460,000
No. 34	\$1,255,000	No. 126	\$1,609,000
No. 35	\$1,138,000	No. 123	\$605,000
No. 36	\$5,147,000	No. 134	\$159,000
No. 37	\$4,150,000	No. 39	\$7,064,000
No. 38	\$2,913,000		
Total		\$66,050,000	

Note: Excludes property acquisition costs of properties within floodplain (\$349,599,000); Property Value – 2018 Assessed Value (MPAC)



Table 48: Project Cost Estimates – Alternative 3A (Watercourse Improvements)

WATERCOURSE IMPROVEMENT	PROJECT COST	WATERCOURSE IMPROVEMENT	PROJECT COST
No. 1	\$1,585,000	No. 18	\$247,000
No. 2	\$1,602,000	No. 19	\$2,017,000
No. 3	\$1,752,000	No. 20	\$1,710,000
No. 4	\$1,016,000	No. 21	\$2,039,000
No. 5	\$367,000	No. 22	\$1,298,000
No. 6	\$3,594,000	No. 23	\$1,598,000
No. 7	\$5,713,000	No. 24	\$152,000
No. 8	\$1,052,000	No. 25	\$2,640,000
No. 9	\$4,204,000	No. 26	\$888,000
No. 10	\$4,758,000	No. 27	\$3,534,000
No. 11	\$1,008,000	No. 28	\$1,242,000
No. 12	\$139,000	No. 29	\$810,000
No. 13	\$2,326,000	No. 30	\$7,396,000
No. 14	\$660,000	No. 31	\$876,000
No. 15	\$355,000	No. 32	\$3,209,000
No. 16	\$1,561,000	No. 33	\$293,000
No. 17	\$407,000	No. 34	\$1,767,000
Total			\$63,815,000

Note: Excludes property acquisition costs of properties within floodplain (\$349,599,000); Property Value – 2018 Assessed Value (MPAC)



Table 49: Project Cost Estimates – Alternative 3A (Trunk Sewers)

TRUNK STORM SEWER IMPROVEMENT	PROJECT COST	TRUNK STORM SEWER IMPROVEMENT	PROJECT COST
No. 1	\$4,614,000	No. 7	\$12,442,000
No. 2	\$2,035,000	No. 8	\$4,524,000
No. 3	\$11,672,000	No. 9	\$2,004,000
No. 4	\$13,724,000	No. 10	\$1,166,000
No. 5	\$6,119,000	No. 11	\$2,474,000
No. 6	\$2,057,000	No. 12	\$309,000
Total			\$63,140,000

Note: Excludes property acquisition costs of properties within floodplain (\$349,453,000); Property Value – 2018 Assessed Value (MPAC)

10.3.2 Alternative 3B – Culvert/Watercourse/Major Drainage System Improvements (City Design Flood Frequency Criteria)

The existing condition HEC RAS hydraulic models of the various creeks were updated to determine the culvert sizes and watercourse improvements required to satisfy the City's current design standards and design flood frequency criteria. A summary of the required culvert sizes is presented in the following table and the detailed model results are included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

Table 50: Culvert Summary – Alternative 3B

CULVERT ID & LOCATION		SIZE	CAPACITY (m ³ /s)	LEVEL OF SERVICE
13	Cundles Rd. W.	3455 mm x 2195 mm conc. Elliptical culvert	23.2	1:100 Year
145	Dunlop St. W.	6000 mm x 1500 mm conc. box culvert	14.8	1:100 Year
143	Highway 400	2400 mm x 1830 mm conc. box culvert (MTO)	8.8	1:50 Year
142	Highway 400	4200 mm x 1500 mm conc. box culvert (MTO)	9.0	1:50 Year



CULVERT ID & LOCATION		SIZE	CAPACITY (m ³ /s)	LEVEL OF SERVICE
141	Highway 400	Twin 1800 mm x 1200 mm conc. box culvert (MTO)	10.7	1:50 Year
24	Bradford St.	Twin 7.62 m open span structures	41.7	Regional
28	Dunlop St. W.	3043 mm x 914 mm conc. box culvert	8.4	1:100 Year
29	Ferndale Dr. N.	10.67 m open bottom span structure	12.3	1:100 Year
41	Mayfair Dr.	750 mm Dia. conc. culvert	1.6	1:100 Year
42	Ardagh Rd.	900 mm Dia. conc. culvert	2.5	1:100 Year
43	Morrow Rd.	4572 mm x 1219 mm conc. box culvert	8.6	1:50 Year
44	Essa Rd.	3048 mm x 914 mm conc. box culvert	8.3	Regional
135	Railway Crossing	4878 mm x 914 mm conc. box culvert	19.8	1:100 Year
48	Tiffin St.	4267 mm x 1829 mm conc. box culvert	17.0	1:50 Year
49	Anne St. S.	Extend existing 4270 mm x 2440 mm conc. box culvert	34.6	1:100 Year
53	Harvie Rd.	2100 mm x 900 mm conc. box culvert	3.9	1:100 Year
54	Harvie Rd.	1800 mm Dia. Conc. culvert	6.4	1:100 Year
56	Fairview Rd.	2700 mm x 1200 mm conc. box culvert	8.4	1:100 Year
60	Huron Rd.	10.67 m open bottom span structure	26.1	1:50 Year
62	Little Ave.	Twin 7.36 m open bottom span structures	27.1	1:25 Year
63	Yonge St.	Twin 3000 mm x 1800 mm conc. box culverts	38.9	1:100 Year
64	Hurst Dr.	3000 mm x 2100 mm conc. box culvert	38.3	1:100 Year
89	Lockhart Rd.	10.67 m open bottom span structure	13.5	1:100 Year
95	Mapleview Dr. E.	3000 mm x 2100 mm conc. box culvert	7.8	1:50 Year
91	Lockhart Rd.	Twin 10.67 m open bottom span structures	96.7	1:100 Year
94	Welham Rd.	2400 mm x 1500 mm conc. box culvert	7.8	1:50 Year
92	Huron Rd.	3600 mm x 1500 mm conc. box culvert	13.3	1:100-Year



CULVERT ID & LOCATION		SIZE	CAPACITY (m ³ /s)	LEVEL OF SERVICE
99	Ellis Dr.	3000 mm × 1200 mm conc. box culvert	8.3	1:50-Year
98	Welham Rd.	Twin 3000 mm × 1200 mm conc. box culverts	30.9	1:50-Year
97	Huronia Rd.	3000 mm × 1200 mm conc. box culvert	8.0	1:100-Year
105	Tollendal Mill Rd.	3892 mm x 10356 mm Low Profile Bridge Plate Arch 1 x 2100 x 3000 mm Conc. Box	119.0	1:100-Year
83	Mapleview Dr. E.	10.67 m open bottom span structure	70.8	1:100-Year
82	Penetanguishene Rd.	2400 mm × 1200 mm conc. box culvert	5.1	1:100 Year
78	Ardagh Rd.	900 mm Dia. conc. culvert	2.3	1:100-Year
80	County Rd. 27	Triple 525 mm Dia. HDPE culverts	1.1	1:2-Year

The analysis demonstrates that the level of service provided by the road culvert crossings under this alternative generally satisfy the City's current design flood frequency criteria.

Preliminary project cost estimates have been developed for the preliminary design concepts. The project cost estimates are summarized in the following table and enclosed in Appendix L for reference:



Table 51: Project Cost Estimates – Alternative 3B

CULVERT IMPROVEMENT	PROJECT COST	CULVERT IMPROVEMENT	PROJECT COST
No. 13	\$1,091,000	No. 60	\$2,975,000
No. 145	\$4,234,000	No. 62	\$4,327,000
No. 143	\$878,000 (MTO)	No. 63	\$1,905,000
No. 142	\$1,956,000 (MTO)	No. 64	\$2,103,000
No. 141	\$700,000 (MTO)	No. 89	\$3,216,000
No. 24	\$5,173,000	No. 91	\$3,667,000
No. 28	\$979,000	No. 94	\$661,000
No. 29	\$1,764,000	No. 95	\$1,548,000
No. 41	\$293,000	No. 92	\$986,000
No. 42	\$308,000	No. 99	\$594,000
No. 43	Project Completed	No. 98	\$2,346,000
No. 44	\$1,322,000 (MTO)	No. 97	\$723,000
No. 135	\$3,273,000	No. 105	\$1,042,000
No. 48	\$2,287,000	No. 83	\$2,048,000
No. 49	\$1,378,000	No. 82	\$624,000
No. 53	\$917,000	No. 78	\$363,000
No. 56	\$1,795,000	No. 80	\$4,524,000
Total			\$62,000,000

Note: Excludes property acquisition costs of properties within floodplain (\$349,599,000); Property Value – 2018 Assessed Value (MPAC)



11 Overall Alternatives Evaluation

The overall improvement alternatives developed in Section 7 and described in detail in Section 10 have been evaluated with respect to their impact on the physical, natural, social, cultural and economic environments presented in Section 3 to establish a preferred approach to address the drainage deficiencies across the City. Moving forward, the overall preferred alternatives selected through the following evaluation will be used to develop and select the individual projects described in Section 14.

The evaluation of the overall improvement alternatives is descriptive or qualitative in nature allowing for a comparative evaluation of the pros and cons associated with each alternative. The evaluation is focused on the ability of the alternatives to adequately address the problem statement, and in doing so, provide an approach to addressing the drainage deficiencies that is consistent with the requirements of the governing policies. The alternatives evaluation completed is provided next in the following tables:



Table 52: Assessment of Improvement Alternatives – Existing Conditions

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 1A: “Do Nothing” Minor Drainage Systems	Design Alternative 1B: “Do Nothing” Major Drainage Systems
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding	 Continued frequent nuisance flooding of private property during minor storm throughout the study area	 Continued flooding of private property during major storm events throughout the study area
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area	 Aging/deteriorating storm infrastructure deficient throughout study area. Areas absent of any minor drainage system	 Aging/deteriorating storm infrastructure deficient throughout study area.
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer	 No conflicts with the existing sanitary sewer system/services Continued inflow of stormwater to sanitary sewer system during minor storm events	 No conflicts with the existing sanitary sewer system/services Continued inflow of stormwater to sanitary sewer system during major storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services	 No conflicts with the existing water mains/services	 No conflicts with the existing water mains/services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities	 No impact on existing utilities	 No impact on existing utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance. Severity of the disturbance to the transit system during construction	 Continued flooding of existing transportation system during minor storms No disturbance to existing transits system as no construction is involved in this alternative	 Continued flooding of existing transportation system during major storms No disturbance to existing transits system as no construction is involved in this alternative
	Impact on Existing Flood Lines	Increase/Decrease in flood level along the creeks and through the downtown core	 No impact on flood levels in study area	 No impact on flood levels in study area
	Impact on Parklands	Loss/Gain of parkland and/or green space	 No impact on parkland or green space	 No impact on parkland or green space
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern. Enhancement / Diminishment of native species.	 No impact on existing vegetation	 No impact on existing vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in various creeks	 Continued degradation of water quality will negatively impact fish habitat and aquatic features in the various creeks	 Continued degradation of water quality will negatively impact fish habitat and aquatic features in the various creeks
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area	 No impact to wildlife habitat in the study area	 No impact to wildlife habitat in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality	 Continued diminishment of the stormwater quality throughout the watershed	 Continued diminishment of the stormwater quality throughout the watershed



Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 1A: “Do Nothing” Minor Drainage Systems	Design Alternative 1B: “Do Nothing” Major Drainage Systems
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property	 Decrease in property value due to continued flooding during minor storm events Municipal Infrastructure to remain on private property	 Decrease in property value due to continued flooding during major storm events Municipal Infrastructure to remain on private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion	 Potential public safety concerns remain due to continued flooding and erosion during minor storms	 Potential public safety concerns remain due to continued flooding and erosion during major storms
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources	No archaeological or heritage impacts 	No archaeological or heritage impacts 
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure	 Increase in drainage system maintenance costs due to aging/deteriorating storm infrastructure and continued flooding/erosion No improvement to access to the existing drainage infrastructure	 Increase in drainage system maintenance costs due to aging/deteriorating storm infrastructure and continued flooding/erosion No improvement to access to the existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs	 \$0	 \$349,599,000
	Impact on Construction Costs	Preliminary estimated construction costs	 \$0	 \$0
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property	 Increase in private property maintenance costs due to aging/deteriorating storm infrastructure and continued flooding	 Increase in private property maintenance costs due to aging/deteriorating storm infrastructure and continued flooding

Negative Impact				Neutral Impact	Positive Impact			
Greatest			Least		Least			Greatest
								



Table 53: Assessment of Improvement Alternatives – Flow Reduction / Water Quality Improvements

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2A: Retrofit/New Stormwater Management Facilities for Quantity Control	Design Alternative 2B: Retrofit/New Stormwater Management Facilities for Quality Control
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding	 Reduction of peak flows downstream of SWMF's during minor and major storm events resulting in a decrease in private property flooding, however, flooding will still occur	 Reduction of peak flows downstream of SWMF's during minor and major storm events resulting in a decrease in private property flooding, however, flooding will still occur
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area	 Reduction in peak flow to local and trunk storm sewers throughout the study area	 Reduction in peak flow to local and trunk storm sewers throughout the study area
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer	 No conflicts with the existing sanitary sewer system or services  Reduction of stormwater inflow to sanitary sewer during minor and major storm events	 No conflicts with the existing sanitary sewer system or services  Reduction of stormwater inflow to sanitary sewer during minor and major storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services	 No impact on existing water mains or services	 No impact on existing water mains or services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities	 No impact on existing utilities	 No impact on existing utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance. Severity of the disturbance to the transit system during construction	 Decrease in flooding of existing transportation system throughout the study area; temporary disturbance to local roadway during construction	 Decrease in flooding of existing transportation system throughout the study area; temporary disturbance to local roadway during construction
	Impact on Existing Flood Lines	Increase/Decrease in flood level along the creeks and through the downtown core	 Decrease in flood levels and extent of floodplain along the various creeks throughout the study area due to decrease flows	 Decrease in flood levels and extent of floodplain along the various creeks throughout the study area due to decrease flows
	Impact on Parklands	Loss/Gain of parkland and/or green space	 No loss/gain of parkland and/or greenspace; temporary disturbance to parkland during construction	 No loss/gain of parkland and/or greenspace; temporary disturbance to parkland during construction
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern. Enhancement / Diminishment of native species.	 Minor loss of vegetation (grasses) through SWMF retrofit/construction Opportunity to enhance native plantings	 Minor loss of vegetation (grasses) through SWMF retrofit/construction Opportunity to enhance native plantings
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in various creeks	 Reduced erosion and improved water quality will positively impact fish habitat and aquatic features in the various creeks	 Reduced erosion and improved water quality will positively impact fish habitat and aquatic features in the various creeks
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area	 Opportunity to enhanced wildlife habitat in existing SWMF's; potential loss of habitat for construction of new SMWF's	 Opportunity to enhanced wildlife habitat in existing SWMF's; potential loss of habitat for construction of new SMWF's
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality	 Improvement in water quality	 Improvement in water quality



Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2A: Retrofit/New Stormwater Management Facilities for Quantity Control	Design Alternative 2B: Retrofit/New Stormwater Management Facilities for Quality Control
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding	 Increase in property values due to reduced flooding; Alternative does not remove municipal infrastructure from private property	 Increase in property values due to reduced flooding; Alternative does not remove municipal infrastructure from private property
	Impact on Public Safety	Presence of municipal infrastructure on Increase/Decrease in potential public safety hazards due to flooding and erosion	 Decrease in potential public safety hazards due to reduction flows, flooding and erosion during minor/major storm events	 Decrease in potential public safety hazards due to reduction flows, flooding and erosion during minor/major storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources	 Potential contribution to the removal of archaeological resources for the construction of new SWMF's	 Potential contribution to the removal of archaeological resources for the construction of new SWMF's
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure	 Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements No impact on access to existing drainage infrastructure	 Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements No impact on access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs	 \$20,324,000	 \$10,181,000
	Impact on Construction Costs	Preliminary estimated construction costs	 \$47,755,000	 \$42,319,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property	 Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements	 Reduction in peak flows and flooding along with an improvement in water quality will decrease maintenance requirements

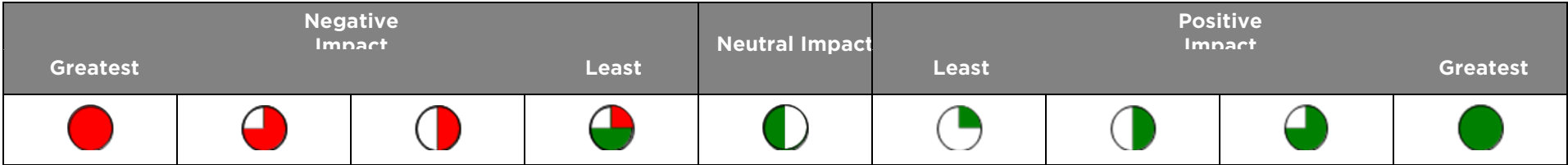


Table 53: Assessment of Improvement Alternatives – Flow Reduction / Water Quality Improvements (continued)

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2C: Lot Level Low Impact Development	Design Alternative 2D: Linear Low Impact Development
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding	 Essentially no reduction of minor/major storm peak flows	 Minor reduction of minor storm peak flows resulting in the reduction of frequent nuisance flooding. Insignificant reduction in major system peak flows and flooding
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area	 Essentially no reduction of flows to local and trunk storm sewer during minor/major storm events	 Minor reduction of flows to local and trunk storm sewer during minor storm events, however no significant reduction of flows during major storm events
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer	 No conflicts between lot level LIDs and sanitary sewer system or services No reduction of stormwater inflow to sanitary sewer during minor storm events	 Potential conflicts between linear LIDs and sanitary sewer system or services Reduction of stormwater inflow to sanitary sewer during minor storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services	 No conflicts between lot level LIDs and water services	 Potential conflicts between linear LIDs and water main/services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities	 No conflicts between lot level LIDs and utilities	 Potential conflicts between linear LIDs and utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance. Severity of the disturbance to the transit system during construction	 No decrease in flooding of the transportation system during minor/major storm events	 Minor decrease in frequent nuisance flooding in localized areas, however no reduction during major storms
	Impact on Existing Flood Lines	Increase/Decrease in flood level along the creeks and through the downtown core	 No significant decrease in flows during major storm events resulting in no significant decrease in flood levels in the study area	 No significant decrease in flows during major storm events resulting in no significant decrease in flood levels in the study area
	Impact on Parklands	Loss/Gain of parkland and/or green space	 No loss/gain of parkland and/or greenspace	 No loss/gain of parkland and/or greenspace
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern. Enhancement / Diminishment of native species.	 No loss/gain of vegetation	 No loss/gain of vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in various creeks	No impact on fish habitat or aquatic features in various creeks	Improved water quality and reduced erosion will positively impact fish habitat and aquatic features in various creeks
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area	 No impacts to wildlife in the study area	 No impacts to wildlife in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality	 Minor improvement of water quality throughout the study area during minor storm events	 Improvement of water quality throughout the study area during minor storm events



Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2C: Lot Level Low Impact Development	Design Alternative 2D: Linear Low Impact Development
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property	 No impact on property values	 Increase in property values due to reduce frequent nuisance flooding during minor storm events, Alternative does not remove municipal infrastructure from private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion	 No impact on public safety	 Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources	 No potential contribution to the removal of archaeological resources	 No potential contribution to the removal of archaeological resources
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure	 No impact on the drainage system maintenance costs	 Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements of storm sewer; increased maintenance requirements to maintain function of linear LIDs No impact on access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs	 \$0	 \$0
	Impact on Construction Costs	Preliminary estimated construction costs	 \$0	 \$20,017,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property	 No impact on private property maintenance costs	 Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements

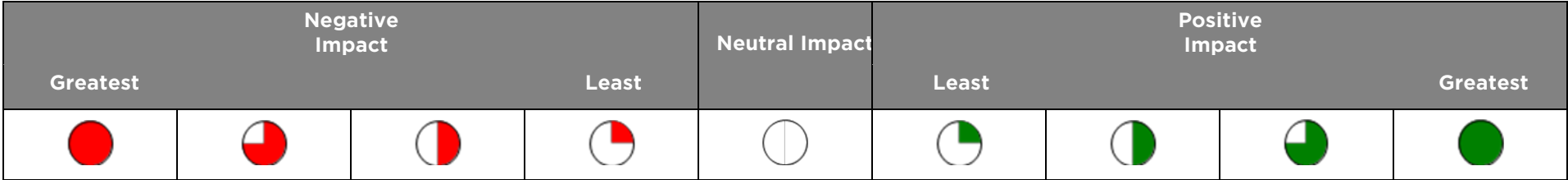


Table 53: Assessment of Improvement Alternatives – Flow Reduction / Water Quality Improvements (continued)

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2E: Centralized Low Impact Development
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding	 Minor reduction of minor storm peak flows resulting in the reduction of frequent nuisance flooding. Insignificant reduction in major system peak flows and flooding
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area	 Minor reduction of flows to local and trunk storm sewer during minor storm events, however no significant reduction of flows during major storm events
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer	 No conflicts between centralized LIDs and sanitary sewer system or services Reduction of stormwater inflow to sanitary sewer during minor storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services	 No potential conflicts between centralized LIDs and water main/services
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities	 No potential conflicts between centralized LIDs and utilities
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance. Severity of the disturbance to the transit system during construction	 Minor decrease in frequent nuisance flooding in localized areas, however no reduction during major storms
	Impact on Existing Flood Lines	Increase/Decrease in flood level along the creeks and through the downtown core	 No significant decrease in flows during major storm events resulting in no significant decrease in flood levels in the study area
	Impact on Parklands	Loss/Gain of parkland and/or green space	 No loss/gain of parkland and/or greenspace; temporary disturbance during construction and maintenance activities
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern. Enhancement / Diminishment of native species	 No loss/gain of vegetation
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the various creeks	 No impact on fish habitat or aquatic features in the various creeks
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area	 No impacts to wildlife in the study area
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality	 Improvement of water quality throughout the study area during minor storm events



Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 2E: Centralized Low Impact Development
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property	 Increase in property values due to reduce frequent nuisance flooding during minor storm events, Alternative does not remove municipal infrastructure from private property
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion	 Decrease in potential public safety hazards due to reduction of frequent nuisance flooding during minor storm events
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources	 No potential contribution to the removal of archaeological resources
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure	 Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements of storm sewer; increased maintenance requirements to maintain function of centralized LIDs No impact on access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs	 \$0
	Impact on Construction Costs	Preliminary estimated construction costs	 \$34,350,000
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property	 Reduction in frequent nuisance flooding and improvement in water quality will reduce maintenance requirements

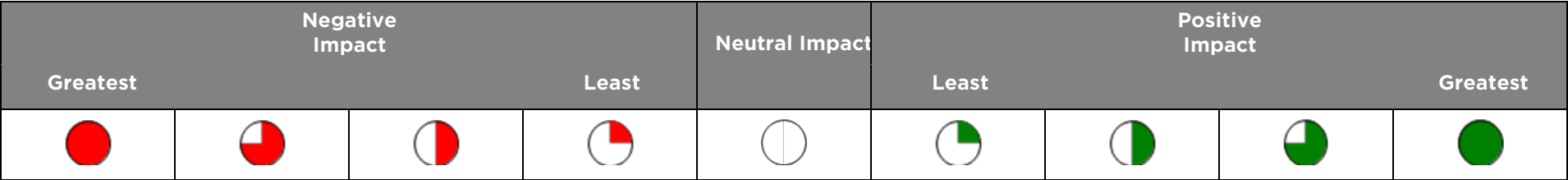
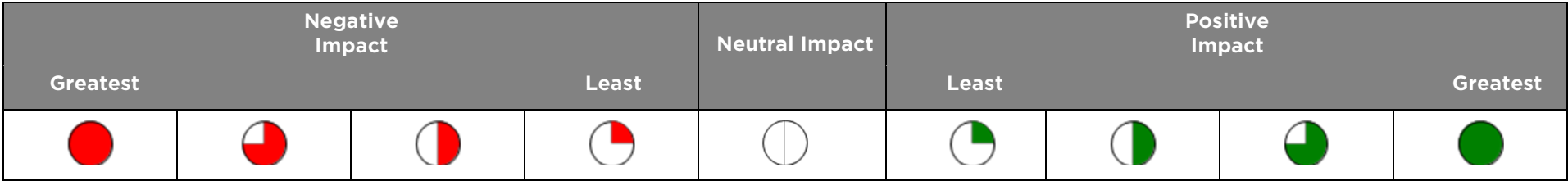


Table 54: Assessment of Improvement Alternatives – Conveyance Capacity Improvements

Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 3A: Culvert/Watercourse/Major Drainage System Improvements (MDP Recommended Design Flood Frequency)	Design Alternative 3B: Culvert/Watercourse/Major Drainage System Improvements (City Design Flood Frequency Criteria)
Physical Environment	Impact on Existing Private Property	Increase/Decrease in the extent and frequency of private property flooding	 Reduction in the extent and frequency of flooding on private property	 Reduction in the extent and frequency of flooding on private property
	Impact on Existing Storm Sewer System	Increase/Decrease of flow to local and trunk storm sewer throughout the study area	 No impact on flow to local and trunk storm sewer	 No impact on flow to local and trunk storm sewer
	Impact on Existing Sanitary Sewer System	Severity/Number of conflicts with existing sanitary sewer/services Increase/Decrease in stormwater inflow to sanitary sewer	 Potential conflicts with the existing sanitary sewer system Reduction in stormwater inflow into the sanitary sewer system during minor and major storm events	 Potential conflicts with the existing sanitary sewer system Reduction in stormwater inflow into the sanitary sewer system during minor and major storm events
	Impact on Existing Water Main	Severity/Number of conflicts with existing water main/services	 Conflict with the existing water main requiring the water main to be lowered at multiple road crossings	 Conflict with the existing water main requiring the water main to be lowered at multiple road crossings
	Impact on Existing Utilities	Severity/Number of conflicts with existing underground utilities	 Conflict with the existing utilities requiring the utilities to be relocated at multiple road crossings	 Conflict with the existing utilities requiring the utilities to be relocated at multiple road crossings
	Impact on Existing Transportation System	Increase/Decrease in the extent and frequency of flooding within the road allowance. Severity of the disturbance to the transit system during construction	 Decrease in the extent and frequency of flooding within the road allowance during minor/major storms; temporary disturbance to the transit system at each road crossing during construction	 Decrease in the extent and frequency of flooding within the road allowance during minor/major storms; temporary disturbance to the transit system at each road crossing during construction
	Impact on Existing Flood Lines	Increase/Decrease in flood level along the creeks and through the downtown core	 Decrease in flood levels along the various creeks during minor and major storm events	 Decrease in flood levels along the various creeks during minor and major storm events
	Impact on Parklands	Loss/Gain of parkland and/or green space	 No loss/gain of parkland and/or green space or use thereof	 No loss/gain of parkland and/or green space or use thereof
Natural Environment	Impact on Existing Vegetation	Loss/Gain of vegetation (trees, shrubs, etc.) designated endangered, threatened or special concern. Enhancement / Diminishment of native species	 Minor loss of vegetation along the various creeks; opportunity to enhance native species along improved channel sections	 Minor loss of vegetation along the various creeks; opportunity to enhance native species along improved channel sections
	Impact on Fisheries within Creek	Alteration, disruption and/or destruction of fish habitat and aquatic features in the various creeks	 Daylighting watercourses and watercourse improvements will have a positive long term impact on fish habitat and aquatic features Alteration and disruption to fish habitat for short term during construction	 Daylighting watercourses and watercourse improvements will have a positive long term impact on fish habitat and aquatic features Alteration and disruption to fish habitat for short term during construction
	Impact on Terrestrial Wildlife	Loss/Gain of wildlife habitat throughout the study area	 Opportunity to enhanced wildlife habitat along improved watercourse sections	 Opportunity to enhanced wildlife habitat along improved watercourse sections
	Impact on Existing Water Quality	Improvement/Diminishment of storm water runoff quality	 Daylighting watercourse will provide minor improvement to storm water quality	 Daylighting watercourse will provide minor improvement to storm water quality



Evaluation Criteria		How Criteria is Being Assessed	Design Alternative 3A: Culvert/Watercourse/Major Drainage System Improvements (MDP Recommended Design Flood Frequency)	Design Alternative 3B: Culvert/Watercourse/Major Drainage System Improvements (City Design Flood Frequency Criteria)
Social Environment	Impact on Property Value	Increase/Decrease in property values due to the extent and frequency of flooding Presence of municipal infrastructure on private property	 Increase in property values throughout the study area due to reduced flooding during minor and major storms	 Increase in property values throughout the study area due to reduced flooding during minor and major storms
	Impact on Public Safety	Increase/Decrease in potential public safety hazards due to flooding and erosion	 Decrease in potential public safety hazards due to reduced flooding and erosion during minor and major storms	 Decrease in potential public safety hazards due to reduced flooding and erosion during minor and major storms
Cultural Heritage Environment	Archeological and Heritage Impacts	Potential contribution to the removal of archeological resources	No archaeological or heritage impacts 	No archaeological or heritage impacts 
Economic Environment	Impact on Drainage System Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance to municipal drainage systems Improvement/diminishment of access to drainage infrastructure	 Reduction in flooding will decrease maintenance requirements Improved access to existing drainage infrastructure	 Reduction in flooding will decrease maintenance requirements Improved access to existing drainage infrastructure
	Impact on Property Acquisition Costs	Property and easement acquisition costs	 Culvert Improvements - \$5,756,000 Watercourse Improvements - \$26,463,000 (same as 3B) Trunk storm sewer improvements - \$492,000 (same as 3B)	 Culvert Improvements - \$5,159,000 Watercourse Improvements - \$26,463,000 (same as 3A) Trunk storm sewer improvements - \$492,000 (same as 3A)
	Impact on Construction Costs	Preliminary estimated construction costs	 Culvert Improvements - \$60,294,000 Watercourse Improvements - \$37,352,000 (same as 3B) Trunk storm sewer improvements - \$62,648,000 (same as 3B)	 Culvert Improvements - \$56,841,000 Watercourse Improvements - \$37,352,000 (same as 3A) Trunk storm sewer improvements - \$62,648,000 (same as 3A)
	Impact on Private Property Maintenance Costs	Increase/Decrease in maintenance required to clear obstructions, repair erosion, remove accumulated sediment, and perform routine maintenance on private property	 Reduction in flooding will decrease private property maintenance requirements	 Reduction in flooding will decrease private property maintenance requirements



12 Preferred Approach

Following a comprehensive review of the alternatives, receipt of all comments from the interested stakeholders and agencies, and completion of the overall improvement alternatives evaluation the preferred approach to addressing the drainage deficiencies across the City has been selected. The preferred approach to address the drainage deficiencies includes the alternatives outlined in the following sections.

12.1 FLOW REDUCTION / WATER QUALITY IMPROVEMENTS

12.1.1 Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control

It is recommended that the City retrofit existing stormwater management facilities and construct new stormwater management facilities within the City of Barrie to improve water quantity control, attenuate peak flows and reduce downstream flooding. Alternative 2A is part of the preferred approach. As such, the individual SWMF retrofit/creation projects identified under Alternative 2A have been carried forward for further evaluation. A list of the water quantity SWMF retrofits/creations (individual projects) is provided in Appendix L of this report. The individual projects are illustrated on Figures 17 through 21 provided in Appendix L.

12.1.2 Alternative 2B – Retrofit/New Stormwater Management Facilities for Quality Control

The City also has the ability to retrofit existing stormwater management facilities and construct new stormwater management facilities within the City of Barrie to improve watershed water quality, promote infiltration and improve the water balance. This includes retrofitting existing dry ponds to include an LID component where feasible or convert the dry ponds to wetlands or wet ponds with a permanent pool component for enhanced treatment and improved phosphorus removal. Alternative 2B is part of the preferred approach. As such, the individual SWMF retrofit/creation projects identified under Alternative 2B have been carried forward for further evaluation. A list of the water quantity SWMF retrofits/creations (individual projects) is provided in Appendix L of this report. The individual projects are illustrated on Figures 17 through 21 provided in Appendix L.

12.1.3 Alternative 2C – Lot Level Low Impact Development

The implementation of lot level Low Impact Development (LID) measures on private property across the City to increase infiltration, improve the water balance and watershed water quality will provide an overall benefit to the preferred alternatives. The City should promote the use of rain barrels and implementation of soakaway pits by residents and property owners in the City.



The promotion of lot level LIDs by the City is carried forward as a general recommendation of this Drainage Master Plan.

12.1.4 Alternative 2D - Linear Low Impact Development

This study has identified target volumes and areas for the implementation of linear Low Impact Development (LID) measures within local roadways to attenuate peak flows, promote infiltration, improve the water balance and watershed water quality throughout the City. The City should implement perforated pipe systems or infiltration systems as part of local road reconstruction projects and intensification in the City of Barrie. The target runoff volume captured in each watershed/drainage area should be consistent with objectives identified in Table 39. It is understood the City of Barrie is currently developing Low Impact Development design standards and the linear Low Impact Development (LID) measures implemented should remain consistent with these standards and the Low Impact Development Stormwater Management Planning and Design Guide developed by Credit Valley Conservation and Toronto and Region Conservation. The implementation of linear LIDs on local roads by the City is carried forward as a general recommendation of this Drainage Master Plan.

12.1.5 Alternative 2E - Centralized Low Impact Development

The implementation of centralized Low Impact Development (LID) measures within suitable existing parkland throughout the City has been shown to have the ability to attenuate peak flows, promote infiltration, and improve the water balance and watershed water quality. Alternative 2E is part of the preferred approach. As such, the centralized LIDs identified under Alternative 2E have been carried forward for further evaluation. A list of the centralized LIDs (individual projects) is provided in Appendix L of this report. The individual projects are illustrated on Figures 17 through 21 provided in Appendix L.

12.1.6 Alternative 3A - Culvert/Watercourse/Major Drainage System Improvements (Previous MDP Recommended Design Flood Frequency Criteria)

It is recommended that the City implement culvert, watercourse and trunk storm in the study area to reduce flooding and address safety concerns. For many watersheds the past approved MDPs have set an appropriate criteria to be met. Alternative 3A is part of the preferred approach. As such, the individual conveyance capacity projects identified under Alternative 3A have been carried forward for further evaluation. A list of the conveyance capacity projects is provided in Appendix L of this report. The individual projects are illustrated on Figures 17 through 21 provided in Appendix L.



12.1.7 Alternative 3B – Culvert/Watercourse/Major Drainage System Improvements (City Design Flood Frequency Criteria)

The conveyance improvements were also evaluated comparing the current City design criteria versus recommended criteria from previous MDPs. In some instances achieving the City design flood frequency criteria was selected as the preferred approach. For these areas it is recommended that the City implement culvert, watercourse and trunk storm in the study area to satisfy the City's current design flood frequency criteria. Alternative 3B is part of the preferred approach. As such, the individual conveyance capacity projects identified under Alternative 3B have been carried forward for further evaluation. A list of the conveyance capacity projects is provided in Appendix L of this report. The individual projects are illustrated on Figures 17 through 21 provided in Appendix L.



13 Public Consultation – Public Information Center (PIC#2)

For the Barrie Drainage Master Plan, public consultation was completed in accordance with the Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association (MEA) *Municipal Class Environmental Assessment Document* (October 2000, as amended in 2007, 2011 and 2015). The public consultation undertaken leading up to and including Public Information Centre #2 (PIC#2) for this study is outlined in the following sections.

13.1 NOTICE OF STUDY COMMENCEMENT AND PUBLIC INFORMATION CENTRE

A second Public Information Centre (PIC) was held Tuesday, April 17, 2018 at the South Shore Centre (205 Lakeshore Drive) to present the preferred approach to addressing the drainage deficiencies across the City and the drainage projects identified under each preliminary preferred alternative solution. Attendees were encouraged to provide input / feedback regarding the study and the preliminary preferred drainage projects presented. Comment sheets were provided and attendees were encouraged to identify their preferences regarding the individual drainage projects. The PIC presentation materials are enclosed in Appendix M for reference.

Prior to the PIC, a Draft Environmental Assessment document was made available for public review at the City of Barrie Clerk's Office and City of Barrie Engineering. The document was also made accessible via the City's webpage. A notification letter was distributed to local residents and stakeholders presenting the preferred approach and notifying them of the PIC. The notification included a copy of the PIC comment sheet to provide everyone with an opportunity to provide input / comments regarding the study. The notification letter is enclosed in Appendix M for reference.

At the second Public Information Centre, the preliminary preferred alternative solutions were presented to the public. This included the preferred overall approach, the citywide general recommendations and the individual drainage solutions (projects) developed to address identified drainage deficiencies. The preliminary preferred alternative solutions presented at PIC#2 are enclosed in Appendix M for reference.

13.2 RESULTS OF PUBLIC CONSULTATION

The Mandatory Public Information Centre (PIC#2) was attended by 74 interested stakeholders and 39 written comments were provided. A copy of the comments received are available in



Appendix M for reference. Through the written comments, a number of attendees identified specific drainage issues they have witnessed. Several of the comments related to drainage issues that were previously identified and have a proposed improvement alternative. These comments have been considered in finalizing the Preferred Alternative Solution for these areas. Of note, two additional drainage issues were identified as follows:

- 10 Elizabeth Street – municipal drainage crossing private property;
- 140 Lockhart Drive – municipal drainage infrastructure crossing private property resulting in flooding.;

The remaining comments were largely related to individual property acquisition concerns or lot grading and development issues outside the scope of this project.



14 Individual Drainage Project Evaluation

Following Public Information Center #2, the individual projects identified under each recommended Alternative Solution presented in Section 12 were evaluated on a watershed by watershed basis with respect to their impact on the physical, natural, social, cultural and economic environments presented in Section 3. The evaluation considered feedback/input received from the public and interested stakeholders at PIC #2.

To assess the effectiveness of the individual drainage projects considered, the existing conditions minor and major drainage system models of the study area have been revised to include the proposed projects. The results of the analysis, specifically the reductions in peak flows, reduction in phosphorus loading rates, and flooding impacts under each improvement alternative are discussed in the subsequent sections.

For select projects, specifically Schedule B projects, several options were evaluated to establish the option that produced the greatest positive impact on the project environments. The evaluation of each option is presented on the subsequent sections.

Qualitative and quantitative evaluations were completed allowing for a comparative evaluation of the pros and cons associated with each project. The evaluation is focused on the ability of the individual projects to adequately address the problem statement, and in doing so, provide a solution that is consistent with the requirements of the governing policies. The individual project evaluation completed is provided in the following table.



Table 55: Qualitative Individual Project Evalauton Summary

			Recommended Project		Feasible Project (Conditional)	Not Recommended/Not Feasible	
Watershed	Project No.	Opportunity (ID)	Phsyical Environment	Economic Environment	Social/Cultural Environment	Natural Environment	Overall Impact
Kidd's Creek Watershed (Refer to Figure 18)	1	SWMF Retrofit No. 11 (KD06)	 Reduction in phosphorus, frequent nuisance flooding, and erosion.	 Moderate capital costs and potential cost savings, with a major increase in maintenance costs.	 Minor property disruption, public safety improvements and archeological impacts.	 Fishery improvements and minor tree removal.	
	2	SWMF Retrofit No. 18 (KD05)	 Reduction in phosphorus, frequent nuisance flooding, and erosion.	 Minor capital costs and major increase in maintenance costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Improved quality of fisheries.	
			 Reduction in major system flooding.	 Minor capital costs and a minor reduction in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Minor tree removal.	
			 Reduction in phosphorus, frequent nuisance flooding, and erosion.	 Minor capital costs and a major increase in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal.	
	3	SWMF Retrofit No. 13 (KD03)	 Reduction in phosphorus, frequent nuisance flooding, and erosion.	 Minor capital costs and potential savings with a major increase in maintenance costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Improved quality of fisheries.	
	4	Watercourse Improvement No. 1	 Reduction in ersion potential.	 Minor capital costs and no maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, moderate tree removal, minor impact on natural heritage resources, and minor wildlife enhancement.	
	5	Culvert Improvement No. 13	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	6	Sunnidale Park Centralized LID	 Reduction in phosphorus, frequent nuisance flooding, and moderate decrease in erosion.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and moderate impact on natural heritage resources.	
	7	SWMF Creation No. 17	 Reduction in phosphorus, widespread flooding, and moderate decrease in erosion.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife degradation.	
			 Minor reduction in phosphorus.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disturbance.	 Fishery improvements and moderate impact on natural heritage resources.	
	161	Watercourse Improvement No. 34	 Reduction in ersion potential.	 The need for maintenance costs is eliminated.	 Moderate archeological impact.	 Fishery improvements, moderate tree removal, minor impact on natural heritage resources, and minor wildlife enhancement.	
	162A	Trunk Storm Sewer No. 9 (Option 1)	 Reduction in widespread flooding and erosion.	 Minor capital costs and potential savings with a moderate increase in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Minor impact on natural heritage resources.	
	162B	Trunk Storm Sewer No. 9 (Option 2)	 Reduction in widespread flooding and erosion.	 Minor capital costs and potential savings with a moderate increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Moderate tree removal and minor impact on natural heritage resources.	
	162C	Trunk Storm Sewer No. 9 (Option 3)	 Reduction in widespread flooding and erosion.	 Minor capital costs and potential savings with a moderate increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Minor tree removal and minor impact on natural heritage resources.	
	162D	Trunk Storm Sewer No. 9 (Option 4)	 Reduction in widespread flooding and erosion.	 Moderate capital costs and minor potential savings with a moderate increase in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Minor impact on natural heritage resources.	
	8A	Culvert Improvement No. 16	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Major property disturbances and minor public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	162A	Trunk Storm Sewer No. 9	 Reduction in widespread flooding and erosion.	 Minor capital costs and potential savings with a moderate increase in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Minor impact on natural heritage resources.	
	163	Watercourse Improvement No. 2	 Reduction in erosion potential.	 Minor capital costs and maintenance is not required.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	Improvements in Combination (Option 1)		 Reduction in widespread flooding and erosion.	 Moderate capital costs with minor potential savings and a major increase in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	8B	Culvert Improvement No. 16	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Major property disturbances and minor public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	163	Watercourse Improvement No. 2	 Reduction in erosion potential.	 Minor capital costs and the need for maintenance is eliminated.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	164	Culvert Improvement No. 17	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Major property disturbances and moderate improvements to public safety.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	Improvements in Combination (Option 2)		 Reduction in localized flooding and erosion.	 Minor capital costs and the need for maintenance is eliminated.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and moderate tree removal, impact on natural heritage resources, and wildlife enhancement.	
	9	Culvert Improvement No. 18	 Reduction in localized flooding and minor reduction in erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Minor impact on natural heritage resources.	
	10	Watercourse Improvement No. 3	 Reduction in erosion potential.	 Minor capital costs and maintenance is not required.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	165	Watercourse Improvement No. 25	 Reduction in localized flooding and and a minor increase in erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and habitat creation.	
	166	Culvert Improvement No. 145	 Reduction in localized flooding.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	167	Watercourse Improvement No. 26	 Reduction in localized flooding and and a minor increase in erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and habitat creation.	
	11A	Trunk Storm Sewer No. 11	 Reduction in localized flooding.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	Improvements in Combination (Option 1)		 Reduction in widespread flooding and a minor increase in erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and habitat creation.	
	11B	Trunk Storm Sewer No. 11 (Option 2)	 Reduction in widespread flooding.	 Major capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements and minor impact on natural heritage resources.	

Table 55: Qualitative Individual Project Evalauton Summary

Table 55: Qualitative Individual Project Evalaution Summary				Recommended Project		Feasible Project (Conditional)		Not Recommended/Not Feasible	
Watershed	Project No.	Opportunity (ID)	Physical Environment	Economic Environment	Social/Cultural Environment	Natural Environment	Overall Impact		
Bunkers Creek Watershed (Refer to Figure 18)	31	SWMF Retrofit No. 10 (BK03)	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs with minor potential savings and a major increase in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor impact on natural heritage resources.			
	32	Trunk Storm Sewer No. 1	 Reduction in widespread flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Minor impact on natural heritage resources.			
			 Reduction in widespread flooding and an increase in erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Minor tree removal and minor impact on natural heritage resources.			
	33	Gibbon Park Centralized LID	 Reduction in phosphorus and frequent nuisance flooding.	 Minor capital costs and a major increase in manitenance costs.	 Minor property distrbance and moderate archeological impact.	 Improved quality of fisheries.			
	34	Watercourse Improvement No. 4	 Reduction of erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property distrbance and moderate archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	35	Watercourse Improvement No. 5	 Reduction of erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property distrbance and moderate archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	36	Culvert Improvement No. 143	 Reduction in localized flooding and erosion.	 Minor reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Minor impact on natural heritage resources.			
	37	Culvert Improvement No. 142	 Reduction in localized flooding and erosion.	 Minor reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Minor impact on natural heritage resources.			
	38	Culvert Improvement No. 141	 Reduction in localized flooding and erosion.	 Minor reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Minor impact on natural heritage resources.			
	39	SWMF Retrofit No. 94 / SWMF Retrofit No. 72	 Reduction in phosphorus and widespread flooding.	 Moderate capital costs and a major increase in maintenance costs.	 Major property disturbances, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, moderate tree removal, minor impact on natural heritage resources, and a habitat creation.			
			 Reduction in phosphorus and widespread flooding.	 Moderate capital costs and a major increase in maintenance costs.	 Major property disturbances, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor tree removal, minor impact on natural heritage resources, and a habitat creation.			
			 Reduction in phosphorus and widespread flooding.	 Minor reduction in maintenance costs.	 Moderate public safety improvements and archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and habitat creation.			
	168	Watercourse Improvement No. 7	 Reduction in localized flooding and an increase in erosion.	 Moderate capital costs and reduction in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor tree enhancement, minor impact on natural heritage resources, and a habitat creation.			
	40A	Trunk Storm Sewer No. 2	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Minor impact on natural heritage resources.			
	Improvements in Combination (Option 1)		 Reduction in widespread flooding.	 Moderate capital costs and reduction in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor tree enhancement, minor impact on natural heritage resources, and a habitat creation.			
	40B	Trunk Storm Sewer No. 2 (Option 2)	 Reduction in widespread flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Minor impact on natural heritage resources.			
	40C	Trunk Storm Sewer No. 2 (Option 3)	 Reduction in widespread flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Minor impact on natural heritage resources.			
	41	Watercourse Improvement No. 8	 Reduction in erosion potential.	 Minor capital costs and maintenance is not required.	 Moderate property disturbance and archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	42	Pond Retrofit No. 95 (Milligan's Pond)	 No net change.	 Minor capital costs and maintenance is not required.	 Minor property distrbance and moderate archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	43	Culvert Improvement No. 22	 Reduction in localized flooding and and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	44	Culvert Improvement No. 23	 Reduction in localized flooding and and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
			 Reduction in localized flooding and an increase in erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	45	Culvert Improvement No. 24	 Reduction in localized flooding and and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
	46	Watercourse Improvement No. 27	 Reduction in localized flooding and and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.			
Dyments Creek Watershed (Refer to Figure 18)	47	SWMF Retrofit No. 15 (DY02)	 Reduction in phosphorus, nuisance flooding, and erosion.	 Minor capital costs and a major increase in manitenance costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements and moderate impact on natural heritage resources.			
	48	Cloughley Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenance costs.	 Minor property disturbance and archeological impacts.	 Improved quality of fisheries.			
	49	Watercourse Improvement No. 29	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and major tree removal, impact on natural heritage resources, and wildlife enhancement.			
	181	SWMF Retrofit No. 78	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs with major potential savings and a minor increase in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and major tree removal, impact on natural heritage resources, and major wildlife enhancement.			
	182	Culvert Improvement No. 28	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.			
	183	Watercourse Improvement No. 9	Reduction in localized flooding and an increase in erosion.	Moderate capital costs and a major reduction in maintenance costs.	Moderate property disturbance and archeological impact.	Fishery improvements, major tree removal, and minor impact on natural heritage resources and wildlife enhancement.			
	Improvements in Combination		Reduction in phosphorus, widespread flooding, and erosion,	Moderate capital costs with major potential savings and a major reduction in maintenance costs.	Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife enhancement.			

Table 55: Qualitative Individual Project Evalauton Summary

Table 55: Qualitative Individual Project Evaluation Summary				Recommended Project		Feasible Project (Conditional)		Not Recommended/Not Feasible		
Watershed	Project No.	Opportunity (ID)	Physical Environment	Economic Environment		Social/Cultural Environment		Natural Environment		Overall Impact
Dyments Creek Watershed (Refer to Figure 18)	50	Culvert Improvement No. 29	 Reduction in localized flooding and and erosion.	 Minor capital costs and a moderate reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	51	Watercourse Improvement No. 10	 Reduction in localized flooding and and erosion.	 Moderate capital costs and a major reduction in maintenace costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
	52	Culvert Improvement No. 30	 Reduction in localized flooding and and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
			 Reduction in localized flooding and and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor impact on natural heritage resources.				
	53	Culvert Improvement No. 31	 Reduction in localized flooding and and erosion.	 Major reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	54	Culvert Improvement No. 33	 Reduction in localized flooding and and erosion.	 Major reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	55	Culvert Improvement No. 32	 Reduction in localized flooding and and erosion.	 Minor capital costs and a moderate reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
			 Reduction in localized flooding and and erosion.	 Minor capital costs and a major reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	56	Watercourse Improvement No. 11	 Reduction in localized flooding and an increase in erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree enhancement, minor impact on natural heritage resources, and a habitat creation.				
			 Reduction in localized flooding and and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements and minor impact on natural heritage resources.				
			 Reduction in localized flooding and an increase in erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree enhancement, minor impact on natural heritage resources, and a habitat creation.				
	57	Culvert Improvement No. 34	 Reduction in localized flooding and and erosion.	 Minor capital costs and a moderate reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	169	Culvert Improvement No. 35	 Reduction in localized flooding and erosion.	 Minor capital costs and maintenace is not required.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement				
	170A	SWMF Retrofit No. 79 (DY01)	 Reduction in widespread flooding and erosion.	 Moderate capital costs with major potential savings and a minor increase in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery degradation, moderate tree removal, and minor impact on natural heritage resources.				
	58	Culvert Improvement No. 36	 Reduction in localized flooding and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	Improvements in Combination		 Reduction in widespread flooding and erosion.	 Major capital costs and potential savings with a moderate reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Moderate tree removal, minor impact on natural heritage resources, and minor wildlife enhancement.				
	169	Culvert Improvement No. 35	 Reduction in localized flooding and erosion,	 Minor capital costs and maintenace is not required.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, major tree removal, and minor impact on natural heritage resources and wildlife enhancement.				
	170B	SWMF Retrofit No. 79 (DY01)	 Increase in phosphorus and reduction in widespread flooding and erosion.	 Moderate capital costs with major potential savings and a moderate reduction in maintenace costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, moderate tree enhancement, and minor impact on natural heritage resources.				
	58	Culvert Improvement No. 36	 Reduction in localized flooding and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	Improvements in Combination (Option 2)		 Increase in phosphorus and reduction in widespread flooding and erosion.	 Major capital costs and potential savings with a major reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree enhancement, and minor impact on natural heritage resources and wildlife enhancement.				
	58	Culvert Improvement No. 36 (Option 3)	 Reduction in localized flooding and erosion.	 Moderate capital costs and a mionr reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	59	Watercourse Improvement No. 12	 Decrease in erosion potential.	 Minor capital costs and maintenace is not required.	 Minor public safety improvements and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
	60	Culvert Improvement No. 37	 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
	61	Culvert Improvement No. 38	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenace costs.	 Moderate property disturbance and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
	62	Culvert Improvement No. 39	 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement				
	63	Watercourse Improvement No. 28	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor public safety improvements and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
Hotchkiss Creek (Refer to Figure 20)	12	Culvert Improvement No. 41	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	13	Culvert Improvement No. 42	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				
	16	Culvert Improvement No. 44	 Reduction in localized flooding and erosion	 Moderate reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Minor impact on natural heritage resources.				
	17	SWMF Retrofit No. 44	 Reduction of phosphorus, localized flooding, and erosion.	 Moderate capital costs and a major increase in maintenace costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and a habitat creation.				
			 Reduction in phosphorus, nuisance flooding, and erosion.	 Moderate capital costs and a major increase in maintenace costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements and minor impact on natural heritage resources.				

Table 55: Qualitative Individual Project Evalauton Summary

Table 55: Qualitative Individual Project Evalaution Summary				Recommended Project		Feasible Project (Conditional)		Not Recommended/Not Feasible		
Watershed	Project No.	Opportunity (ID)	Phsyical Environment	Economic Environment		Social/Cultural Environment		Natural Environment		Overall Impact
Hotchkiss Creek (Refer to Figure 20)	18	Culvert Improvement No. 46	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Minor impact on natural heritage resources and minor wildlife enhancement.				
	19	SWMF Retrofit No. 81	 Reduction in widespread flooding and erosion.	 Major capital costs with moderate potential savnigs and a minor increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, major tree enhancement, minor impact on natural heritage resources, and major wildlife enhancement.				
	20	SWMF Retrofit No. 96	 Reduction in widespread flooding and erosion.	 Moderate capital costs and potential savings with a minor increase in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor tree enhancement, minor impact on natural heritage resources, and minor wildlife degradation.				
	21	Culvert Improvement No. 135	 Reduction in localized flooding and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
	22	Culvert Improvement No. 48	 Reduction in localized flooding and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
	23	Watercourse Improvement No. 6	 Reduction in phosphorus, localized flooding, and an increase in erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and a habitat creation.				
			 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
			 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Watercourse enclosure, minor impact natural heritage resources, and habitat destruction.				
	24	Culvert Improvement No. 49	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
	25	Watercourse Improvement No. 13	 Reduction in phosphorus, localized flooding, and an increase in erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree enhancement, minor impact on natural heritage resources, and a habitat creation.				
			 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
	26	SWMF Retrofit No. 48 (HT13)	 Reduction in phosphorus and widespread flooding.	 Moderate capital costs with minor potential savings and a moderate increase in maintenance costs.	 Major property disturbances, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife degradation.				
	27	Culvert Improvement No. 50	 Reduction in localized flooding.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
	Improvements in Combination (Option 1)		 Reduction in phosphorus and widespread flooding.	 Moderate capital costs with minor potential savings and a moderate increase in maintenance costs.	 Major property disturbances, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife degradation.				
	27	Culvert Improvement No. 50 (Option 2)	 Reduction in localized flooding.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
28	Watercourse Improvement No. 14	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.					
29	Allandale Heights Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenace costs.	 Minor property disturbance and archeological impacts.	 Improved quality of fisheries.					
30	Trunk Storm Sewer No. 10	 Reduction in widespread flooding and erosion.	 Minor capital costs and potential savings with a moderate reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Improved quality of fisheries.					
Huronía Creek Drainage Area (Refer to Figure 21)	164	Greenfield Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.				
	184	SWMF Retrofit No. 85 (HR03)	 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Moderate property disturbance and archeological impact.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and minor wildlife degradation.				
	185	SWMF Retrofit No. 28 (HR01)	 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Moderate property disturbance and archeological impact.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife degradation.				
Whiskey Creek Watershed (Refer to Figure 19)	64	Mapleton Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.				
	65	Harvie Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.				
	66	Montserrand Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenance costs.	 Minor property distrbance and moderate archeological impact.	 Fishery improvements and minor tree removal.				
	67	SWMF Retrofit No. 42	 Reduction in phosphorus, widesread flooding, and erosion.	 Minor capital costs with major potential savings and a major increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, major tree removal, moderate impact on natural heritage resources and moderate wildlife degradation.				
			 Reduction in phosphorus, widesread flooding, and erosion.	 Minor capital costs with major potential savings and a minor increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, major tree removal, moderate impact on natural heritage resources and moderate wildlife degradation.				
	68	Culvert Improvement No. 53	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement.				
69	SWMF Retrofit No. 92 (WK05)	Reduction in phosphorus and erosion.	Minor capital costs and a major increase in manitenace costs.	Moderate archeological impact.	Fishery improvements, major tree removal, minor impact on natural heritage resources and wildlife degradation.					

Table 55: Qualitative Individual Project Evalauton Summary

			Recommended Project		Feasible Project (Conditional)	Not Recommended/Not Feasible	
Watershed	Project No.	Opportunity (ID)	Phsyical Environment	Economic Environment	Social/Cultural Environment	Natural Environment	Overall Impact
Whiskey Creek Watershed (Refer to Figure 19)	70	Culvert Improvement No. 54	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	171	Watercourse Improvement No. 15	 Reduction in localized flooding and erosion.	 Minor capital costs.	 Moderate public safety improvements and archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources and wildlife degradation.	
	172A	Culvert Improvement No. 55	 Reduction in widespread flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate public safety improvements.	 Watercourse enclosure, minor tree removal, minor impact natural heritage resources, and minor wildlife degradation.	
	Improvements in Combination (Option 1)		 Reduction in widespread flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate public safety improvements and archeological impacts.	 Minor tree removal, minor impact natural heritage resources, and minor wildlife degradation.	
	70	Culvert Improvement No. 54	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	172B	Culvert Improvement No. 55	 Reduction in localized flooding and erosion.	 Minor reduction in maintenance costs.	 Moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	Improvements in Combination (Option 2)		 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	71	Culvert Improvement No. 56	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	72	Culvert Improvement No. 57	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	73	Watercourse Improvement No. 16	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Moderate property disturbance and archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	74	Watercourse Improvement No. 30	 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife enhancement.	
		Trunk Storm Sewer	 Reduction in localized flooding and erosion.	 Moderate capital costs and a major increase in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Minor tree removal and minor impact on natural heritage resources.	
	75	SWMF Retrofit No. 40	 Reduction in phosphorus, widespread flooding, and erosion.	 Minor capital costs with major potential savings and a major increase in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, minor tree removal, and minor wildlife degradation.	
	76	Watercourse Improvement No. 17	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	77	Watercourse Improvement No. 18	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	78	Culvert Improvement No. 147	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	79	Assickinack Park Centralized Park LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.	
	80	Culvert Improvement No. 60	 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	81	Watercourse Improvement No. 31	 Decrease in erosion potential.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	82	SWMF Retrofit No. 26	 Reduction in phosphorus and localized flooding.	 Minor capital costs with moderate potential savings and a moderate increase in maintenance costs.	 Minor property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources and moderate wildlife degradation.	
	83	SWMF Retrofit No. 25 (WK01)	 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvments, moderate impact on natural heritage resources, and minor wildlife enhancement.	
	84	Culvert Improvement No. 62	 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	179	Watercourse Improvement No. 32	 Reduction in localized flooding and erosion.	 Moderate capital costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree removal, and minor impact on natural heritage resources and wildlife enhancement.	
	Improvements in Combination		 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements, moderate tree removal, minor impact on natural heritage resources, and major wildlife enhancement.	
	85	Culvert Improvement No. 63	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	86	Culvert Improvement No. 138	 Reduction in localized flooding and erosion.	 Minor reduction in maintenance costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	87	SWMF Retrofit No. 20 (WK04)	 Reduction in phosphorus.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.	
	88	Culvert Improvement No. 64	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	89	Watercourse Improvement No. 19	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Moderate property disturbance and archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	

Table 55: Qualitative Individual Project Evalauton Summary

Table 55: Qualitative Individual Project Evalaution Summary			Recommended Project		Feasible Project (Conditional)		Not Recommended/Not Feasible	
Watershed	Project No.	Opportunity (ID)	Physical Environment	Economic Environment	Social/Cultural Environment	Natural Environment	Overall Impact	
Whiskey Creek Watershed (Refer to Figure 19)	174A	Culvert Improvement No. 65	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	175	Watercourse Improvement No. 20	 Reduction in localized flooding and erosion.	 Minor capital costs.	 Moderate property disturbance and archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	176	Culvert Improvement No. 66	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	177	Watercourse Improvement No. 21	 Reduction in localized flooding and erosion.	 Minor capital costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	Improvements in Combination (Option 1)		 Reduction in localized flooding and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	90A	Trunk Storm Sewer No. 13	 Reduction in localized flooding and erosion.	 Moderate capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.		
	174B	Culvert Improvement No. 65	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	175	Watercourse Improvement No. 20	 Reduction in localized flooding and erosion.	 Minor capital costs.	 Moderate property disturbance and archeological impact.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	176	Culvert Improvement No. 66	 Reduction in localized flooding and erosion.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	177	Watercourse Improvement No. 21	 Reduction in localized flooding and erosion.	 Minor capital costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	Improvements in Combination (Option 2)		 Reduction in localized flooding and erosion.	 Major capital costs and a minor reduction in maintenance cost.	 Moderate property disturbance, public safety improvements, and archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	90B	Trunk Storm Sewer No. 13 (Option 3)	 Reduction in localized flooding and erosion.	 Major capital costs and a major increase in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.		
Lovers Creek Watershed (Refer to Figure 19)	95	SWMF Retrofit No. 86 (LV16)	 Reduction in phosphorus.	 Minor capital costs and a moderate increase in maintenance costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	96	SWMF Retrofit No. 87 (LV17)	 Reduction in phosphorus.	 Minor capital costs and a moderate increase in maintenance costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements, minor tree removal, and moderate wildlife enhancement.		
	97	SWMF Retrofit No. 65 (LV07)	 Reduction in phosphorus, nuisance flooding, and erosion.	 Moderate capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor wildlife enhancement.		
	98	Culvert Improvement No. 126	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife degradation.		
	99	Culvert Improvement No. 89	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	101	Culvert Improvement No. 91	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor tree removal, minor impact on natural heritage resources, and moderate wildlife enhancement.		
	102	SWMF Retrofit No. 45 (LV05)	 Decrease in erosion potential.	 Minor capital costs and a major reduction in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and moderate wildlife enhancement.		
	103	Culvert Improvement No. 94	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	104	Culvert Improvement No. 95	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	105A	Culvert Improvement No. 123	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	Improvements in Combination (Option 1)		 Reduction in localized flooding and erosion.	 Moderate capital costs and reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and moderate wildlife enhancement		
	105B	Culvert Improvement No. 123 (Option 2)	 Reduction in localized flooding and erosion.	 Minor capital costs with major potential saving and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	106	SWMF Retrofit No. 32 (LV12)	 Reduction in phosphorus.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.		
	107	Culvert Improvement No. 92	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	109	Culvert Improvement No. 99	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements, moderate impact on natural heritage resources, and minor wildlife enhancement.		
	110	Culvert Improvement No. 98	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		
	111	SWMF Retrofit No. 30 (LV02)	 Reduction in phosphorus.	 Minor capital costs and a minor reduction in maintenace costs.	 Moderate archeological impact.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement		
	112	SWMF Retrhoit No. 31 (LV03)	 Reduction in phosphorus and erosion.	 Minor capital costs and a minor increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, minor tree removal and wildlife enhancement.		
	113	Culvert Improvement No. 97	Reduction in localized flooding and erosion.	Minor capital costs and a moderate reduction in maintenance costs.	Minor property disturbance and moderate public safety improvements.	Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.		

Table 55: Qualitative Individual Project Evalaution Summary

Table 55: Qualitative Individual Project Evalaution Summary				Recommended Project		Feasible Project (Conditional)		Not Recommended/Not Feasible		
Watershed	Project No.	Opportunity (ID)	Physical Environment	Economic Environment		Social/Cultural Environment		Natural Environment		Overall Impact
Lovers Creek Watershed (Refer to Figure 19)	114	Trunk Storm Sewer No. 7	 Reduction in localized flooding.	 Major capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.				
	115	Madeline Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements and minor tree removal.				
	129	Kuzmich Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in manitenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.				
	116	Golden Meadow Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Moderate capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.				
	117	Carter Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.				
	118	SWMF Retrofit No. 37 (LV10)	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.				
	119	SWMF Retrofit No. 68 (LV01)	 Reduction in phosphorus, localized flooding, and erosion.	 Moderate capital costs and a mionr reduction in maintenance costs.	 Moderate property disturbance and archeological impact.	 Fishery improvements, moderate tree removal, and moderate wildlife degradation.				
	120	Watercourse Improvement No. 22	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, major tree removal, moderate impact on natural heritage resources, and minor wildlife enhancement.				
	121	Watercourse Improvement No. 23	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, major tree removal, moderate impact on natural heritage resources, and minor wildlife enhancement.				
	122	Culvert Improvement No. 105	 Reduction in localized flooding and erosion.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.				
Hewitts Creek Watershed (Refer to Figure 21)	125	Culvert Improvement No. 83	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenance costs.	 Moderate property disturbance and public safety improvements.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement				
	126	Queensway/Hyde Park Centralized LID	 Reduction in phosphorus, nuisance flooding, and erosion.	 Moderate capital costs and a major increase in maintenance costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements, minor tree removal, and moderate impact on natural heritage resources.				
	127	Sandringham Park Centralized LID	 Reduction in phosphorus, nuisance flooding, and erosion.	 Moderate capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, major tree removal, and moderate impact on natural heritage resources.				
	128	SWMF Retrofit No. 27	 Reduction in phosphorus, nuisance flooding, and erosion.	 Minor capital costs with the cost of new maintenance.	 Minor public safety improvements and moderate archeological impact.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife degradation.				
	130	Trunk Storm Sewer No. 6	 Reduction in localized flooding.	 Minor capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.				
Georgian Creek Watershed (Refer to Figure 17)	133	Strabane Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 No impact.				
	134	SWMF Retrofit No. 76 (GR04)	 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvments and moderate tree removal and wildlife degradation.				
	135	Trunk Storm Sewer No. 3	 Reduction in widespread flooding.	 Major capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.				
	136	Dunsmore Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Moderate capital costs and a major increase in maintenance costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements, minor tree removal, and moderate impact on natural heritage resources.				
	137	Trunk Storm Sewer No. 4	 Reduction in widespread flooding.	 Major capital costs and a moderate reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.				
	138	SWMF Retrofit No. 75 (GR01)	Reduction in phosphorus.	Minor capital costs and a minor increase in maintenance costs.	Minor property disruption and moderate archeological impacts.	Fishery improvements, minor tree removal, and minor wildlife degradation.				
	139	Culvert Improvement No. 82	Reduction in localized flooding and erosion.	Minor capital costs and a moderate reduction in maintenance costs.	Minor property disturbance and moderate public safety improvements.	Fishery improvements, minor tree removal, and minor wildlife enhancement.				

Table 55: Qualitative Individual Project Evalauton Summary

			Recommended Project		Feasible Project (Conditional)	Not Recommended/Not Feasible	
Watershed	Project No.	Opportunity (ID)	Phsyical Environment	Economic Environment	Social/Cultural Environment	Natural Environment	Overall Impact
Little Lake Watershed (Refer to Figure 17)	140	Cartwright Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Improved quality of fisheries.	
	141	Trunk Storm Sewer No. 5	 Reduction in localized flooding.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.	
	142	SWMF Retrofit No. 77 (LT01)	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and the cost of new maintenance.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal.	
			 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and a minor increase in maintenance costs.	 Major property disturbance, moderate public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, and minor wildlife enhancement.	
			 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Moderate property disturbance and archeological impacts, and minor public safety improvements.	 Fishery improvements and minor wildlife enhancement.	
			 Reduction in flooding.	 Property acquisition costs.	 Major property disturbance.	 No Impact.	
	143	Watercourse Improvement No. 24	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, minor tree removal, impact on natural heritage resources, and wildlife degradation.	
	144	SWMF Retrofit No. 89 (LT05)	 Reduction in phosphorus and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and minor wildlife degradation.	
	145	SWMF Retrofit No. 84 (LTGM)	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and potential savings with a minor increase in maintenance costs.	 Moderate property disturbance and public safety improvements, and minor archeological impacts.	 Fishery improvements and minor tree removal.	
	178A	SWMF Retrofit No. 91 (LT04)	 Reduction in phosphorus.	 Minor capital costs and a minor reduction in maintenance costs.	 Minor property disturbance and archeological impacts.	 Fishery improvements, minor tree removal, minor impact on natural heritage resources, and minor wildlife degradation.	
	Improvements in Combination (Option 1)		 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and a minor increase in maintenance costs.	 Moderate property disturbance and public safety improvements, and minor archeological impacts.	 Fishery improvements, moderate tree removal, minor impact on natural heritage resources, and minor wildlife degradation.	
Bear Creek Watershed (Refer to Figure 20)	145	SWMF Retrofit No. 84 (LTGM) - Option 2	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and potential savings with a minor increase in maintenance costs.	 Moderate property disturbance and public safety improvements, and minor archeological impacts.	 Fishery improvements and minor tree removal.	
	178B	SWMF Retrofit No. 91 (LT04) - Option 3	 Reduction in phosphorus, widespread flooding, and erosion.	 Moderate capital costs and a minor increase in maintenance costs.	 Minor property disturbance and archeological impact, and moderate public safety improvements.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and moderate wildlife degradation.	
	147	Lougheed Park Centralized LID	 Reduction in phosphorus, nuisance flooding, and erosion.	 Minor capital costs and a major increase in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, minor tree removal, and moderate impact on natural heritage resources.	
	148	Wessenger Park Centralized LID	 Reduction in phosphorus, nuisance flooding, and erosion.	 Minor capital costs and a major increase in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.	
	149	Bear Creek Centralized LID	 Reduction in phosphorus, nuisance flooding, and erosion.	 Major capital costs and a major increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements and minor tree removal.	
	150	SWMF Retrofit No. 61 (BR08b)	 Reduction in phosphorus and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, minor tree removal and wildlife degradation, and moderate impact on natural heritage resources.	
	151	SWMF Retrofit No. 69 (BR13)	 Reduction in phosphorus.	 Moderate capital costs and a minor increase in maintenance costs.	 Major property disturbance and moderate archeological impact.	 Fishery improvements, major tree removal, minor impact on natural heritage resources, and major wildlife enhancement.	
	152	SWMF Retrofit No. 90 (BR14)	 Reduction in phosphorus.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disruption and moderate archeological impacts.	 Moderate impact on natural heritage resources and moderate wildlife degradation.	
	153	SWMF Retrofit No. 62 (BR05)	 Reduction in phosphorus.	 Minor capital costs and a minor increase in maintenance costs.	 Minor property disruption and moderate archeological impacts.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	154	Culvert Improvement No. 78	 Reduction in localized flooding and erosion.	 Minor capital costs and a minor reduction in maintenace costs.	 Minor property disturbance and minor public safety improvements.	 Fishery improvements and minor tree removal, impact on natural heritage resources, and wildlife enhancement.	
	155	Watercourse Improvement No. 33	 Decrease in erosion potential.	 Minor capital costs and maintenance is not required.	 Minor property disruption, minor public safety improvements, and moderate archeological impacts.	 Fishery improvements and minor tree removal and natural heritage resources.	
Johnson Drainage Area (Refer to Figure 17)	156	Culvert Improvement No. 134	 Decrease in erosion potential.	 Minor capital costs.	 Minor property disturbance.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
	157	Culvert Improvement No. 80	 Decrease in erosion potential.	 Minor capital costs.	 Minor property disturbance.	 Fishery improvements, minor impact on natural heritage resources, and minor wildlife enhancement	
Nelson Drainage Area (Refer to Figure 17)	159	Trunk Storm Sewer No. 8	 Reduction in widespread flooding.	 Moderate capital costs and reduction in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.	
	160	Shoreview Park Centralized LID	 Reduction in phosphorus and nuisance flooding.	 Minor capital costs and a major increase in maintenace costs.	 Minor property distrbance and moderate archeological impact.	 Improved quality of fisheries.	
Nelson Drainage Area (Refer to Figure 17)	180	Trunk Storm Sewer No. 12	 Reduction in widespread flooding.	 Minor capital costs and a moderate increase in maintenance costs.	 Minor property disturbance and moderate public safety improvements.	 No impact.	

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Kidd's Creek Watershed (Refer to Figure 18)	1	SWMF Retrofit No. 11 (KD06)	Livingstone St. W. and Ford St.	Construct underground infiltration system for water quality treatment, erosion control and active storage offset (SWMF KD02).	8	SWMF KD06 satisfies the LSRCA Peak Flow Control Credits criteria for infiltration systems and will provide volume offset for SWMF KD02. SWMF KD06 is located outside the LSRCA Regulated Area.
	2	SWMF Retrofit No. 18 (KD05)	Livingstone St. W. and Neelands St.	Underground infiltration system for water quality treatment and phosphorus removal.	3	SWMF KD05 satisfies the LSRCA Peak Flow Control Credits criteria for infiltration systems and is located outside the LSRCA Regulated Area.
				Grade major overland flow route through 81 and 83 Janice Dr. to prevent private property flooding.	-10	Construction of overland flow route will reduce infrequent flooding during major storm events when flows leave SWMF KD05 via the overflow spillway. Option impacts 81 and 83 Janice Drive.
				Improvements Completed in Combination	-3	Improvements implemented in combination (SWMF retrofit and overland flow route) produces an overall negative impact on the project environments.
	3	SWMF Retrofit No. 13 (KD03)	Between Irwin Dr. and Sunnidale Rd.	Underground infiltration system for water quality treatment, phosphorus removal and active storage offset (SWMF KD02)	11	SWMF KD03 satisfies the LSRCA Peak Flow Control Credits criteria for infiltration systems and will provide volume offset for SWMF KD02. SWMF KD06 is located outside the LSRCA Regulated Area.
	4	Watercourse Improvement No. 1	Between Lilian Cres. and Cundles Rd. W. (Reaches Ki-1 and Ki-2)	Watercourse Improvements on Kidd's Creek to stabilize existing bank erosion	10	Watercourse improvements consistent with the recommendations of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preferred Alternative (Water's Edge / Azimuth, March 2017).
	5	Culvert Improvement No. 13	Cundles Rd. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency)	13	Culvert improvements consistent with the recommendations of the Kidd's Creek MDP.
	6	Sunnidale Park Centralized LID	Sunnidale Park	Construct underground infiltration gallery (LID) for water quality treatment and phosphorus removal	-9	Sunnidale Park is located in a Significant Groundwater Recharge Area and a Well Head Protection Area. The LID will receive runoff from a collector road. As such, infiltration systems are not permitted in Sunnidale Park.
	7	SWMF Creation No. 17	Between Coulter St. and Highway 400	Construct wet pond SWMF for water quality treatment and erosion control	-7	The impacts of the SWMF creation outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, SWMF Creation No. 17 should be re-evaluated in consultation with the LSRCA.
				Install oil grit separators for water quality treatment	-15	Installing oil grit separators to improve water quality produces a greater overall negative impact than the creation of a SWMF at this location. Oil grit separators do not provide phosphorus treatment.
	161	Watercourse Improvement No. 34	Kidd's Creek between Cundles Rd. and Highway 400 (Reach Ki-3 through Ki-6)	Watercourse Improvements on Kidd's Creek to stabilize existing bank erosion	14	Watercourse improvements consistent with the recommendations of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preferred Alternative (Water's Edge / Azimuth, March 2017).
	162A	Trunk Storm Sewer No. 9 (Option 1)	Thomson St., Sophia St. W., Florence St., Park St. and Eccles St. N.	Trunk storm sewer to alleviate downstream erosion	14	Option 1 provides the greatest overall benefit to the watershed. As such, Option 1 has been carried forward as part of the Alternative Solutions evaluation.
	162B	Trunk Storm Sewer No. 9 (Option 2)	Thomson St., Sophia St. W. and Florence St.	Trunk storm sewer to alleviate downstream erosion	0	
	162C	Trunk Storm Sewer No. 9 (Option 3)	Thomson St., Sophia St. W., Florence St., Park St. and Mulholland St.	Trunk storm sewer to alleviate downstream erosion	2	
	162D	Trunk Storm Sewer No. 9 (Option 4)	Thomson St., Sophia St. W., Florence St., Park St. and Parkside Dr.	Trunk storm sewer to alleviate downstream erosion	9	
	8A	Culvert Improvement No. 16	Thomson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP)	-6	Culvert upgrades to satisfy 1:100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP) in combination with Trunk Storm Sewer No. 9.
	162A	Trunk Storm Sewer No. 9	Thomson St., Sophia St. W. and Florence St.	Construct trunk storm sewer to reduce flows through Kidd's Creek from Thomson St. to Eccles St. N.	14	Trunk storm sewer sized to convey the difference between the 100 year return frequency peak flow and Eccles St. N. culvert capacity (3.3 cms).
	163	Watercourse Improvement No. 2	Between Thomson St. and Eccles St. (Reach Ki-8a)	Watercourse Improvements on Kidd's Creek to stabilize existing bank erosion	8	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	Improvements in Combination (Option 1)		Thomson St., Sophia St. W. and Florence St. and between Thomson St. and Eccles St.	Improvements Completed in Combination	31	Improvements implemented in combination (Option 1) produces the greatest overall positive impact on the project environments of the options considered and is recommended for implementation.
	8B	Culvert Improvement No. 16	Thomson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP)	-6	Culvert improvements consistent with the recommendations of the Kidd's Creek MDP.
	163	Watercourse Improvement No. 2	Between Thomson St. and Eccles St.	Watercourse Improvements on Kidd's Creek to stabilize existing bank erosion	8	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	164	Culvert Improvement No. 17	Eccles St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP)	2	Culvert improvements consistent with the recommendations of the Kidd's Creek MDP.
	Improvements in Combination (Option 2)		Thomson St. and Eccles St. and between Thomson and Eccles St.	Improvements Completed in Combination	18	Improvements implemented in combination (Option 2) produces a positive overall impact on the project environments. However, Option 1 produces a greater overall positive impact on the project environments.
	9	Culvert Improvement No. 18	Wellington St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency)	24	Culvert improvements consistent with the recommendations of the Kidd's Creek MDP.
	10	Watercourse Improvement No. 3	Between Eccles St. and Henry St. (Reaches Ki-10b through Ki-10c)	Watercourse improvements on Kidd's Creek to stabilize existing bank failures/erosion	8	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	165	Watercourse Improvement No. 25	Between Eccles St. and Dunlop St. W. (Reach Ki-11)	Daylight watercourse through 150 Dunlop St. W.	16	Daylight watercourse to increase conveyance capacity and reduce flooding. Option impacts 150 Dunlop St. W.
	166	Culvert Improvement No. 145	Dunlop St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency)	5	Culvert improvements consistent with the recommendations of the Kidd's Creek MDP.
	167	Watercourse Improvement No. 26	Between Dunlop St. W. and Bradford St. (Reach Ki-11)	Daylight watercourse through 125 Dunlop St. W.	31	Daylight watercourse to increase conveyance capacity and reduce flooding.
	11A	Trunk Storm Sewer No. 11	Bradford St.	Trunk storm sewer extension to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency)	10	Trunk storm sewer sized to satisfy the City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).
	Improvements in Combination (Option 1)		Dunlop St. W. and Bradford St. and between Eccles St. and Bradford St.	Improvements Completed in Combination	3	Improvements implemented in combination (Option 1) produces the greatest overall positive impact on the project environments of the options considered and is recommended for implementation.
	11B	Trunk Storm Sewer No. 11 (Option 2)	Dunlop St. W. to Bradford St.	Trunk storm sewer upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency)	-18	Trunk storm sewer sized to satisfy the City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency). Option 2 produces an overall negative impact on the project environment.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Bunkers Creek Watershed (Refer to Figure 18)	31	SWMF Retrofit No. 10 (BK03)	Northwest of Shelley Ln. and Anne St. N. Intersection	Construct underground infiltration system for water quality treatment and phosphorus removal. SWMF outlet modifications for peak flow attenuation.	18	SWMF BK03 satisfies the LSRCA Peak Flow Control Credits criteria for infiltration system. SWMF BK03 is located in the LSRCA Regulated Area.
	32	Trunk Storm Sewer No. 1	Anne St. N. from BK03 to Edgehill Dr.	Construct trunk storm sewer on Anne St. N. to divert flows reducing downstream flooding and erosion on Bunkers Creek (Reach Bu-3).	28	The option of constructing a trunk storm sewer on Anne St. N. produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
			Existing Storm Sewer Alignment (Valley Dr. to Wesley St.)	Replace local storm sewer with trunk storm sewer (existing alignment) to reduce flooding.	-2	The option of constructing a trunk storm sewer along the existing sewer alignment produces an overall negative impact on the project environments. However, constructing a trunk storm sewer on Anne St. S. is recommended.
	33	Gibbon Park Centralized LID	Gibbon Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-10	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Gibbon Park LID should be re-evaluated in consultation with the LSRCA.
	34	Watercourse Improvement No. 4	Bunkers Creek downstream of Shirley Ave. (Reach Bu-3)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-3).	8	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	35	Watercourse Improvement No. 5	Bunkers Creek downstream of Edgehill Rd. (Reach Bu-7)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-7).	13	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	36	Culvert Improvement No. 143	Highway 400 - Bunkers Creek (North Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	37	Culvert Improvement No. 142	Highway 400 - Bunkers Creek (Central Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	38	Culvert Improvement No. 141	Highway 400 - Bunkers Creek (South Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	39	SWMF Retrofit No. 94 / SWMF Retrofit No. 72	New SWMF between Highway 400 and Dunlop St. W. east of future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south and central branches of Bunkers Creek.	-5	The options of constructing a SWMF on private property produce an overall negative impact on the project environments. These options are not recommended for implementation regardless of the implementation of the SWMF within the Highway 400 ramp.
			New SWMF north of Dunlop St. W. east of future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south and central branches of Bunkers Creek.	-3	
			New SWMF within future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south and central branches of Bunkers Creek.	38	The option of constructing a new SWMF within the Highway 400 ramp produces the greatest positive overall impact on the project environments of the options considered and is recommended for implementation.
	168	Watercourse Improvement No. 7	Through 280, 284, 286 and 290 Dunlop St. W.	Daylight watercourse (construct open channel) from future Highway 400 E/W-N ramp to Anne. St. S. to convey Bunkers Creek (Central and South Branch) flows.	5	Daylight watercourse to increase conveyance capacity and reduce flooding. Option impacts 280, 284, 286, and 290 Dunlop St. W.
	40A	Trunk Storm Sewer No. 2	Anne St. S. from Dunlop St. W. to Perry St.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	17	Trunk storm sewer sized to satisfy the City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).
	Improvements in Combination (Option 1)		Through 280, 284, 286 and 290 Dunlop St. W. and Anne St. S. from Dunlop St. W. to Perry St.	Improvements Completed in Combination	5	Improvements implemented in combination produces a positive overall impact on the project environments. However, Option 2 produces a greater overall positive impact on the project environments.
	40B	Trunk Storm Sewer No. 2 (Option 2)	Dunlop St. W. and Anne St. S. from Highway 400 E/W-N-ramp to Perry St.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	15	Supplementing the existing trunk storm sewer by constructing a new trunk storm sewer within the road allowance produces the greatest positive overall impact on the project environments of the options considered.
	40C	Trunk Storm Sewer No. 2 (Option 3)	Through existing Easement from Dunlop St. W. to Anne St. S.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	5	Constructing a trunk storm sewer through the existing easement produces a positive overall impact on the project environments. However, Option 2 produces a greater overall positive impact on the project environments.
	41	Watercourse Improvement No. 8	Bunkers Creek between Anne St. S. and Innisfil St. (Reaches Bu-11 and Bu-15)	Toe treatment to mitigate bank scour and undercutting on Bunkers Creek (Reach Bu-11 and Bu-15).	3	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	42	Pond Retrofit No. 95 (Milligan's Pond)	Milligan's Pond between Boyz St. and Innisfil St.	Cleanout accumulated sediment from Milligans Pond and reinstate watercourse.	6	Milligan's Pond is not a SWMF. Recommended improvement is to reinstate the watercourse through Milligan's Pond.
	43	Culvert Improvement No. 22	Innisfil St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Bunkers Creek MDP).	11	Culvert improvements consistent with the recommendations of the Bunkers Creek MDP.
	44	Culvert Improvement No. 23	Commercial Plaza Entrance Road	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Bunkers Creek MDP).	11	The option of improving the culvert produces an overall positive impact on the project environments. However, removing the culvert crossing and installing a pedestrain bridge is recommended.
				Remove existing culvert and daylight watercourse. Install pedestrian bridge for access to paking lot.	17	The option of removing the existing culvert crossing and replacing it with a pedestrain bridge produces the greatest positive overall impact on the project environments of the options considered and is recommended for
	45	Culvert Improvement No. 24	Bradford St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	6	Culvert improvements consistent with the recommendations of the Bunkers Creek MDP.
	46	Watercourse Improvement No. 27	Bunkers Creek (Reach Bu-16) downstream of Bradford St. to Lakeshore Dr.	Natural watercourse enhancement on Bunkers Creek (Reach Bu-16) to increase conveyance capacity, habitat and canopy.	5	Watercourse improvements consistent with the recommendations of the Bunkers Creek MDP.
Dyments Creek Watershed (Refer to Figure 18)	47	SWMF Retrofit No. 15 (DY02)	Between McVeigh Dr. and Cundles Rd. W.	Construct underground infiltration system for water quality treatment and phosphorus removal.	-7	SWMF DY02 is located in a Well Head Protection Area and receives runoff from collector roads. Infiltration systems are not permitted in SWMF DY02.
	48	Cloughley Park Centralized LID	Cloughley Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-13	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Cloughly Park LID should be re-evaluated in consultation with the LSRCA.
	49	Watercourse Improvement No. 29	Downstream of Sproule Dr. to SWMF Retrofit No. 78	Realign Dyments Creek from Sproule Dr. to SWMF Retrofit No. 78.	-2	Realign Dyments Creek through SWMF Retrofit No. 78.
	181	SWMF Retrofit No. 78	Between Sproule Dr. and Dunlop St. W.	Construct SWMF above low flow channel for peak flow attenuation during major storms.	15	SWMF creation consistent with the recommendations of the Dyments Creek MDP.
	182	Culvert Improvement No. 28	Dunlop St. W.	Relocate and upgrade culvert to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	20	Culvert improvements consistent with the recommendations of the Dyments Creek MDP. Dunlop St. W. culvert crossing to be relocated as part of recommended solution.
	183	Watercourse Improvement No. 9	Dunlop St. W. to Ferndale Dr. N (Reach Dy-2a)	Realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. to facilitate SWMF retrofit (No. 78) and increase conveyance capacity.	-17	Natural channel enhancement between Dunlop St. W. and Ferndale Dr. Watercourse improvement will improve conveyance capacity and reduce flooding.
Improvements in Combination			Dyments Creek (Reach Dy-1 and Dy-2a) between Sproule Dr. and Ferndale Dr. N.	Improvements Completed in Combination	21	Improvements implemented in combination produces a positive overall impact on the project environments. Implementing the projects in combination is recommended.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Dyments Creek Watershed (Refer to Figure 18)	50	Culvert Improvement No. 29	Ferndale Dr. N.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	16	Culvert improvements consistent with the recommendations of the Dyments Creek MDP.
	51	Watercourse Improvement No. 10	Ferndale Dr. N. to Sarjeant Dr. (Reach Dy-2b)	Regrade/reshape Dyments Creek from Ferndale Dr. N. to Sarjeant Dr. to provide positive drainage and increased conveyance capacity.	2	Watercourse improvements consistent with the recommendations of the Dyments Creek MDP.
	52	Culvert Improvement No. 30	Sarjeant Dr. and Dunlop St. W. Within existing easement through 15 Sarjeant Dr., Address Not Available and 395 Dunlop St. W.	Realign and upgrade culvert to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	5	The option of installing new culvert within the road allowance and eliminating the infrastructure from private property produces the greatest overall positive impact on the project environments.
				Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	-5	The option of improving the existing culvert through private property produces an overall negative impact on the project environments. This option is not recommended for implementation.
	53	Culvert Improvement No. 31	Highway 400 E/W-S and N-E/W Ramps	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	15	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	54	Culvert Improvement No. 33	Highway 400	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	5	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	55	Culvert Improvement No. 32	Hart Dr.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	6	The option of improving the existing culvert crossing under Hart Dr. produces an overall positive impact on the project environments. However, extending the Highway 400 culvert under Hart Dr. is recommended.
				Extend Highway 400 Culvert under Hart Dr.	15	The option of extending the Highway 400 culvert under Hart Dr. produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
	56	Watercourse Improvement No. 11	Downstream of Hart Dr. (Reach Dy-3)	Daylight watercourse (through 65 Hart Dr.)	16	The option of daylighting the watercourse through 65 Hart Dr. produces an overall positive impact on the project environments. However, daylighting the watercourse through 55 Hart Dr. is recommended.
				Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	-11	The option of improving the existing culvert crossing 65 Hart Dr. produces an overall negative impact on the project environments and is not recommended.
				Daylight watercourse (through 55 Hart Dr.)	26	The option of daylighting the watercourse through 55 Hart Dr. produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
	57	Culvert Improvement No. 34	George St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	11	Culvert improvements consistent with the recommendations of the Dyments Creek MDP.
	169	Culvert Improvement No. 35	Victoria St.	Remove roadway and culvert crossing for expansion of SWMF DY01.	28	Victoria St. is a service road that is not required across Dyments Creek. The culvert crossing and roadway are to be removed as part of the expansion of SWMF DY01.
	170A	SWMF Retrofit No. 79 (DY01)	Between George St. and Anne St. S.	Remove Victoria Street culvert crossing and extend SWMF DY01 downstream to Anne St. S. for additional water quality treatment, peak flow attenuation and erosion control.	-24	Expansion of the SWMF DY01 (wet pond) downstream of Victoria St. to Anne St. S. LSRCA does not support the construction of online wet pond SWMF's.
	58	Culvert Improvement No. 36	Anne St. S. and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	-3	Culvert improvements consistent with the recommendations of the Dyments Creek MDP. Improvement impacts 71 Anne St. S.
	Improvements in Combination		Dyments Creek (Reach Dy-4) between Victoria St. and John St.	Improvements Completed in Combination	1	Option 1 produces an overall positive impact on the project environments. However, reinstating Dyments Creek between George St. and Anne St. S. is recommended.
	169	Culvert Improvement No. 35	Victoria St.	Remove roadway and culvert crossing daylighting channel	28	Victoria St. is a service road that is not required across Dyments Creek. The culvert crossing and roadway are to be removed as part of the reinstatement of Dyments Creek between George St. and Anne St. S.
	170B	SWMF Retrofit No. 79 (DY01)	Between George St. and Anne St. S.	Remove Victoria Street culvert crossing, channel improvements through SWMF DY01 from Georga St. to Anne St. S and utilize floodplain storage for peak flow attenuation during	14	Eliminate the existing online SWMF, reinstate the watercourse between George St. and Anne St. S. and utilize the natural floodplain storage in this area to attenuate peak flows and reduce downstream flooding.
	58	Culvert Improvement No. 36	Anne St. S. and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	-3	Culvert improvements consistent with the recommendations of the Dyments Creek MDP. Improvement impacts 71 Anne St. S.
	Improvements in Combination (Option 2)		Dyments Creek (Reach Dy-4) between Victoria St. and John St.	Improvements Completed in Combination	6	Option 2 produces in the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
	58	Culvert Improvement No. 36 (Option 3)	Anne St. S and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	-3	Culvert improvements consistent with the recommendations of the Dyments Creek MDP. Improvement impacts 71 Anne St. S. Culvert improvement to be implemented in combination with upstream improvements.
	59	Watercourse Improvement No. 12	Between Anne St. S. and Innisfil St. (Reach Dy-5)	Toe treatment to mitigate bank scouring and undercutting.	23	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	60	Culvert Improvement No. 37	Innisfil Street	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	12	Culvert improvements consistent with the recommendations of the Dyments Creek MDP.
	61	Culvert Improvement No. 38	Sanford St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	2	Culvert improvements consistent with the recommendations of the Dyments Creek MDP.
	62	Culvert Improvement No. 39	Bradford St.	Culvert upgrades to satisfy Regulatory flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	8	Culvert improvements consistent with the recommendations of the Dyments Creek MDP.
	63	Watercourse Improvement No. 28	Downstream of Bradford St. to Lakeshore Dr. (Reach Dy-6)	Watercourse improvements to increase conveyance capacity and decrease flooding.	11	Watercourse improvements consistent with the recommendations of the Dyments Creek MDP.
Hotchkiss Creek (Refer to Figure 20)	12	Culvert Improvement No. 41	Mayfair Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	7	Mayfair Dr. culvert was not evaluated as part of the Hotchkiss Creek MDP. Culvert is deficient and is recommended for improvement as part of ths Master Drainage Plan.
	13	Culvert Improvement No. 42	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	7	Ardagh Rd. culvert was not evaluated as part of the Hotchkiss Creek MDP. Culvert is deficient and is recommended for improvement as part of ths Master Drainage Plan.
	16	Culvert Improvement No. 44	Essa Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	11	MTO proposed culvert improvement. Culvert improvements to be implemented in accordance with MTO design as part of the Highway 400 improvements.
	17	SWMF Retrofit No. 44	85 Morrow Rd.	Construct wetland SWMF for water quality treatment and phosphorus removal.	8	The option of constructing a wetland SWMF produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
				Construct bioretention facility (LID) for water quality treatment and phosphorus removal.	-19	The option of constructing a bioretention facility produces an overall negative impact on the project environments and is not recommended.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Hotchkiss Creek (Refer to Figure 20)	18	Culvert Improvement No. 46	Highway 400	Add additional culvert to crossing to prevent spill at railway tracks.	5	Hotchkiss Creek MDP recommended solution has been implemented by the MTO. The option to further improve the culvert crossing to eliminate the spill along the BCRY railway is not recommended for implementation.
	19	SWMF Retrofit No. 81	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	28	SWMF improvement consistent with the recommendations of the Hotchkiss Creek MDP.
	20	SWMF Retrofit No. 96	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	17	SWMF improvement consistent with the recommendations of the Hotchkiss Creek MDP.
	21	Culvert Improvement No. 135	BCRY Railway Crossing (between Wood St. and Tiffin St.)	Construct proposed SWMF Retrofit No. 96 outlet controls.	13	Culvert improvements consistent with the recommendations of the Hotchkiss Creek MDP. Improvements include daylighting a reach of Hotchkiss Creek through 155 Tiffin St.
	22	Culvert Improvement No. 48	Tiffin St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	16	Culvert improvements consistent with the recommendations of the Hotchkiss Creek MDP.
	23	Watercourse Improvement No. 6	Hotchkiss Creek between Tiffin St. and Anne St. S. (Reach Ho-8)	Daylight watercourse through 115 Brock St., 128 Anne St. S. and 134 Tiffin St.	13	The option to daylight the watercourse produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
				Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	-1	The option to replace the existing culvert with an appropriately sized culvert produces a relatively neutral impact on the project environments.
				Construct a trunk storm sewer on Tiffin St. to remove channel /culvert from private property.	-11	The option to install a trunk storm sewer within the road allowance to convey flows eliminates infrastructure from private property. However, it produces an overall negative impact on the projects environments.
	24	Culvert Improvement No. 49	Anne St. S.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	17	Culvert improvements consistent with the recommendations of the Hotchkiss Creek MDP.
	25	Watercourse Improvement No. 13	Hotchkiss Creek between Anne St. S. and Innisfil St. (Reach Ho-9)	Daylight watercourse through 108 and 120 Tiffin St.	20	The option to daylight the watercourse produces the greatest overall positive impact on the project environments of the projects considered and is recommended for implementation.
				Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	6	The option to replace the existing culvert with an appropriately sized culvert produces a positive overall impact on the project environments. However, daylighting the watercourse through 108 and 120 Tiffin St. is recommended.
	26	SWMF Retrofit No. 48 (HT13)	Between Anne St. S. and Innisfil St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	-32	SWMF improvement consistent with the recommendations of the Hotchkiss Creek MDP.
	27	Culvert Improvement No. 50	Innisfil St.	Construct SWMF Retrofit 48 outlet	-2	Culvert improvements consistent with the recommendations of the Hotchkiss Creek MDP.
	Improvements in Combination (Option 1)			Improvements Completed in Combination	-37	The option of constructing a peak flow attenuation facility produces an overall negative impact on the project environments and is not recommended.
	27	Culvert Improvement No. 50 (Option 2)	Innisfil St.	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Hotchkiss Creek MDP).	3	Culvert improvements consistent with the recommendations of the Hotchkiss Creek MDP. Option 2produces the greatest overall positive impact on the project environments of the projects considered and is recommended.
	28	Watercourse Improvement No. 14	Reach Ho-9 between Innisfil St. and Bradford St.	Watercourse improvements along Hotchkiss Creek to stabilize existing bank erosion.	13	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	29	Allandale Heights Park Centralized LID	Allandale Heights Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-13	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Allandale Heights Park LID should be re-evaluated in consultation with the LSRCA.
	30	Trunk Storm Sewer No. 10	Essa Rd. (between Fairview Rd. and Innisfil St.)	Construct trunk storm sewer to convey 100 year peak flows.	24	Trunk storm sewer sized to satisfy the City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).
Huronia Creek Drainage Area (Refer to Figure 21)	164	Greenfield Park Centralized LID	Greenfield Park	Construct underground infiltration system for water quality treatment and groundwater recharge.	-11	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Greenfield Park LID should be re-evaluated in consultation with the LSRCA.
	184	SWMF Retrofit No. 85 (HR03)	265 Burton Ave.	Expand existing SWMF to include a permanent pool wet pond cell and increased active storage volume for water quality treatment and peak flow attenuation.	-12	Expanding the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended.
	185	SWMF Retrofit No. 28 (HR01)	279 Yonge St.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	-15	Retrotting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended.
Whiskey Creek Watershed (Refer to Figure 19)	64	Mapleton Park Centralized LID	Mapleton Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-14	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Mapleton Park LID should be re-evaluated in consultation with the LSRCA.
	65	Harvie Park Centralized LID	Harvie Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-14	Harvie Park is located in an area with high groundwater levels. Infiltration systems are not permitted in Harvie Park.
	66	Montserrand Park Centralized LID	Montserrand Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-17	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Montserrand Park LID should be re-evaluated in consultation with the LSRCA.
	67	SWMF Retrofit No. 42	Between Beacon Rd. and Montserrand St.	Construct combination underground infiltration system and dry SWMF for water qaulity treatment, erosion control and peak flow attenuation.	20	Constructing an infiltration system within the base of a dry pond is the LSRCA preferred approach. This option is the recommended approach for implementation.
				Construct wetpond SWMF for water qaulity treatment, erosion control and peak flow attenuation.	19	The option of constructing a wet pond SWMF produces a positive impact on the project environments. However, the LSRCA preferred approach to stormwater management is to incorporate LID techniques into design.
	68	Culvert Improvement No. 53	Harvie Road	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	26	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	69	SWMF Retrofit No. 92 (WK05)	Between Beacon Rd. and Harvie Rd.	Retrofit existing SWMF to include underground infiltration system for improved water quality treatment.	-26	The impacts of the SWMF Retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the WK05 retrofit should be re-evaluated in consultation with the LSRCA.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Whiskey Creek Watershed (Refer to Figure 19)	70	Culvert Improvement No. 54	Harvie Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	29	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	171	Watercourse Improvement No. 15	From Harvie Road to Highway 400 (Reach Wh-3)	Realign Whiskey Creek (Reach Wh-3) from Harvie Road to Highway 400 to accommodate Harvie Road improvements.	17	Watercourse improvements to realign Whiskey Creek and accommodate Harvie Rd. improvements. Watercourse improvements consistent with Harvie Road and Big Bay Point Road New Crossing - Highway 400 design.
	172A	Culvert Improvement No. 55	Highway 400	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	-9	Culvert improvements to realign Whiskey Creek and accommodate Harvie Rd. improvements. Culvert improvements consistent with Harvie Road and Big Bay Point Road New Crossing - Highway 400 design.
	Improvements in Combination (Option 1)		From Harvie Road to Highway 400 (Reach Wh-3)	Improvements Completed in Combination	1	The option (Option 1) to realign the watercourse and culvert crossing Highway 400 produces an overall positive impact on the project environments of the projects considered and is recommended for implementation.
	70	Culvert Improvement No. 54	Harvie Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	29	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	172B	Culvert Improvement No. 55	Highway 400	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	-2	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	Improvements in Combination (Option 2)		Harvie Rd. and Highway 400	Improvements Completed in Combination	5	The option (Option 2) of improving the culvert produces the greatest overall positive impact on the project environments. However, Option 1 is recommended as the improvements proposed under Option 2 conflict with the
	71	Culvert Improvement No. 56	Fairview Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	13	Culvert improvements consistent with Harvie Road and Big Bay Point Road New Crossing - Highway 400 design.
	72	Culvert Improvement No. 57	Bayview Dr.	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	5	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	73	Watercourse Improvement No. 16	Downstream of Bayview Dr. (Reach Wh-4a)	Minor watercourse realignment for long-term watercourse bed stabilization.	4	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	74	Watercourse Improvement No. 30	Downstream of Bayview Dr. (Reaches Wh-4a through 4C)	Watercourse improvements to increase conveyance capacity and decrease flooding.	7	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP. Watercourse improvements produce the greatest overall positive impact on the project environment of the options considered.
		Trunk Storm Sewer	Through 279 Bayview Dr.	Construct trunk storm sewer through 279 Bayview Dr. to convey flow exceeding downstream channel capacity.	-26	Trunk storm sewer sized to convey flow exceeding watercourse limiting capacity around 279 Bayview Dr. The trunk storm sewer produces an overall negative impact on the project environments and is not recommended.
	75	SWMF Retrofit No. 40	43 Chieftain Cres. and 110 Fairview Rd.	Construct combination underground infiltration system and dry SWMF in combination with Emergency Services Campus SWMF.	30	Chieftain Cres. drains uncontrolled and untreated directly to Whiskey Creek and no overland flow route is provided. Construtting an underground infiltration system in combination with the ESC SWMF is recommended.
	76	Watercourse Improvement No. 17	Downstream of Bayview Drive (Reach Wh-5)	Watercourse improvements along Whiskey Creek to stabilize existing bed and bank erosion.	14	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	77	Watercourse Improvement No. 18	Downstream of Bayview Drive (Reach Wh-6)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	14	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	78	Culvert Improvement No. 147	BCRY Railway Crossing	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	10	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	79	Assikinack Park Centralized Park LID	Assikinack Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-19	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Assikinack Park LID should be re-evaluated in consultation with the LSRCA.
	80	Culvert Improvement No. 60	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	7	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	81	Watercourse Improvement No. 31	Downstream of Huronia Rd. (Reach Wh-7b through 7c)	Watercourse realignment between Huronia Rd. and SWMF WK01.	6	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	82	SWMF Retrofit No. 26	East of Huronia Rd., north of Big Bay point Rd.	Construct a wet pond SWMF to provide water quality treatment, erosion control and peak flow attenuation.	-6	SWMF Retrofit No. 26 is located in a natural heritage area and is not permitted by the LSRCA.
	83	SWMF Retrofit No. 25 (WK01)	Little Ave. and Firman Dr.	Construct a wetland permanent pool cell to provide water quality treatment.	5	Retrofotting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended.
	84	Culvert Improvement No. 62	Little Ave.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	14	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	179	Watercourse Improvement No. 32	Downstream of Little Ave. (Reach Wh-9)	Watercourse improvements downstream of Little Ave. to improve conveyance capacity.	-6	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	Improvements in Combination		Little Ave. and downstream through Reach Wh-9	Improvements Completed in Combination	0	Implementing the improvements in combination produces an overall neutral impact on the project environments. The improvements are recommended for implementation.
	85	Culvert Improvement No. 63	Yonge St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	15	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	86	Culvert Improvement No. 138	Metrolink Railway Crossing (between Yonge St. and Tollendal Mill Rd.)	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	14	Culvert sized to maximize floodplain storage used upstream of crossing during the 100 year return frequency storm without overtopping the railway.
	87	SWMF Retrofit No. 20 (WK04)	South of Tollendal Mill Rd.	Install oil grit seperator to provide pre-treatment for SWMF WK04 in absence of sediment forebay.	-13	Retrofotting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended.
	88	Culvert Improvement No. 64	Hurst Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	89	Watercourse Improvement No. 19	Between Tollendal Mill Rd. and The Boulevard (Reach Wh-10)	Watercourse improvements on Whiskey Creek to stabilize existing bank erosion.	2	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Whiskey Creek Watershed (Refer to Figure 19)	174A	Culvert Improvement No. 65	The Boulevard	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	16	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	175	Watercourse Improvement No. 20	Between The Boulevard and Brennan Avenue (Reach Wh-10)	Reconstruct/regrade the watercourse between The Boulevard and Brennan Avenue to increase conveyance capacity.	-14	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	176	Culvert Improvement No. 66	Brennan Ave.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	16	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	177	Watercourse Improvement No. 21	Downstream of Brennan Ave. to Kempenfelt Bay (Reach Wh-10)	Reconstruct/regrade the watercourse downstream of Brennan Avenue to increase conveyance capacity.	-4	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	Improvements in Combination (Option 1)		The Boulevard to Kempenfelt Bay	Improvements Completed in Combination	1	The option (Option 1) to improve the watercourse and culvert crossings between The Boulevard and Kempenfelt Bay produces the greatest overall positive impact on the project environments of the projects considered.
	90A	Trunk Storm Sewer No. 13	Minets Point Rd. and White Oaks Rd. from Hurst Dr. to Brennan Ave.	Construction of trunk storm sewer to divert peak flows from Hurst Dr. to Brennan Ave.	14	Trunk storm sewer designed to divert flow away from erosion prone reach of Whiskey Creek and away from deficient culvert crossing under The Boulevard.
	174B	Culvert Improvement No. 65	The Boulevard	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	21	Culvert size reduced as trunk storm sewer diverts a portion of flow around deficient culvert.
	175	Watercourse Improvement No. 20	Between The Boulevard and Brennan Avenue (Reach Wh-10)	Reconstruct/regrade the watercourse between The Boulevard and Brennan Avenue to increase conveyance capacity.	-14	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	176	Culvert Improvement No. 66	Brennan Ave.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	16	Culvert improvements consistent with the recommendations of the Whiskey Creek MDP.
	177	Watercourse Improvement No. 21	Downstream of Brennan Ave. to Kempenfelt Bay (Reach Wh-10)	Reconstruct/regrade the watercourse downstream of Brennan Avenue to increase conveyance capacity.	-4	Watercourse improvements consistent with the recommendations of the Whiskey Creek MDP.
	Improvements in Combination (Option 2)		Hurst Dr. to Kempenfelt Bay	Improvements Completed in Combination	-9	The option (Option 2) to construct a trunk storm sewer to divert flow around The Boulevard culvert crossing produces an overall negative impact on the project environments of the projects considered.
	90B	Trunk Storm Sewer No. 13 (Option 3)	Minets Point Rd. and White Oaks Rd. from Hurst Dr. to Kempenfelt Bay	Construction of trunk storm sewer to divert peak flows from Hurst Dr. to Kempenfelt Bay.	5	Trunk storm sewer is not feasible due to excessive sewer depths. Option 1 is recommended for implementation.
Lovers Creek Watershed (Refer to Figure 19)	95	SWMF Retrofit No. 86 (LV16)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	-2	The impacts of the SWMF Retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the LV16 retrofit should be re-evaluated in consultation with the LSRCA.
	96	SWMF Retrofit No. 87 (LV17)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	11	Retrofitting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended for implementation.
	97	SWMF Retrofit No. 65 (LV07)	Between Bayview Dr. and Saunders Rd.	Retrofit existing SWMF to include a sediment forebay and underground infiltration system for water quality treatment.	1	Retrftoting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended for implementation.
	98	Culvert Improvement No. 126	BCRY Railway Crossing (north of Lockhart Rd.)	Culvert upgrades to satisfy 100 Year design flood frequency criteria.	4	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	99	Culvert Improvement No. 89	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	9	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	101	Culvert Improvement No. 91	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	1	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	102	SWMF Retrofit No. 45 (LV05)	Between Highway 400 and Bayview Drive	SWMF cleanout and channel improvements to repair and stabilize existing bed and bank erosion.	4	Retrofitting the SWMF for water quality control and reinstating the watercourse produces an overall positive impact on the project environments and is recommended for implementation.
	103	Culvert Improvement No. 94	Welham Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	13	Culvert crossing deficient due to backwater condition created by BCRY railway crossing downstream.
	104	Culvert Improvement No. 95	Mapleview Dr. E.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3	Culvert crossing deficient due to backwater condition created by BCRY railway crossing downstream.
	105A	Culvert Improvement No. 123	BCRY Railway Crossing (south of Mapleview Dr. E.)	Culvert upgrades to satisfy 50 Year design flood frequency criteria.	18	Upsizing the culvert to convey the 50 Year design flood frequency criteria still produces a backwater condition upstream at Welham Rd. and Mapleview Dr. E.
	Improvements in Combination (Option 1)		Welham Rd., Mapleview Dr. E. and BCRY Railway Crossing	Improvements Completed in Combination	5	The option (Option 1) to improve the Welham Rd., Mapleview Dr. E. and BCRY railway crossings produces an overall positive impact on the project environments of the projects considered.
	105B	Culvert Improvement No. 123 (Option 2)	BCRY Railway Crossing (south of Mapleview Dr. E.)	Culvert upgrades to convey Regional (Hurricane Hazel) peak flows to reduce backwater impacts on Culvert Improvements No. 94 and 95 eliminating these deficiencies.	26	Upsizing the culvert to convey the Regional storm peak flow reduces the backwater upstream and eliminates the Welham Rd. and Mapleview Dr. E. deficiencies. Option 2 is recommended for implementation.
	106	SWMF Retrofit No. 32 (LV12)	East of Welham Rd.	Retrofit the existing SWMF to include an underground infiltration system for water quality treatment.	-13	SWMF LV12 is located in a Significant Groundwater Recharge Area and a Well Head Protection Area. Infiltration systems are not permitted in SWMF LV12.
	107	Culvert Improvement No. 92	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	20	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	109	Culvert Improvement No. 99	Ellis Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	12	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	110	Culvert Improvement No. 98	Welham Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	1	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	111	SWMF Retrofit No. 30 (LV02)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	13	Retrofitting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended for implementation.
	112	SWMF Retrfoit No. 31 (LV03)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	19	Retrofitting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended for implementation.
	113	Culvert Improvement No. 97	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	22	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Lovers Creek Watershed (Refer to Figure 19)	114	Trunk Storm Sewer No. 7	Esther Drive from Dean Ave. to SWMF LV19	Construct a trunk storm sewer (upsized local sewer) to eliminate overland flow deficiency.	0	This improvement has a neutral impact on the project environments. Consideration should be given to upsizing the local storm sewer to address the overland flow route deficiencies as part of future road renewal projects.
	115	Madelaine Park Centralized LID	Madelaine Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-15	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Madelaine Park LID should be re-evaluated in consultation with the LSRCA.
	129	Kuzmich Park Centralized LID	Kuzmich Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-16	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Kuzmich Park LID should be re-evaluated in consultation with the LSRCA.
	116	Golden Meadow Park Centralized LID	Golden Meadow Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-16	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Golden Meadow Park LID should be re-evaluated in consultation with the LSRCA.
	117	Carter Park Centralized LID	Carter Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-11	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Carter Park LID should be re-evaluated in consultation with the LSRCA.
	118	SWMF Retrofit No. 37 (LV10)	North of Mary Anne Dr.	Retrofit the existing SWMF to include an underground infiltration system for water quality treatment.	-13	The impacts of the SWMF retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the SWMF LV10 retrofit should be re-evaluated in consultation with the LSRCA.
	119	SWMF Retrofit No. 68 (LV01)	East of Welham Rd.	Expand existing SWMF to include a permanent pool wet pond cell for water quality treatment.	-13	Retrofitting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended for implementation.
	120	Watercourse Improvement No. 22	Between Yonge St. and Hurst Dr. (Reach Lo-19)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander.	7	The watercourse improvements produce an overall positive impact on the project environments and is recommended for implementation.
	121	Watercourse Improvement No. 23	Upstream of Tollendal Mill Rd. (Reach Lo-20)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander.	7	The watercourse improvements produce an overall positive impact on the project environments and is recommended for implementation.
	122	Culvert Improvement No. 105	Tollendal Mill Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	12	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
Hewitts Creek Watershed (Refer to Figure 21)	125	Culvert Improvement No. 83	Mapleview Dr. E.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	126	Queensway/Hyde Park Centralized LID	Queensway/Hyde Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-17	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Queensway/Hyde Park LID should be re-evaluated in consultation with the LSRCA.
	127	Sandringham Park Centralized LID	Sandringham Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-22	Sandringham Park is located in an area with high groundwater levels. Infiltration systems are not permitted in Sandringham Park.
	128	SWMF Retrofit No. 27	East of Walnut Cres. And West of Hewitts Creek	Construct a wet pond SWMF for water quality treatment and phosphorus removal.	-9	SWMF Retrofit No. 27 is located in the floodplain of Hewitts Creek and is not permitted by the LSRCA.
	130	Trunk Storm Sewer No. 6	Princess Margaret Gate and Camelot Sq.	Construct a trunk storm sewer to eliminate overland flow deficiency.	9	The trunk storm sewer improvement produce an overall positive impact on the project environments and is recommended for implementation.
Georgian Creek Watershed (Refer to Figure 17)	133	Strabane Park Centralized LID	Strabane Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-7	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Strabane Park LID should be re-evaluated in consultation with the NVCA.
	134	SWMF Retrofit No. 76 (GR04)	Douglas Dr and Johnson St	Retrofit existing SWMF to include a permanent pool wet pond cells for water quality treatment.	-5	The impacts of the SWMF retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the SWMF GR04 retrofit should be re-evaluated in consultation with the NVCA.
	135	Trunk Storm Sewer No. 3	SWMF GR04 to SWMF GR01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF GR04 to GR01.	0	This improvement has a neutral impact on the project environments. Consideration should be given to upsizing the local storm sewer to address the overland flow route deficiencies as part of future road renewal projects.
	136	Dunsmore Park Centralized LID	Dunsmore Park	Construct underground infiltration system for water quality treatment and groundwater phosphorus removal.	-22	Dunsmore Park is located in an area with high groundwater levels. Infiltration systems are not permitted in Dunsmore Park.
	137	Trunk Storm Sewer No. 4	Dunsmore Park to Penetanguishene Rd	Construct a trunk storm sewer to convey the 100 year peak flow from Dunsmore Park to Penetanguishene Rd.	0	This improvement has a neutral impact on the project environments. Consideration should be given to upsizing the local storm sewer to address the overland flow route deficiencies as part of future road renewal projects.
	138	SWMF Retrofit No. 75 (GR01)	Between Hickling Tr and Penetanguishene Rd	Retrofit existing SWMF to include a permanent pool wet pond cell for water quality treatment.	-5	The impacts of the SWMF retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the SWMF GR01 retrofit should be re-evaluated in consultation with the NVCA.
	139	Culvert Improvement No. 82	Penetanguishene Rd	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	30	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.

Table 56: Quantitative Individual Project Evalaution Summary

Recommended Project	Feasible Project (Conditional)	Not Recommended/Not Feasible

Watershed	Project No.	Opportunity (ID)	Location	Description	Total Weighted Score	Comments
Little Lake Watershed (Refer to Figure 17)	140	Cartwright Park Centralized LID	Cartwright Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-12	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Cartwright Park LID should be re-evaluated in consultation with the NVCA.
	141	Trunk Storm Sewer No. 5	SWMF LT02 to SWMF LT01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF LT02 to LT01 to eliminate overland flow route deficiencies.	7	The trunk storm sewer improvement produce an overall positive impact on the project environments and is recommended for implementation.
	142	SWMF Retrofit No. 77 (LT01)	Between Cardinal St. and St. Vincent St.	SWMF expansion for water quality treatment (infiltration), erosion control and peak flow attenuation.	6	Retrofitting the SWMF to include an infiltration system for water quality and quantity control produces an overall positive impact on the project environments.
				SWMF expansion for water quality treatment (wet pond), erosion control and peak flow attenuation.	26	Retrofitting the SWMF to a wet pond for water quality and quantity control produces the greatest overall positive impact on the project environments and is recommended for implementation.
				SWMF retrofit for water quality treatment / quality control as per recommendations of MDP.	-7	Retrofitting the SWMF to maximize the water quality/quantity control provided within the existing footprint of the pond produces an overall negative impact on the project environments and is not recommended for implementation.
				Property Acquisiton to eliminate private property flooding and property damage.	-6	Acquiring the properties susceptible to flooding and property damage is an interim measure that may be implemented until such time that additional funding is available to retrofit SWMF LT01.
	143	Watercourse Improvement No. 24	Downstream of Livingstone St. E. (Reach Li-1)	Watercourse improvements along Little Lake Creek to stabilize existing bank erosion.	14	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	144	SWMF Retrofit No. 89 (LT05)	Osprey Ridge Rd.	Expand existing SWMF to increase the permanent pool volume to provide improved water quality treatment.	-10	Retrofitting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended for implementation.
	145	SWMF Retrofit No. 84 (LTGM)	509 Bayfield St.	Expand existing SWMF to increase the permanent pool and active storage volume for water quality treatment and peak flow attenuation.	7	Retrofitting the SWMF for water quality and quantity control produces an overall positive impact on the project environments.
	178A	SWMF Retrofit No. 91 (LT04)	Hanmer St. E.	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment with upstream improvements in place (SWMF LTGM).	-9	Retrofitting the SWMF for water quality control produces an overall negative impact on the project environments.
	Improvements in Combination (Option 1)		Retrofit SWMF LTGM amd LT04 in combination	Improvements Completed in Combination	-17	The option (Option 1) to retrofit SWMF LV04 and LTGM in combination produces an overall negative impact on the project environments of the projects considered and is not recommended for implementation.
	145	SWMF Retrofit No. 84 (LTGM) - Option 2	509 Bayfield St.	Expand existing SWMF to increase the permanent pool and active storage volume for water quality treatment and peak flow attenuation.	7	Retrofitting the SWMF for water quality and quantity control produces an overall positive impact on the project environments and is recommended for implementation.
Bear Creek Watershed (Refer to Figure 20)	147	Lougheed Park Centralized LID	Lougheed Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-21	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Lougheed Park LID should be re-evaluated in consultation with the NVCA.
	148	Wessenger Park Centralized LID	Wessenger Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-15	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Wessenger Park LID should be re-evaluated in consultation with the NVCA.
	149	Bear Creek Centralized LID	Bear Creek Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-32	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Bear Creek Park LID should be re-evaluated in consultation with the NVCA.
	150	SWMF Retrofit No. 61 (BR08b)	Between Red Oak Dr. and County Rd. 27	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment.	14	Retrofitting the SWMF for water quality control produces an overall positive impact on the project environments and is recommended for implementation.
	151	SWMF Retrofit No. 69 (BR13)	Snowshoe Park	Expand the existing SWMF to provide a permanent pool cell for water quality treatment.	-16	Retrofitting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended for implementation.
	152	SWMF Retrofit No. 90 (BR14)	North of Bishop Dr.	Regrade the permanent pool cell to increase the permanent pool volume for water quality treatment.	-18	Retrofitting the SWMF for water quality control produces an overall negative impact on the project environments and is not recommended for implementation.
	153	SWMF Retrofit No. 62 (BR05)	Between Red Oak Dr. and County Rd. 28	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment.	-11	The impacts of the SWMF retrofit outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the SWMF BR05 retrofit should be re-evaluated in consultation with the NVCA.
	154	Culvert Improvement No. 78	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	The culvert improvement produces an overall positive impact on the project environments and is recommended for implementation.
	155	Watercourse Improvement No. 33	Downstream of Ardagh Rd. (Reach Be-14)	Watercourse improvements on Bear Creek to stabilize existing bed erosion.	16	Watercourse improvements consistent with the recommendations of the Fluvial Geomorphologic & Erosion Threshold Assessment (Water's Edge, January 2018).
	156	Culvert Improvement No. 134	BCRY Railway Crossing	Culvert upgrades to satisfy 50 Year design flood frequency criteria.	-10	The impacts of the culvert improvement outweigh the benefits at this time. However, if County Road 27 is to be reconstructed, the culvert improvement should be re-evaluated.
	157	Culvert Improvement No. 80	County Rd. 27	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	-10	The impacts of the culvert improvement outweigh the benefits at this time. However, if County Road 27 is to be reconstructed, the culvert improvement should be re-evaluated.
Johnson Drainage Area (Refer to Figure 17)	159	Trunk Storm Sewer No. 8	Johnson St. from Steel St. to Kempenfelt Bay	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	15	The trunk storm sewer improvement produce an overall positive impact on the project environments and is recommended for implementation.
	160	Shoreview Park Centralized LID	Shoreview Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	-10	The impacts of the Centralized LID outweigh the benefits at this time. However, if a phosphorus offset is required in the watershed, the Shoreview Park LID should be re-evaluated in consultation with the LSRCA.
Nelson Drainage Area (Refer to Figure 17)	180	Trunk Storm Sewer No. 12	Blake St. from Johnson St. to Puget St.	Construct trunk storm sewer to service Blake St. and eliminate overland flow deficiencies.	9	The trunk storm sewer improvement produce an overall positive impact on the project environments and is recommended for implementation.

14.1 KIDD'S CREEK WATERSHED

14.1.1 Project No. 1 (SWMF Retrofit No. 11 – KD06)

SWMF KD06 is a dry pond with a contributing drainage area of approximately 60 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF KD06 has an active storage volume of 23,780 m³, however the SWMF provides essentially no extended detention as the SWMF outlet is a 900 mm diameter storm sewer. Overall, SWMF KD06 attenuates peak flows by 78% during the 1:100-year return frequency storm event. However, SWMF KD06 only attenuates peak flows by 11% during minor storm events (1:5-year return frequency storm).

SWMF KD06 was identified as an opportunity for enhancement in the City of Barrie Asset Management Plan – Stormwater Management Facilities (December 2012). SWMF KD06 was also identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). An opportunity exists to enhance the dry pond to improve water quality treatment and phosphorus removal. As part of this Drainage Master Plan, an opportunity to offset the active storage volume lost from the removal of SWMF KD02 downstream was also identified in SWMF KD06.

Historically, there were three locations in the upper reach of Kidd's Creek (Reach Ki-1) that provided active storage and attenuated minor storm peak flows (collectively referred to as SWMF KD02). The SWMF was formed by constructing three berms across the watercourse to utilize the watercourses natural valley corridor to provide storage. Culverts were installed in each berm to release water downstream at controlled rates and force water to pond upstream of the berms within the natural valley corridor. Unfortunately, during a significant storm event the berms were washed out and SWMF KD02 was removed from the watershed.

The MECP identified the peak flow attenuation provided and requires reinstatement of the active storage volume in the watershed upstream of the pond's previous location. However, the storage volume cannot be provided online as it previously was. The total storage volume that must be provided to offset the storage volume lost through the removal of SWMF KD02 is 5,800 m³.

The MECP recently confirmed they are prepared to accept the replacement of the active storage volume lost through the removal of SWMF KD02 as per the recommendations of this Drainage Master Plan if the following criteria are satisfied:

1. The enhancements proposed are identified as the preferred alternative solution for the Kidd's Creek watershed through the Drainage Master Plan and Municipal Class EA;



2. The City fully explored opportunities to implement centralized Low Impact Development measures upstream of SWMF KD02 and all other opportunities were determined not feasible; and
3. The City continues to explore opportunities to implement linear Low Impact Development measures upstream of SWMF KD02 moving forward as part of road renewal and road reconstruction projects.

The Lake Simcoe Region Conservation Authority noted that they do not support the reinstatement of SWMF KD02. The construction of online SWMFs is not permitted by the LSRCA. The LSRCA confirmed they are prepared to accept the replacement of the active storage volume lost through the removal of SWMF KD02 as per the recommendations of this Drainage Master Plan.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF KD06 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF KD06 confirms that the infiltration rate (47 mm/hr) of the existing soil is suitable for infiltration measures. To provide 80% TSS removal, 1,606 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 60 kg/year in Lake Simcoe (MECP P-Tool).

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m, the SWMF is located outside a significant groundwater recharge area, outside a Well Head Protection Area and satisfies the peak flow control credits specified by the LSRCA. As such, the storage volume provided underground can be considered active storage. In addition, 3,409 m³ of active storage can be added to the surface of SWMF KD06 to offset the storage volume lost from the removal of SWMF KD02. A total active storage volume of 5,015 m³ can be provided in SWMF KD06 to offset the lost storage. Additional active storage could be provided in SWMF KD06, however this was not considered necessary as the balance of storage required to offset the loss of SWMF KD02 can be provided through additional SWMF retrofits in the Kidd's Creek watershed.

Although 5,015 m³ of additional active storage can be provided in SWMF KD06, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit primarily for water quality enhancement. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF KD06 will have an overall positive impact on the project environments and be beneficial to the watershed. Comments received through public consultation supported the enhancement of



SWMF KD06. As such, Project No. 1 is recommended and included in the preferred alternative solution for the Kidd's Creek watershed.

The SWMF retrofit proposed does not require property acquisition as the works can be completed within the existing footprint of the pond. The proposed SWMF retrofit is a Schedule A+ project. The LSRCA was consulted and it was noted that the SWMF falls outside of the LSRCA regulated area and the LSRCA permitting requirements. However, an amendment to the MECP Environmental Compliance Approval will be required. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.1.2 Project No. 2 (SWMF Retrofit No. 18 - KD05)

SWMF KD05 is a dry pond with a contributing drainage area of approximately 27 ha that provides 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF KD05 has an active storage volume of 2,540 m³ and extended detention volume of 2,210 m³. Overall, SWMF KD05 attenuates peak flows by 10% during the 1:100-year return frequency storm event. However, SWMF KD05 provides a peak flow reduction of approximately 52% during minor storm events (1:5-year return frequency storm).

An opportunity exists to enhance the dry pond to improve water quality treatment and phosphorus removal. As part of this Drainage Master Plan, a drainage deficiency was identified in the overland flow route downstream of SWMF KD05 through 81 and 83 Janice Dr. Runoff leaving SWMF KD05 during major storm events via the overflow spillway floods 81 and 83 Janice Dr. downstream due to the lack of a defined overland flow route through these properties to Janice Dr.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF KD05 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing was not conducted in the base of SWMF KD05, however the infiltration rates are expected to be suitable for infiltration measures based on the infiltration testing completed in the surrounding area. To provide 80% TSS removal, 620 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 24 kg/year in Lake Simcoe.

Although 620 m³ of additional active storage can be provided in SWMF KD05, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.



An opportunity also exists to construct a defined overland flow route through 81 and 83 Janice Dr. to eliminate the flooding that currently occurs during major storm events. However, to construct the defined overland flow route, property acquisition is required. 81 Janice Dr. and the northwest corner of 83 Janice Dr. would need to be acquired to facilitate the construction of the overland flow route.

The individual project evaluation completed demonstrates that the proposed construction of a defined overland flow route downstream of SWMF KD05 produces an overall neutral impact on the project environments due to the private property impacts and infrequent nature of flooding. No comments were received regarding the construction of the overland flow route through public consultation. Based on the evaluation completed, the construction of the overland flow route is not recommended for implementation in the Kidd's Creek watershed at this time.

The SWMF retrofit proposed (excluding the construction of the overland flow route) does not require property acquisition as the works can be completed within the existing footprint of the pond. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The LSRCA was consulted and it was noted that the SWMF falls outside of the LSRCA regulated area and the LSRCA permitting requirements. However, an amendment to the MECP Environmental Compliance Approval will be required. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF KD05 will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding the retrofit of SWMF KD05 through public consultation. As such, Project No. 2 (retrofit to SWMF KD05 only) is recommended and included in the preferred solution for the Kidd's Creek watershed.

14.1.3 Project No. 3 (SWMF Retrofit No. 13 – KD03)

SWMF KD03 is a dry pond with a contributing drainage area of approximately 28 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF KD03 has an active storage volume of 6,890 m³ and extended detention volume of 2,630 m³. Overall, SWMF KD03 attenuates peak flows by 83% and 56% during the 1:5-year and 1:100-year return frequency storm events, respectively.

SWMF KD03 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, an opportunity to offset the



active storage volume lost from the removal of SWMF KD02 downstream was also identified in SWMF KD03.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF KD03 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF KD03 confirms that the infiltration rate (93 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 785 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 31 kg/year in Lake Simcoe (MECP P-Tool).

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m, the SWMF is located outside a significant groundwater recharge area and satisfies the peak flow control credits specified by the LSRCA. SWMF KD03 is in Well Head Protection Area D, however the SWMF receives runoff from primarily local roads and residential development making it suitable for infiltration practices. As such, the storage volume provided underground can be considered active storage. A total active storage volume of 785 m³ can be provided in SWMF KD03 to offset the storage lost from the removal of SWMF KD02.

Although 785 m³ of additional active storage can be provided in SWMF KD03, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF KD03 will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding the retrofit of SWMF KD03 through public consultation. Project No. 3 is recommended and included in the preferred alternative solution for the Kidd's Creek watershed.

The SWMF retrofit proposed does not require property acquisition as the works can be completed within the existing footprint of the pond. The proposed SWMF retrofit is a Schedule A+ project. The LSRCA was consulted and it was noted that the SWMF falls outside of the LSRCA regulated area and the LSRCA permitting requirements. However, an amendment to the MECP Environmental Compliance Approval will be required. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.



14.1.4 Project No. 4 (Watercourse Improvements No. 1 – Reach Ki-1 through Ki-2)

Bank and bed erosion were identified in the upper reaches of Kidd's Creek (Reach Ki-1 through Ki-2) as part of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preliminary Alternative Study (Water's Edge, 2017). These findings were supported by the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan.

Conceptual designs for the upper reaches of Kidd's Creek are have been completed as part of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preliminary Alternative Study.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. Although no comments were received regarding Watercourse Improvement No. 1 through public consultation, Project No. 4 is recommended and included in the preferred solution for the Kidd's Creek watershed. It is recommended that the watercourse improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study.

14.1.5 Project No. 5 (Culvert Improvement No. 13 – Cundles Rd. W.)

The preferred alternative solution identified in the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) included improvements to the Kidd's Creek watercourse crossing at Cundles Road W. The preferred alternative solution included improvements to the culvert entrance and lining the existing culvert to improve hydraulics to increase the conveyance capacity of the culvert to satisfy the City of Barrie flow design guidelines for road crossings (Arterial Road - 1:100-year). The preferred approach to addressing the drainage solutions developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 15.7 m³/s or a design flood frequency of 1:50-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3455 mm × 2195 mm concrete elliptical culvert. The conveyance capacity of the replacement culvert is approximately 23.2 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Cundles Rd. W.



The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 13 through public consultation. Project No. 5 is recommended and included in the preferred solution for the Kidd's Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Kidd's Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Kidd's Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.1.6 Project No. 6 (Sunnidale Park Centralized LID)

As part of this Drainage Master Plan, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 8 ha of Sunnidale Road drains via storm sewer through Sunnidale Park directly to Kidd's Creek untreated. An opportunity exists to install an underground infiltration system in Sunnidale Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Sunnidale Park at the location of the proposed centralized LID confirmed that the infiltration rate (76 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 150 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 11 kg/year in Lake Simcoe (MECP P-Tool).

Sunnidale Road is classified as a major collector road and in the City of Barrie salt is applied to major collector roads in the winter. Sunnidale Park is also located in a significant groundwater recharge area and within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are not permitted on major collector roads or in significant groundwater recharge areas. As such Project No. 6 does not comply.



In addition to the groundwater constraints, Project No. 6 was evaluated and produces an overall negative impact on the project environments. As such, Project No. 6 is not recommended for implementation in the Kidd's Creek watershed.

14.1.7 Project No. 7 (SWMF Creation No. 17)

The creation of a SWMF east of SWMF KD01 between Coulter St. and Highway 400 was identified as an opportunity for water quality treatment and phosphorus removal in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

Under existing conditions, approximately 36 ha of primarily commercial development drains via two storm sewers into a valley corridor and watercourse between Coulter St. and Highway 400. An opportunity exists to construct a wet pond SWMF in the valley corridor by constructing a berm across the corridor and utilizing the natural valley storage upstream of the berm to provide treatment and peak flow attenuation. A wet pond with 7,260 m³ of permanent pool storage (required storage volume for 80% TSS removal) can be constructed in the valley corridor. Constructing a wet pond SWMF in this location will result in a phosphorus reduction of nearly 101 kg/year in Lake Simcoe (MECP P-Tool).

A 195 mm diameter orifice (primary outlet) is required to attenuate the 25 mm storm (water quality storm) peak flow and provide the requisite 24 hour drawdown time. During minor storms, the SWMF will attenuate peak flows. However, the storage available in the SWMF upstream of the proposed 3 m high berm (berms greater than 3 m in height are classified as dams) is exceeded during major storm events. During major storms, an overflow spillway will be used to discharge flow downstream and as a result no peak flow attenuation will be provided during major storm events.

The SWMF creation proposed does not require property acquisition as the works can be completed within lands owned by the City. The proposed SWMF retrofit is a Schedule B project. The LSRCA was consulted and it was noted that the LSRCA does not generally support the construction of online SWMF's. However, the LSRCA recognizes the opportunity for water quality treatment and phosphorus removal in this location. To advance any discussions regarding Project No. 7, the LSRCA requires a site walk, a review of the fisheries classification, a geotechnical analysis and incremental cut-fill balance for works within the floodplain. This reach of Kidd's Creek has been identified as a coldwater fishery, however the LSRCA acknowledged that a site walk would be required to confirm the fishery classification.

The individual project evaluation completed demonstrates that SWMF Creation No. 17 produces an overall negative impact on the project environments. No comments were received



regarding SWMF Creation No. 17 through public consultation except the comments from the LSRCA. The individual project evaluation completed demonstrates that the proposed impacts of this SWMF creation outweigh the benefits at this time. However, if a phosphorus offset is required in the Kidd's Creek watershed, SWMF Creation No. 17 should be re-evaluated in consultation with the LSRCA.

14.1.8 Project No. 161 (Watercourse Improvements No. 34 – Reach Ki-3 through Ki-6)

Bank and bed erosion was identified in the upper reaches of Kidd's Creek (Reach Ki-3 through Ki-6) as part of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preliminary Alternative Study (Water's Edge, 2017). These findings were supported by the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan.

Conceptual designs for the upper reaches of Kidd's Creek are have been completed as part of the Upper Kidd's Creek Hydrogeomorphic Assessment & Selection of Preliminary Alternative Study.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Watercourse Improvement No. 34 through public consultation. As such, Project No. 161 is recommended and included in the preferred solution for the Kidd's Creek watershed. It is recommended that the watercourse improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study.

14.1.9 Thomson St. to Eccles St. N. (Projects No. 8, 162, 163 and 164) – Options Evaluation

As part of this Drainage Master Plan, drainage deficiencies were identified between Thomson St. and Eccles St. N. The deficiencies included the following:

1. The Thomson St. culvert crossing is undersized and does not satisfy the recommendations of the previous Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005);
2. Active bank erosion and bank failures on Kidd's Creek through Reach Ki-8a; and
3. The Eccles St. N. culvert crossing is undersized and does not satisfy the City's design flood frequency criteria or the recommendations of the previous Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005).

To address these deficiencies, options were developed and evaluated. Option 1 includes replacing the Thomson St. culvert with a culvert sized based on downstream flow restrictions



(Project No. 8A), constructing a trunk storm sewer to divert flow around the reaches (Ki-8a, Ki-10b and Ki-10C) of Kidd's Creek with active bank erosion and bank failures (Project No. 162), and watercourse improvements to stabilize the existing bank erosion and reinstate the channel banks that have failed (Project No. 163). Option 2 includes replacing the Thomson St. culvert with a culvert sized to satisfy the previous MDP recommended design flood frequency criteria (1:100-year) for the Kidd's Creek watershed (Project No. 8B), watercourse improvements to stabilize the existing bank erosion and reinstate the channel banks that have failed (Project No. 163) and replacing the Eccles St. N. culvert crossing to satisfy the same criteria as the Thomson St. culvert crossing (Project No. 164). The projects included in each option are described in the following sections.

The individual project evaluation completed demonstrates that Option 1 (Project No. 8A, 162, and 163) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. Option 1 is recommended and included in the preferred solution for the Kidd's Creek watershed.

The proposed culvert improvement is a Schedule A project. The proposed trunk storm sewer is a Schedule B project and several alternative alignments were evaluated as part of this Drainage Master Plan. The culvert improvement, trunk storm sewer and watercourse improvements are located on Kidd's Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for the culvert improvements. However, a DFO request for review is anticipated for the watercourse improvements. The trunk storm sewer will require an Environmental Compliance Approval from the MECP. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Kidd's Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the improvements are presented in Section 15 of this report.

The drainage improvements proposed under Project No. 8A, 162 and 163 will reduce flooding during the 1:100-year return frequency storm. However, the Regional storm is the Regulatory storm event for Kidd's Creek and the proposed improvements will not eliminate flooding during a Regional storm.

14.1.10 Project No. 8 (Culvert Improvement No. 16 – Thomson St.)

Project No. 8A

The Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) did not identify any drainage improvements to the Thomson St. culvert crossing. However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity



of this existing culvert crossing does not satisfy the previous MDP recommended design flood frequency criteria for the Kidd's Creek watershed (1:100-year).

Under Project No. 8A, a trunk storm sewer on Thomson St., Sophia St. W. and Florence St. was considered to divert flow away from the active erosion sites on Kidd's Creek and away from the undersized infrastructure downstream. The Eccles St. N. culvert crossing has a capacity of approximately 4.6 m³/s; equivalent to the 1:10-year return frequency storm event peak flow. The proposed trunk storm sewer has been sized to convey the difference between the 1:100-year return frequency peak flow and the Eccles St. N. culvert capacity (3.3 m³/s) to restrict flows through Kidd's Creek (Reach Ki-8a, Ki-10b and Ki-10c) to the limiting capacity of the drainage system during the 1:100-year storm. A 1345 mm × 865 mm concrete elliptical trunk storm sewer at a minimum slope of 0.2% is sufficient to convey the require flow.

The existing Thomson St. culvert crossing (1850 mm × 1050 mm concrete box culvert) has an unobstructed capacity of approximately 5.8 m³/s, or 1.2 m³/s greater than the Eccles St. N. culvert crossing downstream. As such, the existing Thomson St. culvert crossing has sufficient capacity to convey minor flows downstream. However, the existing culvert is partially obstructed with sediment and debris. There is also an opportunity to realign the culvert for improved hydraulics and shorten the length of the culvert by approximately 10 m by daylighting this short section of watercourse. It is recommended to replace the existing culvert with an 1800 mm × 900 mm concrete box culvert as part of Project No. 8A.

To replace the Thomson St. culvert crossing and construct the trunk storm sewer, the City will need to acquire lands or interests therein (easement) adjacent to the existing Thomson St. culvert crossing. 27 Thomson St. is recommended for acquisition. 22 Thomson St. will be impacted by the proposed culvert replacement. An easement over 22 Thomson St. in the favour of the City is recommended for the culvert replacement project.

Project No. 8B

As discussed, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the Thomson St. culvert crossing does not satisfy the previous MDP recommended design flood frequency criteria for the Kidd's Creek watershed (1:100-year). As such, an opportunity exists to replace the existing culvert to increase the existing conveyance capacity of the culvert to satisfy the City's criteria.

The existing Thomson St. culvert crossing has a conveyance capacity of approximately 5.8 m³/s or a design flood frequency of 1:50-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 2400 mm × 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 6.8 m³/s. In addition to an increase in the conveyance capacity, a reduction in the flooding will also occur. There will be a



reduction in the frequency of flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

14.1.11 Project No. 162 (Trunk Storm Sewer Improvement No. 9)

As discussed, a trunk storm sewer on Thomson St., Sophia St. W. and Florence St. was considered to divert flow away from the active erosion sites on Kidd's Creek and away from the undersized infrastructure downstream. The proposed trunk storm sewer has been sized to convey the difference between the 1:100-year return frequency peak flow and the Eccles St. N. culvert capacity ($3.3 \text{ m}^3/\text{s}$) to restrict flows through Kidd's Creek (Reach Ki-8a, Ki-10b and Ki-10c) to the limiting capacity of the drainage system during the 1:100-year storm. A 1345 mm $\times$ 865 mm concrete elliptical trunk storm sewer at a minimum slope of 0.2% is sufficient to convey the require flow.

It is noted that Kidd's Creek is a coldwater fishery and baseflows must be maintained through the main channel of Kidd's Creek. The trunk storm sewer must be designed to allow baseflows/low flows to continue downstream through Kidd's Creek (Reach Ki-8a) by raising the sewers invert above the channel invert of the creek.

As discussed, the trunk storm sewer will run south on Thomson St., west on Sophia St. W., and south on Florence St. to Park St. At Park St., four outlet options were considered for the trunk storm sewer as follows:

1. Option 1 - West on Park St. and south on Eccles St. N. to Kidd's Creek (Reach Ki-10a) downstream of Eccles St. N. This option requires no property acquisition.
2. Option 2 - West through 53 Park St. and 150 Dunlop St. W. to Kidd's Creek (Reach Ki-10a). This option requires the acquisition of 53 Park St. and 150 Dunlop St. W. However, it is understood that the City of Barrie is already in negotiations for the purchase of 150 Dunlop St. W.
3. Option 3 - East on Park St., south on Mulholland St., through 13 Mulholland St. and 150 Dunlop St. W. to Kidd's Creek (Reach Ki-10a). This option requires the acquisition of 13 Mulholland St. and 150 Dunlop St. W. As mentioned, it is understood that the City of Barrie is already in negotiations for the purchase of 150 Dunlop St. W.
4. Option 4 - East on Park St., south on Parkside Dr., and south on Dunlop St. W. to the existing Dunlop St. W. culvert crossing. There are several potential service and utility conflicts that would need to be resolved for this alignment, however, property acquisition is not required.



The individual project evaluation completed demonstrates that Option 1 provides the greatest overall benefit to the watershed. As such, Option 1 has been carried forward as part of the options evaluation.

To replace the Thomson St. culvert crossing and construct the trunk storm sewer, the City will need to acquire lands or interests therein (easement) adjacent to the existing Thomson St. culvert crossing. 27 Thomson St. is recommended for acquisition. Acquiring 150 Dunlop St. W. was part of the preferred solution identified in the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005). The property was identified for acquisition to improve the conveyance capacity of Kidd's Creek.

14.1.12 Project No. 163 (Watercourse Improvement No. 2 – Reach Ki-8a)

Bank erosion/failures were identified in Kidd's Creek (Reach Ki-8a) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified the use of armourstone keyed into the existing banks or bio-engineered bank treatments to mitigate the existing bank erosion/failures.

The City has acquired an easement over Kidd's Creek at 118 Sophia St. W. However, Kidd's Creek is located on private property across several lots between Thomson St. and Eccles St. N. To implement Project No. 163, the City will need to acquire lands or interests therein (easement) between Thomson St. and Eccles St. N. The properties impacted by Project No. 163 are listed in the following table.

Table 57: Project No. 163 – Impacted Properties

PROPERTIES	
18 Thomson St.	14 Thomson St.
77 Eccles St.	75 Eccles St.

Note: Property acquisition to be confirmed at detailed design

14.1.13 Project No. 164 (Culvert Improvement No. 17 – Eccles St. N.)

The Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) did not identify any drainage improvements to the Eccles St. N. culvert crossing. However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of this existing culvert crossing does not satisfy the previous MDP recommended design flood frequency criteria for the Kidd's Creek watershed (1:100-year).



The existing Eccles St. N. culvert crossing has a conveyance capacity of approximately $4.6 \text{ m}^3/\text{s}$ or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a $6000 \text{ mm} \times 800 \text{ mm}$ concrete box culvert. The conveyance capacity of the replacement culvert is approximately $9.3 \text{ m}^3/\text{s}$. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

14.1.14 Project No. 9 (Culvert Improvement No. 18 – Wellington St. W.)

The Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) did not identify any drainage improvements on the tributary of Kidd's Creek. However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Wellington St. W. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial Road – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the existing conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately $0.7 \text{ m}^3/\text{s}$ or a design flood frequency of 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a $1345 \text{ mm} \times 855 \text{ mm}$ concrete elliptical culvert. The conveyance capacity of the replacement culvert is approximately $2.5 \text{ m}^3/\text{s}$. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 18 through public consultation. As such, Project No. 9 is recommended and included in the preferred solution for the Kidd's Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and an existing 7 m wide easement across 121 Wellington St. W. in the favour of the City. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on a tributary of Kidd's Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for the tributary of Kidd's Creek. Additional cultural heritage, archeological and natural heritage



requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.1.15 Project No. 10 (Watercourse Improvements No. 3 – Reach Ki-10b through Ki-10c)

Bank erosion/failures were identified in Kidd's Creek (Reach Ki-10b through Ki-10c) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified the use of armourstone keyed into the existing banks or bio-engineered bank treatments to mitigate the existing bank erosion/failures.

The City has acquired easements over Kidd's Creek at 70 Eccles St. N. and 19 Donald St. and has purchased 32 Eccles St. N. However, Kidd's Creek is located on private property across several lots between Eccles St. N. and Henry St. To implement Project No. 10, the City will need to acquire lands or interests therein (easement) between Eccles St. N. and Henry St. The properties impacted by Project No. 10 are listed in Table 58.

The individual project evaluation completed demonstrates that the watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. The public identified the bank erosion/failures through this reach of Kidd's Creek during PIC#1. Concerns were expressed regarding the impacts bank erosion will have on private property and homes if it continues. As such, Project No. 10 is recommended and included in the preferred solution for the Kidd's Creek watershed.

Table 58: Project No. 10 – Impacted Properties

PROPERTIES	
19 Donald St. (portion of)	11 Donald St. (portion of)
38 Eccles St. (portion of)	10 Henry St. (portion of)
17 Eccles St.	

Note: Property acquisition to be confirmed at detailed design

The proposed watercourse improvements are located on Kidd's Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Kidd's Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.



14.1.16 Eccles St. N. to Bradford St. (Projects No. 11, 165, 166 and 167) – Options Evaluation

As part of this Drainage Master Plan, the capacity of the existing trunk storm sewer that crosses 150 Dunlop St. W., Dunlop St. W., the former Barrie Central Collegiate Institute property and Bradford St. is deficient. The existing 3000 mm × 1950 mm concrete elliptical sewer has a capacity of approximately 5.8 m³/s or a design flood frequency of 1:2-years. Immediately downstream of Bradford St., the trunk storm sewer changes in size to a 6000 mm × 1500 mm concrete box culvert with adequate capacity to convey the 1:100-year return frequency storm peak flow. There is an opportunity to improve the deficient trunk storm sewer to satisfy the recommendations of the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) and provide a 1:100-year conveyance capacity through a sewer replacement.

As discussed, the preferred alternative solution identified in the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005) included the acquisition of 150 Dunlop St. W. and the City is currently negotiating the purchase of the property. Also, the Barrie Central Collegiate Institute is now closed and the property is under the ownership of the City. As such, there is an opportunity to improve the drainage system through 150 Dunlop St. W. and the former Barrie Central Collegiate Institute property. This includes removing the existing deficient trunk storm sewer, daylighting sections of watercourse through 150 Dunlop St. W. and the former Barrie Central Collegiate Institute lands, installing an appropriately sized culvert under Dunlop St. W., and extending the existing 6000 mm × 1500 mm concrete box culvert upstream across Bradford St.

Two options have been identified to address the deficiencies identified through this downstream reach of Kidd's Creek. Option 1 includes the removal of the existing deficient trunk storm sewer, daylighting sections of the watercourse, installing a culvert under Dunlop St. W. and extending the existing trunk storm sewer upstream under Bradford St. as previously described. Option 2 involves replacing the existing deficient trunk storm sewer with an appropriately sized trunk storm sewer. The projects included in each option are described in the following sections.

The individual project evaluation completed demonstrates that Option 1 will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. No comments were received regarding Project No. 165, 166 or 167 through public consultation. As such, Option 1 is recommended and included in the preferred solution for the Kidd's Creek watershed.

The culvert, trunk storm sewer and watercourse improvements are located on Kidd's Creek within the LSRCA Regulated area and will require a permit from the LSRCA. A DFO request for review is anticipated for the culvert, trunk storm sewer and watercourse improvements. The trunk storm sewer will require an Environmental Compliance Approval from the MECP. The



MNRF should be consulted to establish the applicable fishery timing windows for this reach of Kidd's Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

The drainage improvements proposed under Project No. 165, 166 and 167 will reduce flooding during the 1:100-year return frequency storm. However, the Regional storm is the Regulatory storm event for Kidd's Creek and the proposed improvements will not eliminate flooding during a Regional storm.

14.1.17 Project No. 165 (Watercourse Improvement No. 25 – Reach Ki-11)

Kidd's Creek may be daylighted through 150 Dunlop St. W. by removing the deficient 3000 mm × 1950 mm concrete elliptical sewer and reinstating an open channel downstream to Dunlop St. W. Approximately 50 m of Kidd's Creek can be daylighted and reinstated using natural channel design principles. A channel cross-section mimicking the natural channel immediately upstream of the existing trunk storm sewer will provide sufficient capacity to convey the 1:100-year return frequency storm peak flow and reduce flooding in the area.

14.1.18 Project No. 166 (Culvert Improvement No. 145 – Dunlop St. W.)

The trunk storm sewer under Dunlop St. W. can be replaced with a 6000 mm × 1500 mm concrete box culvert matching the trunk storm sewer downstream. The culvert capacity is approximately 14.8 m³/s which exceeds the 1:100-year return frequency storm peak flow and satisfies the previous recommendations of the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005). In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

14.1.19 Project No. 167 (Watercourse Improvement No. 26 – Reach Ki-11)

Between Dunlop St. W. and Bradford St., Kidd's Creek may be daylighted by removing the deficient trunk storm sewer and reinstating an open channel. Approximately 120 m of Kidd's Creek may be daylighted and reinstated using natural channel design principles. A channel cross-section mimicking the natural channel immediately upstream of the existing trunk storm sewer will provide sufficient capacity to convey the 1:100-year return frequency storm peak flow and reduce flooding in the area.



14.1.20 Project No. 11 (Trunk Storm Sewer Improvement No. 11)

Project No. 11A

The existing 6000 mm × 1500 mm concrete box culvert downstream of Bradford St. can be extended northwest across Bradford St. into the former Barrie Central Collegiate Institute property. The trunk storm sewer capacity is approximately 14.8 m³/s which exceeds the 1:100-year return frequency storm peak flow and satisfies the previous recommendations of the Kidd's Creek Master Drainage Plan Addendum (City of Barrie, January 2005). In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

Project No. 11B

As discussed, the capacity of the existing 3000 mm × 1950 mm concrete elliptical trunk storm sewer is deficient and has a capacity of approximately 5.8 m³/s or a design flood frequency of 1:2-years. Immediately downstream of Bradford St., the trunk storm sewer changes in size to a 6000 mm × 1500 mm concrete box culvert with adequate capacity to convey the 1:100-year return frequency storm peak flow. Replacing the existing deficient trunk storm sewer with a 6000 mm × 1500 mm concrete box culvert will increase the conveyance capacity to approximately 14.8 m³/s which exceeds the 1:100-year return frequency storm peak flow.

14.2 BUNKERS CREEK WATERSHED

14.2.1 Project No. 31 (SWMF Retrofit No. 10 - BK03)

SWMF BK03 utilizes a natural valley corridor in the Bunkers Creek watershed to store water and release it downstream at control rates during storm events. SWMF BK03 has a drainage area of approximately 37 ha and provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF BK03 has an active storage volume of 6,440 m³, however provides no extended detention storage as the SWMF's primary outlet is a 1300 mm diameter outlet pipe. Overall, SWMF BK03 attenuates peak flows by 25% during the 1:100-year return frequency storm event. However, SWMF BK03 provides a peak flow reduction of approximately 7% during minor storm events (1:5-year return frequency storm).

An opportunity exists to enhance the SWMF and improve the outlet structure of the pond to improve water quality treatment, phosphorus reduction and peak flow attenuation.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF BK03 to treat runoff from approximately 27 ha of the ponds contributing drainage area. Infiltration testing was not conducted in the base of



SWMF BK03, however the infiltration rates are expected to be suitable for infiltration measures based on the infiltration testing completed in the surrounding area. To provide 80% TSS removal, 750 m³ of storage is required in the underground infiltration system. Constructing the underground infiltration system will result in a phosphorus reduction of nearly 30 kg/year in Lake Simcoe.

SWMF BK03 is located outside the significant groundwater recharge areas, however is located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area D when the contributing drainage area consists of primarily local roads and residential development. As such Project No. 167 is permitted.

An opportunity also exists to improve the existing pond outlet to provide extended detention storage and improve peak flow attenuation. Removing and replacing the existing 1300 mm diameter outlet pipe with a 300 mm diameter low flow orifice and secondary 1200 mm diameter outlet pipe will provide 24 hour drawdown time during the 25 mm storm event and reduce peak flows an additional 17% (total reduction of 42%) during the 1:100-year return frequency storm event.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF BK03 will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding the retrofit of SWMF BK03 through public consultation. As such, Project No. 31 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The SWMF retrofit proposed does not require property acquisition as the works can be completed within the existing footprint of the pond. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The LSRCA was consulted and it was noted that the SWMF is located in the LSRCA regulated area and an LSRCA permit is required. Also, an amendment to the MECP Environmental Compliance Approval will be required. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.2.2 Project No. 32 (Trunk Storm Sewer Improvement No. 1)

The Bunkers Creek Master Drainage Plan Update (Giffels, June 2004) did not identify any drainage improvements to the local drainage systems downstream of SWMF BK03. However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of minor and major drainage systems downstream of SWMF BK03 are deficient. Also, active bank erosion/failures were identified in Bunkers Creek (Reach Bu-3) as part of the



Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The deficiencies included the following:

1. The minor drainage systems on Valley Dr., Castle Dr. and Wesley St. are undersized and do not have sufficient conveyance capacity to convey the peak flows generated by the 1:5-year return frequency storm event;
2. Overland flow deficiencies exist on Valley Dr., Castle Dr. and Wesley St. between SWMF BK03 and Bunkers Creek (Reach Bu-3) resulting in private property flooding during major storm events; and
3. Significant bed and bank erosion leading to bank failures were observed on Bunkers Creek (Reach Bu-3) between Shirley Ave. and Highway 400.

To address these deficiencies, two options were developed and evaluated. Option 1 includes constructing a trunk storm sewer south on Anne St. N. from SWMF BK03 to Edgehill Dr., then west on Edgehill Dr. to an existing storm sewer outlet to Bunkers Creek (Reach Bu-7). Under this option, baseflow/minor flows (~250 L/s) will continue to drain via the existing storm sewer on Valley Dr., Castle Dr. and Wesley St. to Bunkers Creek (Reach Bu-3). However, flow during minor and major storm events will be diverted to Bunkers Creek (Reach Bu-7) via the trunk storm sewer; reducing downstream flooding and erosion. This option eliminates the downstream drainage deficiencies in the minor drainage system; eliminating the need to improve the minor drainage system on Valley Dr., Castle Dr. and Wesley St.

Option 2 involves replacing the existing storm sewer on Valley Dr., Castle Dr. and Wesley St. between SWMF BK03 and Bunkers Creek (Reach Bu-3) with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. Under this option, all flow will continue to drain to Bunkers Creek (Reach Bu-3). However, flooding will be reduced during minor and major storm events along Valley Dr., Castle Dr. and Wesley St. The evaluation of Option 1 and Option 2 is described in the following sections.

Option 1 – Anne St. N. Trunk Storm Sewer

Under Option 1, a trunk storm sewer on Anne St. N. from SWMF BK03 to Bunkers Creek (Reach Bu-7) was considered to divert flow away from the active erosion sites on Bunkers Creek and away from the undersized infrastructure downstream. The local storm sewer on Anne St. N. can be replaced with a trunk storm sewer sized to convey 1:100-year return frequency peak flow minus baseflow (~250 L/s) to Bunkers Creek (Reach Bu-7). A 1200 mm diameter storm sewer is sufficient to convey the require flow to Edgehill Dr. A 2311 mm × 1473 mm elliptical concrete storm sewer is required on Edgehill Dr. from Anne. St. N. to Bunkers Creek (Reach Bu-7). The trunk storm sewer sizing has been completed recognizing the peak flow attenuation provided from the implementation of Project No. 31.



To accommodate the trunk storm sewer, the existing sanitary sewer on Anne St. N. will have to be lowered from Castle Dr. to Edgehill Dr. to avoid service conflicts. As such, it is recommended that the Anne St. N. trunk storm sewer be constructed as part of a road renewal or reconstruction project. It is also recommended that the required watercourse improvements (Project No. 35) on Bunkers Creek (Reach Bu-7) be completed before the Anne St. N. trunk storm sewer is constructed and additional flow is diverted to this reach of Bunkers Creek.

Option 2 – Trunk Storm Sewer through Existing Alignment

Under Option 2, replacing the existing local storm sewer downstream of SWMF BK03 to Bunkers Creek (Reach Bu-3) with a trunk storm sewer sized to convey the 1:100-year return frequency peak flow was considered. The existing local storm sewer on Valley Dr., Castle Dr. and Wesley St. can be replaced with 1200 mm diameter and 1350 mm diameter storm sewer to convey the required flow. The trunk storm sewer sizing has been completed recognizing the peak flow attenuation provided from the implementation of Project No. 31.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. It is also recommended that the required watercourse improvements (Project No. 34) on Bunkers Creek (Reach Bu-3) be completed before the trunk storm sewer is constructed and a more efficient drainage system is installed upstream.

Evaluation

The individual project evaluation completed demonstrates that the Anne St. N. trunk storm sewer (Option 1) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, trunk storm sewer Option 1 is recommended as Project No. 32 moving forward. No comments were received regarding Project No. 32 through public consultation. As such, Project No. 32 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed trunk storm sewer improvement is a Schedule A+ project. The trunk storm sewer improvement is located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA and an Environmental Compliance Approval from the MECP. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.2.3 Project No. 33 (Gibbon Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes



implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 4 ha of local road and residential development drains via storm sewer around Gibbon Park ultimately draining directly into Bunkers Creek untreated. An opportunity exists to install an underground infiltration system in Gibbon Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Gibbon Park at the location of the proposed centralized LID confirmed that the infiltration rate (72 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 125 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 6 kg/year in Lake Simcoe (MECP P-Tool).

Gibbon Park is also located outside the significant groundwater recharge areas, however is located within Well Head Protection Area C. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area C when the contributing drainage area consists of local roads and residential development. As such Project No. 33 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Gibbon Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Bunkers Creek watershed, the Gibbon Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.2.4 Project No. 34 (Watercourse Improvement No. 4 - Reach Bu-3)

Bed and bank erosion/failures were identified in the upper reaches of Bunkers Creek (Reach Bu-3) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified the need to repair the existing gabion baskets lining the watercourse or replacing them entirely with a bed treatment suitable for steep gradients and installing scour and bank treatments to prevent further erosion of the channel bed and banks.

The individual project evaluation completed demonstrates that the watercourse watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 34 during public consultation. As such, Project No. 34 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF



should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.2.5 Project No. 35 (Watercourse Improvement No. 5 – Reach Bu-7)

Bed and bank erosion/failures were identified in the upper reaches of Bunkers Creek (Reach Bu-7) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommends removing the existing gabion basket channel lining and replacing it with a step-pool bed treatment. It is also recommended to install scour and bank treatments to prevent further erosion of the channel bed and banks. The watercourse improvements should be designed considering the recommended trunk storm sewer diversion (Project No. 32) and the increased flow that will be experienced through this reach of Bunkers Creek. Also, the grading limits of the proposed Highway 400 improvements may impact the watercourse. As such, the watercourse improvements should be coordinated with the MTO and the design of the Highway 400 improvements.

The individual project evaluation completed demonstrates that the watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 35 during public consultation. As such, Project No. 35 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.2.6 Project No. 36 (Culvert Improvement No. 143 – Highway 400)

As part of the Highway 400 improvements through Barrie, the MTO is proposing to replace the Bunkers Creek – North Branch culvert crossing. The MTO proposes to replace the existing 52 m – 1200 mm × 1200 mm concrete box culvert with an 81 m – 2400 mm × 1830 mm concrete box culvert to accommodate the proposed road improvements (road widening and profile adjustments). The culvert size has been selected to convey the 1:50-year return frequency storm event peak flow and maintain upstream water levels under proposed conditions.



An opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. The MTO has noted that they would entertain further improvements to the culverts under Highway 400 if the City is open to covering the cost of the additional works. As part of this Drainage Master Plan, we have reviewed the improvements proposed by the MTO to determine if further improvements are warranted.

The culvert size proposed by the MTO will increase the discharge downstream to the recently constructed Boys St. trunk storm sewer. The Boys St. trunk storm sewer has a conveyance capacity of approximately 12 m³/s before the sewer surcharges to the roadway. With the proposed MTO culvert improvements in place, the future land use conditions Regional (Hurricane Hazel) storm peak flow discharging to the Boys St. trunk storm sewer is approximately 11 m³/s. As such, the proposed MTO culvert improvement limits the peak flow to the capacity of the downstream Boys St. trunk storm sewer. To prevent downstream flooding, further improvements beyond what the MTO is proposing are not recommended for this culvert crossing.

It is noted that our evaluation of the proposed Highway 400 culvert improvements considers worst case flow conditions. In the case of Bunkers Creek, the spill from Kidd's Creek into Bunkers Creek is included and the Bunkers Creek peak flows have been increased accordingly.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 143 through public consultation. As such, Project No. 36 is recommended and included in the preferred solution for the Bunkers Creek watershed. It is recommended that the culvert improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study and be implemented by the MTO as part of the Highway 400 improvements.

14.2.7 Project No. 37 (Culvert Improvement No. 142 - Highway 400)

As part of the Highway 400 improvements through Barrie, the MTO is proposing to replace the Bunkers Creek - Central Branch culvert crossing (Culvert No. 142). The MTO proposes to replace the existing 55 m - 1200 mm × 1200 mm concrete box culvert with an 86 m - 4200 mm × 1500 mm concrete box culvert to accommodate the proposed road improvements (road widening and profile adjustments). The culvert size has been selected to convey the 1:50-year return frequency storm event peak flow and maintain upstream water levels under proposed conditions.



As discussed, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. As part of this Drainage Master Plan, we have reviewed the improvements proposed by the MTO to determine if further improvements are warranted.

The culvert size proposed by the MTO will increase ($\sim 1.3 \text{ m}^3/\text{s}$) the discharge downstream to an existing 1800 mm diameter trunk storm sewer between Henry St. and Anne St. S. Both the Central and South branches of Bunkers Creek drain to the trunk storm sewer. The MTO also proposes to replace the existing Bunkers Creek – South Branch culvert crossing with a larger structure. The proposed Bunkers Creek – South Branch improvements will also increase ($\sim 2.0 \text{ m}^3/\text{s}$) the discharge downstream to the trunk storm sewer. Combined, the 1:100-year return frequency storm peak flow will increase by $\sim 3.3 \text{ m}^3/\text{s}$ to $\sim 17.2 \text{ m}^3/\text{s}$. Accounting for future land use conditions (20% increase in peak flows), the 1:100-year return frequency storm peak flow will increase to $\sim 18.8 \text{ m}^3/\text{s}$.

The existing trunk storm sewer has been identified as an existing drainage deficiency as its conveyance capacity (approximately $10 \text{ m}^3/\text{s}$ before the sewer surcharges to the roadway) is less than the 1:10-year return period storm peak flow. As such, increasing the peak flows to this sewer will exacerbate the deficiency. However, there is an opportunity to improve the conveyance system downstream of Highway 400 to Bunkers Creek (see Project No. 40).

Improvements to the trunk storm sewer under Project No. 40 will increase the maximum conveyance capacity of the drainage system to $\sim 22 \text{ m}^3/\text{s}$. The existing and future land use condition 1:100-year return frequency storm peak flows to Bunkers Creek – Main Branch are $21 \text{ m}^3/\text{s}$ and $25 \text{ m}^3/\text{s}$, respectively. As such, the proposed trunk storm sewer improvements do not have sufficient capacity to convey the future land use condition 1:100-year return frequency storm peak flow downstream due to the increase in flows resulting from the proposed MTO culvert improvements. To prevent additional downstream flooding, further improvements beyond what the MTO is proposing are not recommended for this culvert crossing.

It is noted that the City of Barrie has already initiated the trunk storm sewer improvements downstream. Twin 1800 mm $\times$ 1200 mm concrete box culvert stubs were installed across Anne St. S. to facilitate the extension of the trunk storm sewer to Dunlop St. W. in the future.

It is noted that our evaluation of the proposed Highway 400 culvert improvements considers worst case flow conditions. In the case of Bunkers Creek, the spill from Kidd's Creek into Bunkers Creek is included and the Bunkers Creek peak flows have been increased accordingly.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 142



through public consultation. As such, Project No. 37 is recommended and included in the preferred solution for the Bunkers Creek watershed. It is recommended that the culvert improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study and be implemented by the MTO as part of the Highway 400 improvements.

14.2.8 Project No. 38 (Culvert Improvement No. 141 – Highway 400)

As part of the Highway 400 improvements through Barrie, the MTO is proposing to replace the Bunkers Creek – South Branch culvert crossing (Culvert No. 141). The MTO proposes to replace the existing 108 m – 1200 mm × 1200 mm concrete box culvert with twin 97 m – 1800 mm × 1200 mm concrete box culverts to accommodate the proposed road improvements (road widening and profile adjustments). The culvert size has been selected to convey the 1:50-year return frequency storm event peak flow and maintain upstream water levels under proposed conditions.

As discussed, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. As part of this Drainage Master Plan, we have reviewed the improvements proposed by the MTO to determine if further improvements are warranted.

The proposed Bunkers Creek – South Branch improvements will increase (~2.0 m³/s) the discharge downstream to the trunk storm sewer previously describe (Project No. 37). Combined with the increase in flow resulting from the improvement of the Bunkers Creek – Central Branch culvert crossing, the 1:100-year return frequency storm peak flow will increase by ~3.3 m³/s to ~17.2 m³/s. Accounting for future land use conditions (20% increase in peak flows), the 1:100-year return frequency storm peak flow will increase to ~ 18.8 m³/s.

As discussed, the existing trunk storm sewer has been identified as an existing drainage deficiency. Improvements to the trunk storm sewer under Project No. 40 will increase the maximum conveyance capacity of the drainage system to ~22 m³/s. The existing and future land use condition 1:100-year return frequency storm peak flows to Bunkers Creek – Main Branch are 21 m³/s and 25 m³/s, respectively. As such, the proposed trunk storm sewer improvements do not have sufficient capacity to convey the future land use condition 1:100-year return frequency storm peak flow downstream due to the increase in flows resulting from the proposed MTO culvert improvements. To prevent additional downstream flooding, further improvements beyond what the MTO is proposing are not recommended for this culvert crossing.

It is noted that our evaluation of the proposed Highway 400 culvert improvements considers worst case flow conditions. In the case of Bunkers Creek, the spill from Kidd's Creek into Bunkers Creek is included and the Bunkers Creek peak flows have been increased accordingly.



It is noted that the City of Barrie has already initiated the trunk storm sewer improvements downstream. Twin 1800 mm × 1200 mm concrete box culvert stubs were installed across Anne St. S. to facilitate the extension of the trunk storm sewer to Dunlop St. W. in the future.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 141 through public consultation. As such, Project No. 38 is recommended and included in the preferred solution for the Bunkers Creek watershed. It is recommended that the culvert improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study and be implemented by the MTO as part of the Highway 400 improvements.

14.2.9 Project No. 39 (SWMF Retrofit No. 94)

As discussed, the culvert improvements proposed by the MTO will increase the Bunkers Creek – Central Branch and Bunkers Creek – South Branch flows downstream of Highway 400. The existing trunk storm sewer downstream of the culvert improvements is deficient and the increased flow will exacerbate flooding. An opportunity exists to improve the trunk storm sewer to increase the conveyance capacity, however, the proposed trunk storm sewer improvements do not have sufficient capacity to convey the future land use condition peak flows downstream due to the increase in flows resulting from the proposed MTO culvert improvements.

An opportunity exists to construct a stormwater management facility (SWMF) between Highway 400 and Dunlop St. W. to reduce the peak flows to the capacity of the proposed trunk storm sewer. Three locations were considered for the construction of a SWMF as follows:

1. Immediately east of the future Highway 400 E/W-N ramp on 127, 129, 132 and 134 Henry St.;
2. Northwest of the Dunlop St. W. and Anne St. S. intersection on 280, 284, 286 and 290 Dunlop St. W.; and
3. Within the future Highway 400 E/W-N ramp proposed by the MTO.

The evaluation of the various SWMF options are described next.

Option 1 – East of the Future Highway 400 E/W-N Ramp

Under this option, the Bunkers Creek – Central Branch can be daylighted upstream of Dunlop St. W. immediately east of the future Highway 400 E/W-N ramp through 127, 129, 132 and 134 Henry St. A peak flow attenuation facility can be constructed above the daylighted low flow



channel to limit the peak flows downstream of Highway 400 to the capacity of the proposed trunk storm sewer. Approximately 16,000 m³ of storage may be provided within the footprint of the pond above the low flow channel. Combining the storage volume with a controlled outlet (1200 mm × 1200 mm concrete box culvert) will attenuate peak flows by approximately 30% and shift the peak of the hydrograph by approximately 30 minutes; reducing the Bunkers Creek – Main Branch existing and future land use condition 1:100-year return frequency storm peak flows to 18 m³/s and 21 m³/s, respectively. As noted, improvements to the trunk storm sewer under Project No. 40 will increase the maximum conveyance capacity of the drainage system to ~22 m³/s.

Under this option, 127, 129, 132 and 134 Henry St. are impact by the proposed SWMF and would need to be acquired by the City. The existing cul-de-sac at the west end of Henry St. will have to be relocated outside the proposed footprint of the SWMF. The SWMF design will also have to be coordinated with the MTO and their proposed Highway 400 improvements to ensure the SWMF is constructed outside the footprint of the future Highway 400 E/W-N ramp.

Option 2 – Northwest of Dunlop St. W. and Anne St. S. Intersection

Alternatively, Bunkers Creek – Central Branch can be daylighted upstream of Dunlop St. W. immediately east of the future Highway 400 E/W-N ramp through to the intersection of Dunlop St. W. and Anne St. S. The watercourse can be daylighted through 129 and 134 Henry St. and 280, 284, 286, and 290 Dunlop St. W. A peak flow attenuation facility can be constructed above the daylighted low flow channel to reduce the peak flows downstream of Highway 400 through the proposed trunk storm sewer. Approximately 6,000 m³ of storage may be provided within the footprint of the pond above the low flow channel. Combining the storage volume with a controlled outlet will reduce peak flows. However, the peak flow attenuation facility considered at this location alone will not reduce peak flows below the capacity of the proposed trunk storm sewer. Additional storage is required at another location, such as the locations considered under Option 1 and Option 3, to control peak flows to the capacity of the proposed trunk storm sewer downstream.

Option 3 – Within the Future Highway 400 E/W-N Ramp

As part of the Highway 400 improvements through Barrie, the MTO is proposing improvements to the Dunlop St. interchange. As part of the works, the Bunkers Creek – South Branch culvert crossing will be replaced, and the future crossing will daylight within the future Highway 400 E/W-N ramp. An opportunity exists to construct a stormwater management facility within the future Highway 400 E/W-N ramp to attenuate peak flows; reducing peak flows through the trunk storm sewer downstream to the capacity of the future improvements.



The information received to date from the MTO regarding the Highway 400 improvements is conceptual. However, the area available within the future Highway 400 E/W-N ramp is believed to be sufficient to construct a SWMF with the 16,000 m³ of storage required to attenuate peak flows. An appropriately sized outlet can be constructed under the future 400 E/W-N ramp to Dunlop St. W. A culvert crossing under the future Highway 400 E/W-N ramp is required regardless of the SWMF construction to convey the flows from the Bunkers Creek - South Branch downstream.

As part of the Highway 400 improvements, it is understood that the MTO is acquiring several properties for facilitate the works including 292 and 304 Dunlop St. W. Under this option, the proposed works would not impact any properties other than those already impacted by the future Highway 400 improvements.

Evaluation

The individual project evaluation completed demonstrates that the SWMF within the future Highway 400 E/W-N ramp (Option 3) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, Option 3 is recommended as Project No. 39 moving forward. No comments were received regarding Project No. 39 through public consultation. As such, Project No. 39 is recommended and included in the preferred solution for the Bunkers Creek watershed.

It is recommended that the City approach the MTO regarding the construction of a SWMF in the future Highway 400 E/W-N ramp to control the increased flows resulting from the Highway 400 culvert improvements proposed by the MTO. It is recommended that the SWMF be constructed as part of the Highway 400 improvements through Barrie.

The individual project evaluation completed demonstrates that SWMF Option 1 and Option 2 result in a negative overall impact on the project environments. As such, Option 1 and 2 are not recommended for implementation in the Bunkers Creek watershed. If the MTO is not agreeable to the construction a SWMF in the future Highway 400 E/W-N ramp, it is recommended that City proceed with the trunk storm sewer improvements recommended under Project No. 40. The trunk storm sewer improvements are recommended for implementation as part of the Highway 400 improvements in collaboration with the MTO.

14.2.10 Dunlop St. W. to Anne St. S. (Projects No. 18 and 40) – Options Evaluation

Downstream of Highway 400, the Bunkers Creek - Central Branch flows into a 1200 mm diameter trunk storm sewer originating at Henry St. that runs southeast through an existing easement to Dunlop St. W. and Hart Dr. Similarly, the Bunkers Creek - South Branch flows into an 1800 mm diameter trunk storm sewer immediately east of the existing Highway 400 E/W-N



ramp that runs southeast through an existing easement to Dunlop St. W. and Hart Dr. At Dunlop St. W. and Hart Dr., the two trunk storm sewers combine into a single trunk storm sewer that crosses Dunlop St. W., runs south on Hart Dr. and then east across 281 and 285 Dunlop St. W., 11 Hart Dr. and 10 Anne St. S. through an existing 11 m easement to Anne St. S. and Bunkers Creek - Main Branch. The trunk storm sewer consists of primarily 1800 mm diameter storm sewer.

As discussed, the existing trunk storm sewer has been identified as an existing drainage deficiency as its conveyance capacity (approximately 10 m³/s before the sewer surcharges to the roadway) is less than the 1:10-year return period storm peak flow.

The preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004) included constructing a trunk storm sewer beside the existing trunk storm sewer through the existing 11 m easement to increase the conveyance capacity of the system. Twin 1800 mm × 1200 mm concrete box culverts were recommended to increase the capacity of the system to convey the 1:100-year return frequency storm peak flow. As part of the Anne St. S. improvements, twin 1800 mm × 1200 mm concrete box culvert stubs were installed across Anne St. S. to facilitate the extension of the trunk storm sewer upstream in the future.

As part of this Drainage Master Plan, the following drainage improvement options were evaluated between Dunlop St. W. and Anne St. S.:

1. Option 1 - Daylighting the watercourse through 280, 284, 286 and 290 Dunlop St. W. to the intersection of Dunlop St. W. and Anne St. S. (Project No. 168) and extending the twin 1800 mm x 1200 mm trunk storm sewer north on Anne St. S. to the daylighted watercourse (Project No. 40A);
2. Option 2 - Extending the twin 1800 mm x 1200 mm trunk storm sewer north on Anne St. S. and west on Dunlop St. W. to Hart Dr. (Project No. 40B); and
3. Option 3 - Extending the twin 1800 mm x 1200 mm trunk storm sewer to the intersection of Dunlop St. W. and Hart Dr. through the existing easement (Project No. 40C).

The individual project evaluation completed demonstrates that Option 2 (Project No. 40B) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. No comments were received regarding Project No. 40B through public consultation. As such, Project No. 40B is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed trunk storm sewer improvements are a Schedule A+ project. The existing trunk storm sewer is located within the LSRCA Regulated area and will require a permit from the LSRCA. An environmental compliance approval for the MECP will also be required. Additional



cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

The existing and future land use condition 1:100-year return frequency storm peak flows to Bunkers Creek – Main Branch are 21 m³/s and 25 m³/s, respectively. As such, the proposed trunk storm sewer improvements do not have sufficient capacity to convey the future land use condition 1:100-year return frequency storm peak flow downstream due to the increase in flows resulting from the proposed MTO culvert improvements. However, options were explored as part of Project No. 39 to construct a SWMF to reduce peak flows. It is recommended that a peak flow attenuation facility be constructed within the future Highway 400 E/W-N ramp as part of the Highway 400 improvements. Constructing the SWMF will reduce the Bunkers Creek – Main Branch existing and future land use condition 1:100-year return frequency storm peak flows to 18 m³/s and 21 m³/s, respectively.

Constructing the SWMF within the future Highway 400 E/W-N ramp is subject to MTO approval. If the MTO decides not to construct the SWMF, the peak flows draining to the Bunkers Creek – Main Branch will increase due to the Highway 400 improvements. The future land use condition 1:100-year return frequency storm peak flows will exceed the capacity of the proposed trunk storm sewer. However, proposed improvements to the trunk storm sewer will significantly increase the conveyance capacity of the system and reduce flooding downstream of Highway 400 to Anne St. S.

The projects included in each drainage improvement option are described in the following sections.

14.2.11 Project No. 168 (Watercourse Improvement No. 7)

As noted, the existing trunk storm sewer is deficient, and an additional trunk storm sewer was previously recommended to supplement the capacity of the existing trunk storm sewer to provide capacity to convey the 1:100-year return frequency storm peak flow. Rather than improving the conveyance through the construction of a trunk storm sewer, we reviewed options to daylight the watercourse, or at least a portion of watercourse. An opportunity exists to daylight Bunkers Creek through 280, 284, 286, and 290 Dunlop St. W. A channel can be constructed north of Dunlop St. W. from Hart Dr. to Anne St. S. through private property.

14.2.12 Project No. 40 (Trunk Storm Sewer Improvement No. 2)

Project No. 40A

As noted, the existing trunk storm sewer is deficient, and an additional trunk storm sewer was previously recommended to supplement the capacity of the existing trunk storm sewer to provide capacity to convey the 1:100-year return frequency storm peak flow. The existing twin



1800 mm × 1200 mm concrete box culverts install across Anne St. S. can be extended north on Anne St. S. to Dunlop St. W. and the proposed open channel discussed under Project No. 168. The proposed twin 1800 mm × 1200 mm concrete box culverts and the existing 1800 mm diameter trunk storm sewer have a combined capacity of approximately 22 m³/s.

Project No. 40B

The existing trunk storm sewer alignment is through an 11 m easement between Hart Dr. and Anne St. S. The existing trunk storm sewer is located in the centre of the existing easement which does not leave sufficient space for the additional trunk storm sewer required to convey the 1:100-year return frequency storm peak flow. However, an opportunity exists to construct a new trunk storm sewer east on Dunlop St. W. then south on Anne St. S. to supplement the capacity of the existing trunk storm sewer and provide the required additional capacity.

The existing twin 1800 mm × 1200 mm concrete box culverts install across Anne St. S. can be extended north on Anne St. S. and west on Dunlop St. W. to Hart Dr. The proposed twin 1800 mm × 1200 mm concrete box culverts and the existing 1800 mm diameter trunk storm sewer have a combined capacity of approximately 22 m³/s.

Project No. 40C

Under this option, we re-evaluated the original MDP recommendation. The recommendation included constructing a trunk storm sewer consisting of twin 1800 mm × 1200 mm concrete box culverts beside (north of) the existing 1800 mm diameter trunk storm sewer. As identified in the other options considered, the proposed twin 1800 mm × 1200 mm concrete box culverts and the existing 1800 mm diameter trunk storm sewer have a combined capacity of approximately 22 m³/s.

The existing 1800 mm diameter trunk storm sewer is located in the centre of the existing 11 m easement. To construct the proposed trunk storm sewer, the City would need to acquire additional lands across 281 and 285 Dunlop St. W. for the sewer installation or relocate (shift south) the existing trunk storm sewer within the existing easement to provide sufficient space for the new trunk storm sewer.

14.2.13 Project No. 41 (Watercourse Improvement No. 8 – Reaches Bu-11 and Bu-15)

Bank erosion/failures were identified in the lower reaches of Bunkers Creek (Reach Bu-11 and Bu-15) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommends removing the existing concrete slabs used to arrest erosion and install a toe treatment to prevent bank scour and undercutting.



The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 41 during public consultation. As such, Project No. 41 is recommended and included in the preferred solution for the Bunkers Creek watershed.

It is noted that this project is located in a historical landfill site. It is anticipated that additional geotechnical and hydrogeological assessments will be required in support of the proposed watercourse improvements.

The proposed watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.2.14 Project No. 42 (Pond Retrofit No. 95 – Milligan’s Pond)

The City of Barrie has received complaints regarding sediment accumulation in Milligan’s Pond. Deposition of sediment has been noted throughout Bunkers Creek downstream of Anne St. S. to Innisfil St. Milligan’s Pond is an excavated pond located on Bunkers Creek (Reach Bu-14 and Bu-15). The pond was constructed by previous land owners for recreational purposes. An opportunity exists to remove the accumulated sediment and reinstate the watercourse removing the online pond from Bunkers Creek. To do so, the existing outlet control structure will also have to be removed.

The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. As such, Project No. 42 is recommended and included in the preferred solution for the Bunkers Creek watershed.

It is noted that Milligan’s Pond is located in a historical landfill site. It is anticipated that additional geotechnical and hydrogeological assessments will be required in support of the proposed pond cleanout and watercourse improvements.

Milligan’s Pond is located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the pond cleanout



and detailed design of the watercourse improvements are presented in Section 15 of this report.

14.2.15 Project No. 43 (Culvert Improvement No. 22 – Innisfil St.)

The preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004) included improvements to the Bunkers Creek watercourse crossing at Innisfil St. The preferred alternative solution included replacing the existing culverts with 3 – 4200 mm × 1500 mm reinforced concrete box culverts to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing crossing does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 9.2 m³/s or a design flood frequency of <1:2-years. To satisfy the design flood frequency criteria, the existing crossing can be replaced with a 10.06 m open bottom span structure with a minimum clear height of 1.35 m. The conveyance capacity of the replacement culvert is approximately 28.7 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Innisfil St.

The culvert improvement proposed requires watercourse improvements up and downstream of Innisfil St. to accommodate the wider span structure. Watercourse improvements downstream of Innisfil St. to Bradford St. were recommended as part of the preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). The culvert and watercourse improvements will impact 80 Bradford St. east of Innisfil St. It is recommended that the City acquire a portion of 80 Bradford St. over the watercourse to facilitate the construction of the improvements and long-term maintenance of the works.

It is noted that south bank of Bunkers Creek in the vicinity of Innisfil St. is identified as a historical landfill site. It is anticipated that additional geotechnical and hydrogeological assessments will be required in support of the proposed culvert/watercourse improvements.

The individual projects evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 22 through public consultation. As such, Project No. 43 is recommended and included in the preferred solution for the Bunkers Creek watershed.



The proposed culvert/watercourse improvements are a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previously approved Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). As such, subsequent options were not evaluated. The culvert/watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and environmental requirements related to the detailed design of the culvert improvements are presented in Section 15 of this report.

14.2.16 Project No. 44 (Culvert Improvement No. 23 – Commercial Plaza Entrance Road)

The preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004) included improvements to the commercial plaza entrance road crossing Bunkers Creek at 80 Bradford St. The preferred alternative solution included replacing the existing culverts with 3 – 4200 mm × 1500 mm reinforced concrete box culverts to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The City has received complaints regarding flooding at 80 Bradford St. The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing crossing is approximately 7 m³/s or a design flood frequency of <1:2-years. To satisfy the design flood frequency criteria and reduce flooding, two improvement options were considered. Option 1 includes replacing the existing culverts with an appropriately sized crossing and watercourse improvements to accommodate the larger structure. Option 2 involves daylighting the watercourse by removing the commercial plaza entrance road and replacing it with a pedestrian bridge spanning the watercourse. The evaluation of the two options are described next.

Option 1 – Culvert Improvements

To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 7.62 m open bottom span structures with a minimum clear height of 1.35 m. The conveyance capacity of the replacement culverts is approximately 29.7 m³/s. In addition to an increase in the conveyance capacity, a reduction in the flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and



velocity of overtopping during the Regulatory event such that safe access/egress will be provided across the commercial plaza entrance road.

Option 2 – Daylight Watercourse

Alternatively, the commercial plaza entrance road can be removed from the watercourse and the watercourse daylighted. A pedestrian bridge can be installed across the watercourse to provide access to the existing parking lot south of Bunkers Creek. A prefabricated steel pedestrian bridge can span the watercourse, reducing the obstruction to flow at this location.

Evaluation

The individual project evaluation completed demonstrates that Option 2 will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, Option 2 is recommended as Project No. 44 moving forward. No comments were received regarding Project No. 44 through public consultation. As such, Project No. 44 is recommended and included in the preferred solution for the Bunkers Creek watershed.

Both options require watercourse improvements up and downstream of the existing commercial plaza entrance road. Watercourse improvements downstream of Innisfil St. to Bradford St. were recommended as part of the preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). The culvert and watercourse improvements will impact 80 Bradford St. It is recommended that the City acquire a portion of 80 Bradford St. over the watercourse to facilitate the construction of the improvements and long-term maintenance of the works.

The existing commercial plaza entrance is owned and maintained by the property owner. It is recommended that the City approach the property owner of 80 Bradford St. with the various options evaluated and discuss a cost sharing agreement as the proposed improvements also benefit the City.

The individual project evaluation completed demonstrates that Option 1 results in a positive overall impact on the project environments. If the property owner is not agreeable to removing the commercial plaza entrance road and replacing it with a pedestrian bridge, it is recommended that City proceed with the Option 1 – Culvert Improvements. As the existing commercial plaza entrance is owned and maintained by the property owner, it is expected that they will be responsible for a portion of the cost of the improvements. A cost sharing agreement should be entered into between the City and the property owner as they are both benefitting from the works.

The proposed culvert/watercourse improvements are a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the



previously approved Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). As such, subsequent options were not evaluated. The culvert/watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvements are presented in Section 15 of this report.

14.2.17 Project No. 45 (Culvert Improvement No. 24 – Bradford St.)

The preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004) included improvements to the Bunkers Creek watercourse crossing at Bradford St. The preferred alternative solution included replacing the existing culverts with 3 – 4200 mm × 1500 mm reinforced concrete box culverts to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing crossing does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 8.9 m³/s or a design flood frequency of <1:2-years. To satisfy the design flood frequency criteria, the existing crossing can be replaced with twin 7.62 m open bottom span structures with a minimum clear height of 1.35 m. The conveyance capacity of the replacement culvert is approximately 41.7 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Bradford St.

The existing low point on Bradford St. is located approximately 30 m south of the existing culvert crossings inline with 93 Bradford St. When Bradford St. overtops the roadway, 93 Bradford St. is subjected to flooding. It is recommended that the low point in Bradford St. be relocated 30 m north of its current location to be centered over the proposed culvert crossing as part of the culvert improvements.

The culvert improvement proposed requires watercourse improvements up and downstream of Bradford St. to accommodate the wider span structure. Watercourse improvements upstream of Bradford St. were recommended as part of the preferred alternative solution identified in the Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). watercourse improvements



downstream of Bradford St. were not identified, however, they are required to improve the hydraulics of the lower reach of Bunkers Creek from Innisfil St. to Lakeshore Dr. The culvert and watercourse improvements will impact 100 Bradford St. It is recommended that the City acquire a portion of 100 Bradford St. south of the watercourse to facilitate the construction of the improvements and long-term maintenance of the works.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 24 through public consultation. As such, Project No. 45 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed culvert/watercourse improvements are a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previously approved Bunkers Creek Master Drainage Plan Update (Giffels, June 2004). As such, subsequent options were not evaluated. The culvert/watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvements are presented in Section 15 of this report.

14.2.18 Project No. 46 (Watercourse Improvement No. 27 – Reach Bu-16)

Downstream of Bradford St., the low flow channel of Bunkers Creek has limited capacity resulting in flooding on private property within a wide floodplain. The low flow channel capacity is less than the 1:2-year return frequency storm peak flow. An opportunity exists to improve the watercourse from Bradford St. to Lakeshore Dr. Improving the watercourse along this reach of Bunkers Creek will improve the hydraulics of the drainage system and reduce the extent and frequency of flooding.

The individual project evaluation completed demonstrates that the proposed watercourse improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Watercourse Improvement No. 27 through public consultation. As such, Project No. 46 is recommended and included in the preferred solution for the Bunkers Creek watershed.

The proposed watercourse improvements will impact 20 Checkley St. and 93 Bradford St. It is understood that a development application has been submitted for 20 Checkley St. As such, an appropriate setback should be established from the watercourse as part of the Site Plan



application. It is anticipated that the watercourse will be dedicated to the City or LSRCA as part of the Site Plan Process. To facilitate the construction of the watercourse improvements, it is recommended that the City acquire 93 Bradford St.

The proposed watercourse improvements are a Schedule B project. The watercourse improvements are located on Bunkers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bunkers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.3 DYMENTS CREEK WATERSHED

14.3.1 Project No. 47 (SWMF Retrofit No. 15 – DY02)

SWMF DY02 is a dry pond with a contributing drainage area of approximately 18 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF DY02 has an active storage volume of 8,830 m³ and extended detention volume of 3,130 m³. Overall, SWMF DY02 attenuates peak flows by 95% and 90% during the 1:5-year and 1:100-year return frequency storm events, respectively. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 2B – Retrofit/New Stormwater Management Facilities for Quality Control to satisfy the City of Barrie requirements for water quality treatment.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF DY02 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF DY02 confirms that the infiltration rate (64 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 486 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will provide 486 m³ of additional active storage and result in a phosphorus reduction of nearly 19 kg/year in Lake Simcoe (MECP P-Tool).

SWMF DY02 receives runoff from Cundles Rd. W. and Livingstone St. W. Both roads are classified as arterial roads and in the City of Barrie salt is applied to arterial roads in the winter. SWMF DY02 is also located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are not permitted on arterial roads or in well head protection areas. As such Project No. 47 is not permitted.



14.3.2 Project No. 48 (Cloughley Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe. The preferred approach to addressing the drainage deficiencies developed in this Drainage Master Plan includes Alternative 2E – Centralized Low Impact Development as part of the City of Barrie's initiative to attenuate peak flows, promote infiltration, and improve the water balance and watershed water quality.

Currently, approximately 2 ha of local road and residential development drains via storm sewer around Cloughley Park ultimately draining directly into Dyments Creek untreated. An opportunity exists to install an underground infiltration system in Cloughley Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Cloughley Park at the location of the proposed centralized LID confirmed that the infiltration rate (64 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 105 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 2 kg/year in Lake Simcoe (MECP P-Tool).

Cloughley Park is also located outside the significant groundwater recharge areas, however is located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. As such Project No. 48 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Cloughley Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Dyments Creek watershed, the Cloughley Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.3.3 Project No. 49 (Watercourse Improvement No. 29 – Dy-1 and Dy-2a)

Signs of bank erosion were identified in Dyments Creek (Reach Dy-1) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. Dyments Creek has undergone extensive channelization downstream of Sproule Dr. to Ferndale Dr. N. and has limited riparian cover along its length. An opportunity exists to realign Dyments Creek from Sproule Dr. to SWMF Retrofit No. 78 (Project No. 181) to improve conveyance and enhance the watercourse. Realignment of the



watercourse is required to facilitate the construction of Project No. 181 (SWMF Retrofit Opportunity No. 78).

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall neutral impact on the project environments. No comments were provided regarding Project No. 49 during public consultation. As such, Project No. 49 is recommended and included in the preferred solution for the Dyments Creek watershed.

The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.3.4 Project No. 181 (SWMF Creation No. 78)

The creation of a new peak flow attenuation facility east of SWMF DY04 between Sproule Dr. and Dunlop St. W. was included as part of the preferred alternative solution for the Dyments Creek watershed in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006). The preferred approach to address the drainage deficiencies solution developed in this Drainage Master Plan includes Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control to satisfy the City of Barrie requirements for peak flow attenuation.

Under existing conditions, Dyments Creek flows through an undeveloped parcel of land identified as unevaluated wetland between SWMF DY04 and industrial development land. The parcel of land is almost entirely surrounded by berms constructed to form SWMF DY04 and Dunlop St. W. or the raised grades of the surrounding residential and industrial development. An opportunity exists to construct a peak flow attenuation facility by improving and expanding on the existing berms east, south and west of the unevaluated wetland to provide active storage and installing a culvert outlet through the berm to control flows.

By improving and expanding the berms around the unevaluated wetland, approximately 163,000 m³ of active storage can be created for peak flow attenuation. This project was presented to the LSRCA and they noted the peak flow attenuation facility must be constructed above a low flow channel designed to convey minor flows downstream uncontrolled. Also, water quality control cells are not permitted within the SWMF. The proposed SWMF outlet controls consist of a 3048 mm × 914 mm concrete box and a 55 m wide emergency overland



flow weir. The peak flow attenuation facility will detain flows in excess of the 1:2-year return frequency through to the Regional storm.

To implement Project No. 181, the City will need to acquire lands to construct and maintain the peak flow attenuation facility. Specifically, Part Lot 24 Concession 7 will be impacted. No municipal address is available for this parcel of undeveloped land.

The individual project evaluation completed demonstrates that SWMF Creation No. 78 provides a positive benefit to the watershed. As such, Project No. 181 is recommended and included in the preferred solution for the Dyments Creek watershed.

The proposed SWMF retrofit is a Schedule B project. However, Project No. 181 is consistent with the preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006). As such, subsequent options were not evaluated.

The SWMF creation is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.3.5 Project No. 182 (Culvert Improvement No. 28 –Dunlop St. W.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) included improvements to the Dyments Creek watercourse crossing at Dunlop St. W. The preferred alternative solution included replacing the existing culverts with a crossing sized to convey the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City of Barrie design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of less than 1.4 m³/s; less than a design flood frequency of 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3043 mm × 914 mm concrete box culvert. The conveyance capacity of the replacement structure is approximately 8.4 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.



The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 28 through public consultation. As such, Project No. 182 is recommended and included in the preferred solution for the Dyments Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a request for review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural hertiage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.6 Project No. 183 (Watercourse Improvement No. 9 – Reach Dy-2a)

Dyments Creek has undergone extensive channelization downstream of Sproule Dr. to Ferndale Dr. N. and has limited riparian cover along its length. The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) included watercourse improvements from Dunlop St. W. to Ferndale Dr. N.

An opportunity exists to realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. to improve conveyance and enhance the watercourse. Under previous study, the City explored options to relocate the watercourse to the south side of Dunlop St. W. by constructing a new channel through private property; eliminating the reach of Dyments Creek that doubles as a roadside ditch. The watercourse improvements and realignment were revaluated as part of this Drainage Master Plan.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 183 during public consultation. As such, Project No. 183 is recommended and included in the preferred solution for the Dyments Creek watershed.

The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of



Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

As discussed, a new channel constructed on the south side of Dunlop St. W. will run through private property. As such, property acquisition is required. Dyments Creek also runs through 461 Dunlop St. W. and 100 Ferndale Dr. N. to the existing Ferndale Dr. N. culvert crossings. Improvements are required to improve the watercourse through these properties. As such, the City will need to acquire these lands or interests therein (easement). A summary of the impacted properties associated with Project No. 183 is provided in the following table:

Table 59: Project No. 183 – Impacted Properties

PROPERTIES	
461 Dunlop St. W. (portion of)	100 Ferndale Dr. N. (portion of)
Address Not Available (portion of)	Address Not Available (portion of)

Note: Property acquisition to be confirmed at detailed design

14.3.7 Project No. 50 (Culvert Improvement No. 29 – Ferndale Dr. N.)

The Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading the existing 2175 mm × 1275 mm CSPA culvert with three 3000 mm × 1300 mm concrete box culverts to increase the conveyance capacity. The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Ferndale Dr. N. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial Road – 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City of Barrie recommended design flood frequency criteria.

The existing crossing has a conveyance capacity of approximately 3.7 m³/s or a design flood frequency of 1:2-years. The existing culvert can be replaced with a 10.67 m open bottom span structure. The conveyance capacity of the replacement bridge is approximately 12.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of localized flooding and the increase conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 29 through public consultation. As such, Project No. 50 is recommended and included in the preferred solution for the Dyments Creek watershed.



The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance. However, it is noted that the watercourse improvements recommended immediately up and downstream of the culvert improvement do require property acquisition (see Project No. 183 and 51).

The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for the tributary of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.8 Project No. 51 (Watercourse Improvement No. 10 – Reach Dy-2b)

Undercut banks were identified along this reach of Dyments Creek (Reach Dy-2b) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) included watercourse improvements from Ferndale Dr. N. to Sarjeant Dr.. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A/3B – Watercourse Improvements to satisfy the previous MDP and City of Barrie recommended design flood frequency criteria.

An opportunity exists to regrade and reshape the watercourse to provide positive grade from Ferndale Dr. N. to Sarjeant Dr. and increase the conveyance capacity of the watercourse. Also, an opportunity exists to improve the watercourse to stabilize the channel banks and eliminate bank undercutting.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. The proposed watercourse improvement is a Schedule B project, however, as it was previously recommended as part of the preferred alternative solution as part of the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment, additional options were not evaluated. No comments were provided regarding Watercourse Improvement No. 10 during public consultation. As such, Project No. 51 is recommended and included in the preferred solution for the Dyments Creek watershed.

The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF



should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

To implement Project No. 51, the City will need to acquire lands or interests therein (easement) adjacent to the existing watercourse. A summary of the impacted properties associated with Project No. 183 is provided in the following table:

Table 60: Project No. 51 – Impacted Properties

PROPERTIES	
425 Dunlop St. W. (portion of)	433 Dunlop St. W. (portion of)
441 Dunlop St. W. (portion of)	97 Ferndale Dr. N. (portion of)
105 Ferndale Dr. N. (portion of)	30 Elliott Ave. (portion of)
20 Elliott Ave. (portion of)	8 Sarjeant Dr. (portion of)

Note: Property acquisition to be confirmed at detailed design

14.3.9 Project No. 52 (Culvert Improvement No. 30 – Sarjeant Dr. and Dunlop St. W.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading of the existing twin 2000 mm × 1500 mm CSPA culvert crossing at Sarjeant Dr. and Dunlop Street W. with three 3000 mm × 1300 mm concrete box culverts to increase the conveyance capacity of the culvert to satisfy the 1:100-year design flood frequency criteria. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing crossing does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 8.0 m³/s or a design flood frequency of 1:10-years.

Two options were developed to address this deficiency and satisfy the 1:100-year design flood frequency criteria. Option 1 is to realign and upgrade the culvert along Sarjeant Dr. and Dunlop St. W. Under Option 1, the existing twin CSPA culverts running through private property will be abandoned and the municipal drainage will be redirected away from private property. Option 2 is to upgrade the culvert within the existing easement through 15 Sarjeant Dr. and 395 Dunlop St. W. The evaluation of Option 1 and Option 2 are described in the following sections.



Option 1 – Culvert Realignment and Improvements

An opportunity exists to construct a new crossing north on Sarjeant Dr. then east on Dunlop St. W. to satisfy the 1:100-year design flood frequency criteria and remove municipal drainage from private property. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 3000 mm × 1500 mm concrete box culverts. The conveyance capacity of the replacement structure is approximately 18.0 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event. Under this option, the existing culverts would be abandoned.

Option 2 – Culvert Improvements through Existing Easement

An opportunity also exists to replace the existing twin CSPA culverts with an appropriately sized culvert. As in Option 1 the existing culverts may be replaced with twin 3000 mm × 1500 mm concrete box culverts to satisfy the design flood frequency criteria, however the culvert will remain at its current location within the existing easement. As such, municipal drainage will continue to drain through private property.

Evaluation

The individual project evaluation completed demonstrates that Option 1 – Culvert Realignment and Improvements will have the greatest overall positive impact on the project environments and be beneficial to the watershed. As such Option 1 is recommended as Project No. 52 moving forward. No comments were received regarding Culvert Improvement No. 30 through public consultation.

The proposed culvert improvement does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.



14.3.10 Project No. 53 (Culvert Improvement No. 31 – Highway 400 E/W-S and N-E/W Ramps)

As part of the Highway 400 Improvements through Barrie, the MTO is proposing to replace the Dyments Creek culvert crossing of the Highway 400 E/W-S and N-E/W ramps off Dunlop St. W. The MTO proposes to replace the existing 52 m – 1800 mm × 1400 mm concrete box culvert with a 52 m – 9000 mm × 1500 mm concrete box culvert. The culvert size has been selected to convey the 1:50-year return frequency storm event peak flow and maintain upstream water levels under proposed conditions.

As discussed, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. As part of this Drainage Master Plan, we have reviewed the improvements proposed by the MTO to determine if further improvements are warranted.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The proposed MTO replacement culvert has a conveyance capacity of approximately 29.6 m³/s which is sufficient to convey the 1:100-year return frequency storm peak flow. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event. As the MTO proposed culvert improvements satisfy the previous recommendations of the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment; specifically, the design flood frequency criteria, further improvements beyond what the MTO is proposing are not recommended for this culvert crossing.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 53 through public consultation. As such, Project No. 53 is recommended and included in the preferred solution for the Dyments Creek watershed. It is recommended that the culvert improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study and be implemented by the MTO as part of the Highway 400 improvements.

14.3.11 Project No. 54 (Culvert Improvement No. 33 – Highway 400)

As part of the Highway 400 Improvements through Barrie, the MTO is proposing to replace the Dyments Creek culvert crossing Highway 400. The MTO proposes to replace the existing 84 m – 1200 mm × 1100 mm concrete box culvert with a 135 m – 9000 mm × 2000 mm concrete box culvert. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City of Barrie recommended design flood frequency criteria.



As discussed, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. As part of this Drainage Master Plan, we have reviewed the improvements proposed by the MTO to determine if further improvements are warranted.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The proposed MTO replacement culvert has a conveyance capacity of approximately 54.0 m³/s which is sufficient to convey the Regional (Hurricane Hazel) storm peak flow. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. As the MTO proposed culvert improvements exceed the previous recommendations of the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment; specifically, the design flood frequency criteria, further improvements beyond what the MTO is proposing are not recommended for this culvert crossing.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 54 through public consultation. As such, Project No. 54 is recommended and included in the preferred solution for the Dyments Creek watershed. It is recommended that the culvert improvements be implemented in accordance with the conceptual designs already prepared as part of the previous study and be implemented by the MTO as part of the Highway 400 improvements.

14.3.12 Project No. 55 (Culvert Improvement No. 32 – Hart Dr.)

The Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading the existing 1500 mm diameter CSP culvert with three 3000 mm × 2100 mm concrete box culverts to increase the conveyance capacity. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City of Barrie recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of less than 3.7 m³/s; less than a design flood frequency of <1:2-years. Two options were developed to address this deficiency. Option 1 is to provide culvert upgrades in the location of the existing culvert. Option 2 is to extend the proposed Highway 400 culvert under Hart Dr. The evaluation of Option 1 and Option 2 are described in the following sections.



Option 1 – Culvert Improvements

An opportunity exists to replace the existing culvert with a 10.67 m open bottom span structure to convey the 1:100-year return period storm peak flow. The conveyance capacity of the replacement structure is approximately 31.6 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

Option 2 – Highway 400 Culvert Extension

As discussed, the MTO has noted that they would entertain further improvements to the culverts under Highway 400 if the City is open to covering the cost of the additional works. An opportunity exists to extend the MTO proposed 9000 mm × 2000 mm concrete box culvert under Hart Dr. The proposed MTO replacement culvert has a conveyance capacity of approximately 54.0 m³/s which is sufficient to convey the Regional (Hurricane Hazel) storm peak flow. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur.

Evaluation

The individual project evaluation completed demonstrates that Option 2 – Highway 400 Culvert Extension will have a greater overall positive impact on the project environments and be more beneficial to the watershed than Option 1 – Culvert Improvements. As such, Option 2 – Highway 400 Culvert Extension is recommended as Project No. 55 for the Dyments Creek Watershed. No comments were received regarding Culvert Improvement No. 32 through public consultation.

The proposed culvert improvement is a Schedule A project. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report. It is recommended that the culvert improvements be implemented by the MTO and the City when construction of the Highway 400 improvements occur.

14.3.13 Project No. 56 (Watercourse Improvement No. 11 – Reach Dy-3)

Under existing conditions, Dyments Creek runs under the northwest corner of 65 Hart Dr. through three existing culverts. The existing conditions analysis completed as part of this



Drainage Master Plan confirmed that the capacity of the existing culverts does not satisfy the MDP recommended design flood frequency criteria. The existing crossing has a conveyance capacity of approximately 14 m³/s or a design flood frequency of 1:10-years. Three options were developed to address this deficiency. Option 1 is to daylight the watercourse across the northwest corner of 65 Hart Dr. Option 2 is to extend the proposed Highway 400 and Hart Dr. culvert across 65 Hart Dr. Option 3 is to abandon the existing culverts, extend the proposed Highway 400 and Hart Dr. culvert through to 55 Hart Dr. and daylight the watercourse across 55 Hart Dr. The evaluation options is described in the following sections.

Option 1 – Daylight Watercourse Through 65 Hart Dr.

An opportunity exists to remove the existing culverts across 65 Hart Dr. and daylight the watercourse. Removing the culverts and daylighting the watercourse will improve the hydraulic function of the culverts and watercourse in the area. Daylighting the watercourse will remove parking from the existing commercial business occupying 65 Hart Dr. It is understood that the City approved the enclosure of the watercourse in the past to accommodate the additional parking. As such, this option will have negative implications on the existing business. To daylight the watercourse, the City will need to acquire lands or interests therein (easement) across the northwest corner of 65 Hart Dr.

Option 2 – Culvert Improvements

An opportunity exists to replace the existing culverts across 65 Hart Dr. with an appropriately sized culvert. As the recommended improvement identified under Project No. 55 is to extend the proposed Highway 400 culvert under Hart Dr., the culvert could also be extended across 65 Hart Dr. The proposed MTO replacement culvert has a conveyance capacity of approximately 54.0 m³/s which is sufficient to convey the Regional (Hurricane Hazel) storm peak flow. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. To extend the culvert, the City will need to acquire lands or interests therein (easement) across the northwest corner of 65 Hart Dr.

Option 3 – Daylight Watercourse Through 55 Hart Dr.

An opportunity exists to alter the alignment of the proposed Highway 400 and Hart Dr. culvert to daylight north of the existing crossing on 55 Hart Dr. To accommodate the new alignment, watercourse improvements are required across 55 Hart Dr. to connect the proposed culvert extension to Dyments Creek. Realigning the culvert and daylighting the watercourse will improve the hydraulic function of the culverts and watercourse in the area. Under this option, the existing culverts under 65 Hart Dr. would be abandoned. To realign the culvert and



daylight the watercourse, the City will need to acquire lands or interests therein (easement) across the northwest corner of 55 Hart Dr.

Evaluation

The individual project evaluation completed demonstrates that Option 3 – Daylight Through 55 Hart Dr. will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, Option 3 – Daylight Through 55 Hart Dr. is recommended as Project No. 56 for the Dyments Creek Watershed.

The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.3.14 Project No. 57 (Culvert Improvement No. 34 – George St.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading of the existing 2690 mm × 1730 mm concrete elliptical culvert crossing at George St. with two 3000 mm × 2400 mm concrete box culverts to increase the conveyance capacity of the culvert to convey the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 6.8 m³/s or a design flood frequency of 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 3600 mm × 1800 mm concrete box culverts. The conveyance capacity of the replacement structure is approximately 32.2 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 34 through



public consultation. As such, Project No. 57 is recommended and included in the preferred solution for the Dyments Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.15 Project No. 169 (Culvert Improvement No. 35 – Victoria St.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended improvements to the existing Victoria St. crossing to convey the 1:100-year return frequency storm peak flow. As part of this Drainage Master Plan, we evaluated an alternative solution; removing the culvert crossing and daylighting the watercourse.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of less than 2.2 m³/s; less than a design flood frequency of 1:2-years. Victoria St. is a service road that does not provide any access points to the neighbouring lands. The existing culvert crossing functions as the outlet controls for SWMF DY01 located upstream of Victoria Rd. An opportunity exists to remove the existing culvert crossing and reinstate the watercourse in lieu of improving the culvert crossing.

The individual project evaluation completed demonstrates that the proposed culvert removal will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 35 through public consultation. Removing the culvert crossing impacts SWMF DY01 which is considered for retrofit under Project No. 170. However, each option solution considered under Project No. 170 included the removal of the Victoria St. culvert crossing. As such, Project No. 169 is recommended and included in the preferred solution for the Dyments Creek watershed.

14.3.16 Project No. 170 (SWMF Retrofit No. 79 – DY01)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended retrofitting



SWMF DY01 for peak flow attenuation. The DMP recommendation is to expand SWMF DY01 downstream of Victoria St. to increase the active storage volume available to attenuate peak flows and reduce downstream discharges.

Under existing conditions, SWMF DY01 reduces peak flows through Dyments Creek by 2% during major storms and provides less than a basic level of treatment (<60% TSS removal) for its contributing drainage area. An opportunity exists to expand SWMF DY01 to increase the active storage volume available and further attenuate peak flows. As part of this Drainage Master Plan, two options were considered. Option 1 is to expand the existing wet pond SWMF downstream of Victoria St. by removing the existing Victoria St. culvert crossing and constructing a second wet pond cell downstream. Option 2 is to convert SWMF DY01 into a peak flow attenuation facility that utilizes the existing floodplain storage between George St. and Anne St. S. The evaluation of options is described in the following sections.

Option 1 – SWMF Expansion

An opportunity exists to expand SWMF DY01 to improve the level of treatment and peak flow attenuation provided. Removing the existing Victoria St. culvert crossing and expanding SWMF DY01 downstream by constructing a wet pond cell with a permanent pool between Victoria St. and Anne St. S. will increase the total suspended solids removal rate to 70%. Removing the Victoria St. culvert crossing will increase the active storage volume available between George St. and Anne St. South. Modifying the existing Anne St. S. and John St. culvert crossing to include outlet controls along with the increase active storage volume will improve the peak flow attenuation provided. It is estimated that Option 1 will reduce peak flows through Dyments Creek by 24% during major storm events. To implement Option 1, the City will need to acquire 142 John St.

Option 2 – Peak Flow Attenuation Facility

An opportunity exists to retrofit the existing SWMF to remove the online wet pond treatment cell, improve the peak flow attenuation provided and reinstate the watercourse. By removing the Victoria St. crossing and reinstating the watercourse from George St. to Victoria St., the existing online wet pond treatment cell would be removed from the watershed and the active storage volume provided in the floodplain will be increased. Modifying the existing Anne St. S. and John St. culvert crossing to include outlet controls along with the increase active storage volume will improve the peak flow attenuation provided. It is estimated that Option 2 will reduce peak flows through Dyments Creek by 24% during major storm events.



Evaluation

The LSRCA does not support the construction of online SWMF's; specifically, treatment cells. The LSRCA was consulted regarding this project and Option 1 is not permitted.

The individual project evaluation completed demonstrates that Option 2 will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 170 through public consultation. As such, Option 2 – Peak Flow Attenuation Facility is recommended as Project No. 170 for the Dyments Creek Watershed.

The proposed improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit and watercourse improvements are presented in Section 15 of this report.

14.3.17 Project No. 58 (Culvert Improvement No. 36 – Anne St. S. and John St.)

The Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended improving the Anne St. S. and John St. culvert crossing to increase the conveyance capacity of the culvert to satisfy the City of Barrie flow design guidelines for road crossings (Arterial Road - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy the City of Barrie recommended design flood frequency criteria.

The existing crossing has a conveyance capacity of approximately 13.9 m³/s or a design flood frequency of 1:10-years. It is noted that a portion of the culvert crossing, specifically the culvert section across Anne St. S. has been replaced since the original MDP recommendations were filed. The replacement culverts installed is a twin 3000 mm x 2100 mm concrete box culverts. However, the existing section of culvert crossing John St. remains deficient.

To satisfy the design flood frequency criteria, the existing deficient culvert can be replaced with twin 3000 × 2100 mm concrete box culverts. The conveyance capacity of the replacement structure is approximately 28.9 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.



The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 36 through public consultation. As such, Project No. 58 is recommended and included in the preferred solution for the Dyments Creek watershed.

To implement Project No. 58, the City will need to acquire lands or interests therein (easement) near the culvert. Specifically, a portion of 71 Anne St S. will be impacted. It is noted that the culvert currently crosses John St. and 71 Anne St. S., underneath the existing building occupying the property. As part of the proposed improvements, the section of culvert on private property will be abandoned and the culvert alignment will be relocated within the municipal road allowance. However, to tie back into Dyments Creek east of 71 Anne St. S., the culvert will have to cross private property. The culvert will run underneath an existing parking lot under the new alignment rather than underneath the building under existing conditions.

The proposed culvert improvement is a Schedule B project. However, as the previous preferred alternative solution recommended as part of the Master Drainage Plan included improving this culvert crossing, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.18 Project No. 59 (Watercourse Improvement No. 12 – Reach Dy-5)

Bank scour and undercutting were identified in this reach of Dyments Creek (Reach Dy-5) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommends installing toe treatment to prevent bank scour and undercutting through this reach of Dyments Creek.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 12 during public consultation. As such, Project No. 59 is recommended and included in the preferred solution for the Dyments Creek watershed.

The watercourse improvements proposed do not require property acquisition as the works can be completed within the existing watercourse banks. The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from



the LSRCA. It is anticipated that a request for review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.3.19 Project No. 60 (Culvert Improvement No. 37 – Innisfil St.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading of the existing 2000 mm × 1000 mm concrete box culvert crossing at Innisfil St. with three 3000 mm × 1500 mm concrete box culverts to increase the conveyance capacity of the culvert to satisfy the recommendations of the MDP (design flood frequency criteria to the 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing crossing has a conveyance capacity of approximately 4.2 m³/s or a design flood frequency of 1:2-years. The existing culvert can be replaced with a 6.71 m open bottom span structure. The conveyance capacity of the replacement structure is approximately 23.4 m³/s, or the 1:50-year return frequency storm peak flow. During the 1:100-year event, the proposed culvert will convey approximately 97% of the peak flow. The remaining 3% (0.7 m³/s) overtops the roadway. To convey the additional 3% of the 1:100-year return frequency storm peak flow, a significantly larger culvert is required. The culvert size should be reviewed at detailed design to determine if an increase in the conveyance capacity of the culvert is warranted to satisfy the requisite design flood frequency criteria and reduce flooding over the roadway.

In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 37 through public consultation. As such, Project No. 60 is recommended and included in the preferred solution for the Dyments Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will



require a permit from the LSRCA. It is anticipated that a request for review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.20 Project No. 61 (Culvert Improvement No. 38 – Sanford St.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading of the existing twin 1350 mm steel pipe culvert crossing at Sanford St. with three 3000 mm × 1500 mm concrete box culverts to increase the conveyance capacity of the culvert to satisfy the recommendations of the MDP (design flood frequency criteria to the 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 9.0 m³/s or a design flood frequency of 1:5-years. The existing culvert can be replaced with a 4200 mm x 2100 mm conc. Box culvert. The conveyance capacity of the replacement structure is approximately 23.6 m³/s, or the 1:50-year return frequency storm peak flow. During the 1:100-year event, the proposed culvert will convey approximately 97% of the peak flow. The remaining 5% (1.5 m³/s) overtops the roadway. To convey the additional 5% of the 1:100-year return frequency storm peak flow, a significantly larger culvert is required. The culvert size should be reviewed at detailed design to determine if an increase in the conveyance capacity of the culvert is warranted to satisfy the requisite design flood frequency criteria and reduce flooding over the roadway.

In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 38 through public consultation. As such, Project No. 61 is recommended and included in the preferred solution for the Dyments Creek watershed.

To implement Project No. 61, the City will need to acquire lands or interests therein (easement) near the culvert outlet. Specifically, a portion of 95 Sanford St. and 100 Sanford St. will be



impacted. The proposed culvert improvement is a Schedule B project. However, as the previous preferred alternative solution recommended as part of the Master drainage Plan included improving this culvert crossing subsequent options were not evaluated.

The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a request for review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.21 Project No. 62 (Culvert Improvement No. 39 – Bradford St.)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended upgrading of the existing 5400 mm × 1800 mm CSPA culvert crossing at Bradford St. with four 3000 mm × 1800 mm concrete box culverts to increase the conveyance capacity of the culvert to satisfy the recommendations of the MDP (design flood frequency criteria to the 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing crossing has a conveyance capacity of approximately 21.5 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10.67 m open bottom span structure. The conveyance capacity of the replacement structure is approximately 29.5 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 39 through public consultation. As such, Project No. 62 is recommended and included in the preferred solution for the Dyments Creek watershed.

To implement Project No. 62, the City will need to acquire lands or interests therein (easement) to accommodate the crossing. Specifically, 176 Bradford St. will be impacted. The proposed culvert improvement is a Schedule B project. However, as the previous preferred alternative



solution recommended as part of the Master Drainage Plan included improving this culvert crossing, subsequent options were not evaluated.

The culvert improvement is located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a request for review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.3.22 Project No. 63 (Watercourse Improvement No. 28 – Reach Dy-6)

The preferred alternative solution identified in the Dyments Creek Master Drainage Plan Municipal Class Environmental Assessment (City of Barrie, 2006) recommended floodway improvements downstream of Bradford St. to increase the conveyance capacity of the watercourse. An opportunity exists to daylight the watercourse downstream of Bradford St. and widen the watercourse and floodplain to convey the Regional (Hurricane Hazel) storm peak flows.

Approximately 120 m of Dyments Creek can be daylighted and improved downstream of Bradford St. to increase the conveyance capacity of the system. Improving the conveyance capacity will reduce the potential flooding of the WwTF.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 28 during public consultation. As such, Project No. 63 is recommended and included in the preferred solution for the Dyments Creek watershed.

The watercourse improvements proposed do not require property acquisition as the works can be completed within City owned lands. The proposed watercourse improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Dyments Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.



14.4 HOTCHKISS CREEK WATERSHED

14.4.1 Project No. 12 (Culvert Improvement No. 41 – Mayfair Dr.)

The Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, 2012) did not identify any drainage improvements on this reach of Hotchkiss Creek (Reach Ho-1). However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Mayfair Dr. culvert crossing does not satisfy the City's design flood frequency criteria (Minor Collector – 1:50-year). As such, an opportunity exists to replace the existing culvert to increase the existing conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately 0.7 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 750 mm diameter concrete culvert. The conveyance capacity of the replacement culvert is approximately 1.6 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will eliminate flow overtopping the road during the Regulatory event, providing safe access/egress across Mayfair Dr.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 41 through public consultation. As such, Project No. 12 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on a tributary of Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for the tributary of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.2 Project No. 13 (Culvert Improvement No. 42 – Ardagh Rd.)

The Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, 2012) did not identify any drainage improvements on this reach of Hotchkiss Creek (Reach Ho-1). However, the existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Ardagh Rd. culvert crossing does not



satisfy the City's design flood frequency criteria (Arterial - 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of less than $0.6 \text{ m}^3/\text{s}$ or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 900 mm diameter concrete culvert. The conveyance capacity of the replacement culvert is approximately $2.5 \text{ m}^3/\text{s}$. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will eliminate flow overtopping the road during the Regulatory event, providing safe access/egress across Ardagh Dr.

Flow enters the culvert through a ditch inlet structure south of Ardagh Rd. An opportunity exists to improve the hydraulics of the crossing and increase the inlet capacity of the ditch inlet by lowering the structure. Lowering the structure should also reduce the potential for the inlet grate to become obstruction and reduce the maintenance requirements.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 42 through public consultation. As such, Project No. 13 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for the tributary of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.3 Project No. 14 (Culvert Improvement No. 43 – Morrow Rd.)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Morrow Road. The preferred alternative solution included replacing the existing culverts with a 7000 mm × 1600 mm reinforced concrete box culvert to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master



Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culverts have a conveyance capacity of approximately 5.0 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced.

During the preparation of this Drainage Master Plan, the existing Morrow Rd. culvert was replaced with a 4000 mm x 1600 mm conc. box culvert designed in accordance with the recommendations of the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update. As such, the Morrow Rd. culvert crossing is no longer deficient and Project No. 14 is longer required.

14.4.4 Project No. 15 (SWMF Retrofit No. 3 – HT06)

SWMF HT06 is a dry pond with a contributing drainage area of approximately 28 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF HT06 has an active storage volume of 16,070 m³ and extended detention volume of 11,930 m³.

SWMF HT06 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF HT06 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF HT06 confirms that the infiltration rate (86 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 663 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 34 kg/year in Lake Simcoe (MECP P-Tool).

During the preparation of this Drainage Master Plan, SWMF HT06 was retrofitted to include an underground infiltration system to improve water quality treatment and phosphorus removal. As such, Project No. 15 is longer required.

14.4.5 Project No. 16 (Culvert Improvement No. 44 – Essa Rd.)

As part of the Highway 400 Improvements through Barrie, the MTO is proposing to replace the Hotchkiss Creek culvert crossing of Essa Rd. Unfortunately, the available studies prepared in support of the MTO Highway 400 improvements did not specify a replacement size for the culvert improvements. As discussed, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity. However, without knowing the proposed



replacement culvert size we are unable to review the improvements proposed by the MTO to determine if further improvements are warranted.

The existing culvert has a conveyance capacity of less 2.0 m³/s or a design flood frequency of less than 1:2-years. Essa Rd. is an arterial road having a design flood frequency criterion of 1:100-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3048 mm x 914 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 8.0 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Essa Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 44 through public consultation. As such, Project No. 16 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

It is recommended that the culvert improvements be implemented in accordance with the conceptual designs prepared in support of the Highway 400 improvements and be implemented by the MTO as part of the Highway 400 improvements.

14.4.6 Project No. 17 (SWMF Creation No. 44)

The creation of a SWMF between Morrow Rd. and Highway 400, north of Essa Rd. was identified as an opportunity for water quality treatment and phosphorus removal in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

Under existing conditions, approximately 53 ha of primarily residential development drains via a natural channel alongside Highway 400. Two options were developed and evaluated for SWMF Retrofit No. 44. Option 1 includes constructing a wetland to provide water quality treatment and phosphorus removal. Option 2 includes constructing a bioretention facility (LID) to provide water quality treatment and phosphorus removal. The evaluation of Option 1 and Option 2 is described in the following sections.

Option 1 - Wetland

An opportunity exists to construct a wetland SWMF in the east half of 85 Morrow Rd. (unoccupied) to treat approximately 53 ha of drainage. A flow diversion can be constructed in the channel to direct the peak flow resulting from the 25 mm storm into the SWMF while



allowing flows exceeding the 25 mm storm peak flow to continue downstream. To provide 80% TSS removal, 2,435 m³ of permanent pool volume is required in the wetland. Creating the new wetland will result in a phosphorus reduction of nearly 70 kg/year in Lake Simcoe (MECP P-Tool).

Although 11,550 m³ of additional active storage can be provided in the wetland, the active storage volume is insufficient to provide any appreciable peak flow attenuation during major storm events. As such, the wetland SWMF provides little peak flow attenuation and is considered a retrofit for water quality enhancement only.

Option 2 – Bioretention Facility (LID)

An opportunity exists to construct a bioretention facility in the east half of 85 Morrow Rd. (unoccupied) to treat approximately 53 ha of drainage. A flow diversion can be constructed in the channel to direct the peak flow resulting from the 25 mm storm into the SWMF while allowing flows exceeding the 25 mm storm peak flow to continue downstream. To provide 80% TSS removal, 1,320 m³ of infiltration storage is required in the bioretention facility. Creating the new bioretention facility will result in a phosphorus reduction of nearly 79 kg/year in Lake Simcoe (MECP P-Tool).

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m and the SWMF is located outside a significant groundwater recharge area. However, the SWMF would be located in Well Head Protection Area D. With a contributing drainage area consisting of industrial lands and arterial road, this location is unsuitable for infiltration practices. As such, a bioretention facility is not recommended for this location.

Evaluation

The individual project evaluation completed demonstrates that the proposed wetland (Option 1) will have a positive impact on the project environments and be beneficial to the watershed. As such, the construction of a wetland SWMF is recommended as Project No. 17. No comments were received regarding SWMF Retrofit No. 44 through public consultation. As such, Project No. 17 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

To implement Project No. 17, the City will need to acquire a portion of 85 Morrow Rd. The proposed improvements are located on Dyments Creek within the LSRCA Regulated area and will require a permit from the LSRCA. A Ministry of the Environment, Conservation and Parks Environmental Compliance Approval will also be required for the SWMF. Additional cultural



heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.4.7 Project No. 18 (Culvert Improvement No. 46 – Highway 400)

The MTO recently improved the Hotchkiss Creek culvert crossing Highway 400 by lining the existing 1800 mm diameter CSP culvert with a 1070 mm liner and installing a 2100 mm diameter CSP culvert complete with 500 mm of native substrate in the bottom. The existing culvert has a conveyance capacity of approximately 18 m³/s or a design flood frequency of approximately 1:25-years.

A spill from the main channel of Hotchkiss Creek under Highway 400 via the railway tracks north of the culvert crossing is known to occur under existing conditions when the capacity of the culvert is exceeded. As such, an opportunity exists to improve the culvert further by increasing the culvert size and conveyance capacity to reduce the existing spill. The MTO has noted that they would entertain further improvements to the culverts under Highway 400 if the City is open to covering the cost of the additional works. As part of this Drainage Master Plan, we have reviewed the improvements to determine if further improvements are warranted.

To eliminate the flood spill, an 1800 mm diameter conc. culvert can be installed to supplement the capacity of the existing crossing. The capacity of the crossing will be increase to approximately 39.9 m³/s and would have capacity to convey the Regional (Hurricane Hazel) storm peak flow.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall negative impact on the project environments and not be beneficial to the watershed. As such, Project No. 18 is not recommended in the preferred solution for the Hotchkiss Creek watershed.

14.4.8 Project No. 19 (SWMF Creation No. 81)

The creation of a SWMF between Highway 400 and Wood St. was identified as an opportunity to provide peak flow attenuation in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). The preferred alternative solution was to provide 43,300 m³ of active storage by daylighting the Wood St. culvert and controlling outflows through a 4300 mm x 900 mm reinforced concrete box culvert. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control to satisfy the City of Barrie requirements for peak flow attenuation.

Under existing conditions, approximately 267 ha of primarily residential development drains to the Hotchkiss Creek culvert crossing at Highway 400. Approximately 200 m downstream of this



crossing, Hotchkiss Creek is conveyed north through a culvert underneath of Wood St. An opportunity exists to construct a peak flow attenuation facility above a low flow channel (designed to convey the 15 m storm peak flow) to attenuate peak flows. The analysis completed as part of this Drainage Master Plan demonstrates that by combining the 43,300 m³ storage volume with a controlled outlet (4267 mm × 914 mm concrete box culvert), peak flows will be attenuated by approximately 59% reducing the Hotchkiss Creek existing and future land use condition 1:100-year return frequency storm peak flows to 14 m³/s and 17 m³/s, respectively. A 60 m wide emergency overflow weir will safely convey flows in excess of the 1:100-year peak flow downstream.

To construct the peak flow attenuation facility, Wood St. will have to be terminated in a cul-de-sac in front of 27 Wood St. Also, the existing sanitary and water services extending west beyond 27 Wood St. will have to be terminated and removed for the SWMF construction.

The individual project evaluation completed demonstrates that the proposed SWMF creation will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Creation No. 81 through public consultation. As such, Project No. 19 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The proposed SWMF creation is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previous Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). As such, subsequent options were not evaluated. The SWMF creation is located on the main branch of Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the peak flow attenuation facility are presented in Section 15 of this report.

The LSRCA does not permit the construction of online stormwater management facilities. As such, the peak flow attenuation facility needs to be constructed to allow a low flow channel to by-pass minor storm flow. As a minimum it should be designed to convey the peak flow generated by the 15 mm storm event. As minor event peak flows will drain through the low flow channel without attenuation, the peak flow attenuation facility will not provide any water quality benefit or phosphorus removal.

To implement Project No. 19, a portion of 50 Wood St will have to be acquired by the City. It is understood that a development proposal has been submitted to the City of Barrie for 50 Wood St. The conceptual design prepared for SWMF Creation No. 81 was prepared before the



development proposal was submitted. As such, the design of the peak flow attenuation facility may be altered in consultation with the property owner and MTO to satisfy the stormwater management objectives of each party in the future.

14.4.9 Project No. 20 (SWMF Creation No. 96)

The creation of a SWMF between Wood St. and BCRY Railway crossing was identified as an opportunity to provide peak flow attenuation in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). The preferred alternative solution was to provide 8,200 m³ of active storage and control outflows through a 5200 mm x 900 mm concrete box culvert. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control to satisfy the City of Barrie requirements for peak flow attenuation.

Under existing conditions, approximately 295 ha of primarily residential development drains to Hotchkiss Creek downstream of SWMF Creation No. 81. An opportunity exists to construct a peak flow attenuation facility above a low flow channel (designed to convey the 15 mm storm peak flow) to attenuate peak flows. The analysis completed as part of this Drainage Master Plan demonstrates that approximately 23,000 m³ of storage is available within the natural watercourse corridor downstream of Wood St. to the BCRY rail lines. By combining the active storage with a controlled outlet (4878 mm x 914 mm conc. box culvert), peak flows will be attenuated by approximately 61% reducing the Hotchkiss Creek existing and future land use condition 1:100-year return frequency storm peak flows to 14 m³/s and 17 m³/s, respectively.

The controlled outlet required for this project will replace the existing BCRY railway crossing (see Project No. 21). As discussed in subsequent sections of this report, there is an opportunity to adjust the alignment of the BCRY railway crossing to daylight a section of Hotchkiss Creek. Realigning the culvert crossing requires Hotchkiss Creek to be extended and the natural watercourse corridor to be expanded through 47 Alfred St.; increasing the active storage volume available in the peak flow attenuation facility.

The individual project evaluation completed demonstrates that the proposed peak flow attenuation facility will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Creation No. 96 through public consultation. As such, Project No. 20 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The proposed SWMF creation is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previous Hotchkiss Creek



Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). As such, subsequent options were not evaluated.

The SWMF creation is located on the main branch of Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for the tributary of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the peak flow attenuation facility are presented in Section 15 of this report.

The LSRCA does not permit the construction of online stormwater management facilities. As such, the peak flow attenuation facility needs to be constructed above a low flow channel designed to convey the peak flow generated by the 15 mm storm event. As minor event peak flows will drain through the low flow channel without attenuation, the peak flow attenuation facility will not provide any water quality benefit or phosphorus removal.

To implement Project No. 20, a portion of 50 Wood St will have to be acquired by the City. It is understood that a development proposal has been submitted to the City of Barrie for 50 Wood St. The conceptual design prepared for SWMF Creation No. 96 was prepared before the development proposal was submitted. As such, the design of the peak flow attenuation facility may be altered in consultation with the property owner and MTO to satisfy the stormwater management objectives of each party in the future.

14.4.10 Project No. 21 (Culvert Improvement No. 135 – BCRY Railway Crossing)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at BCRY Railway. The preferred alternative solution included replacing the existing culvert with a 5200 mm × 900 mm reinforced concrete box culvert to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of less than 5.0 m³/s or a design flood frequency of less than 1:2-years. Also, the existing culvert crosses two private properties (207 Tiffin St. and 155 Tiffin St.) between the railway tracks and Tiffin St.



This culvert is the primary outlet for SWMF Retrofit No. 96. To utilize the natural storage within the floodplain upstream of the BCRY railway and provide peak flow attenuation, the existing culvert can be removed/abandoned and replaced with a 4878 mm x 914 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 19.8 m³/s or a design flood frequency of 1:100-years. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

As discussed, there is an opportunity to adjust the alignment of the BCRY railway crossing to daylight a section of Hotchkiss Creek. Realigning the culvert crossing requires Hotchkiss Creek to be extended and the natural watercourse corridor to be expanded through 47 Alfred St. The realigned culvert can run north from 47 Alfred St. to 155 Tiffin St. Rather than running the proposed culvert north through 155 Tiffin St. to the location of the existing culvert outlet, approximately 75 m of Hotchkiss Creek can be daylighted.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 135 through public consultation. As such, Project No. 21 is recommended and included in the preferred solution for the Hotchkiss watershed.

The proposed culvert improvement is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previous Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). As such, subsequent options were not evaluated.

To implement Project No. 21, 47 Alfred St. and a portion of 155 Tiffin St. will have to be acquired by the City. The culvert improvement is located on Hotchkiss within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.11 Project No. 22 (Culvert Improvement No. 48 – Tiffin St.)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Tiffin St. The preferred alternative solution included replacing the existing culvert with a 4300 mm x 1800 mm concrete box culvert to



provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert have a conveyance capacity of approximately $0.6 \text{ m}^3/\text{s}$ or a design flood frequency less than 1:2-years. The existing culvert can be replaced with a 4267 mm × 1830 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately $17.0 \text{ m}^3/\text{s}$, or the 1:50-year return frequency storm peak flow. During the 1:100-year event, the proposed culvert will convey approximately 99% of the peak flow. The remaining % ($0.2 \text{ m}^3/\text{s}$) overtops the roadway. To convey the additional 1% of the 1:100-year return frequency storm peak flow, a significantly larger culvert is required. The culvert size should be reviewed at detailed design to determine if an increase in the conveyance capacity of the culvert is warranted to satisfy the requisite design flood frequency criteria and reduce flooding over the roadway.

In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 48 through public consultation. As such, Project No. 22 is recommended and included in the preferred solution for the Hotchkiss watershed.

The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Hotchkiss within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.12 Project No. 23 (Watercourse Improvement No. 6 – Reach Ho-8)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Anne St. S. The Anne St. S. culvert crossing extends east and west of Anne St. S. across private property. Under existing conditions, this



system of culverts (upstream of Anne St., underneath Anne St. and downstream of Anne St.) has a conveyance capacity of less than $8.1 \text{ m}^3/\text{s}$ or a design flood frequency of less than 1:2-years.

Although the previous recommendation was to replace the culvert upstream of Anne St. S. with an appropriately sized structure, we explored options to remove the municipal drainage system from private property as well as daylighting the watercourse upstream of Anne St. S. Three options were developed and evaluated between Tiffin St. and Anne St. S. Option 1 is to daylight the watercourse through 134 Tiffin St., 115 Brock St and 128 Anne St. S. Option 2 is to upsize the culvert to satisfy the design flood frequency criteria (Arterial Road – 1:100-year design flood frequency). Option 3 is to construct a new storm sewer on Tiffin St. and Anne St. S. removing the culvert from private property. The evaluation of each option is described in the following sections.

Option 1 – Daylight Watercourse

An opportunity exists to daylight the watercourse between Tiffin St. and Anne St. S. through 134 Tiffin St., 115 Brock St and 128 Anne St. S. Removing the existing culvert and constructing a watercourse of the same size and shape as the open channel section immediately downstream of Tiffin St. will safely convey the 1:100-year return frequency storm event peaks flows to Anne St. S. To implement this option, the City would have to acquire 134 Tiffin St. and portions of 115 Brock St. and 128 Anne St. S.

Option 2 – Culvert Upgrade

As recommended in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012), the culvert can be improved to convey the 1:100-year return frequency storm event peaks flows. To satisfy the design flood frequency criteria, the existing culvert upstream of Anne St. can be replaced with a $4270 \text{ mm} \times 2440 \text{ mm}$ concrete box culvert. The conveyance capacity of the replacement culvert is approximately $34.6 \text{ m}^3/\text{s}$. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The legal survey completed in the area of Project No. 23 identified existing easements over the culvert across 115 Brock St. and 134 Tiffin St. The 12 m easement across 115 Brock St. is sufficient to accommodate the proposed culvert improvements. However, additional land is required across 134 Tiffin St. to accommodate the improvements and improve the alignment of the culvert. There is currently no easement across 128 Anne St. S. and the City will need to acquire a portion of 128 Anne St. S. or interest therein (easement) to implement Project No. 23.



Option 3 – Trunk Storm Sewer

An opportunity exists to redirect the municipal drainage that crosses 134 Tiffin St., 115 Brock St and 128 Anne St. S. away from private property by constructing a trunk storm sewer on Tiffin St. and Anne St. S. A trunk storm sewer can be constructed from the Tiffin St. culvert crossing (Culvert Improvement No. 48) to the Anne St. S culvert crossing. A 4270 mm × 2440 mm concrete trunk storm sewer at a minimum slope of 0.12% can be constructed with a capacity of approximately 34.6 m³/s which satisfies the City's design flood frequency criteria. The existing culvert crossing private property between Tiffin St. and Anne St. S. can be abandoned. The trunk storm sewer proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands.

Evaluation

The individual project evaluation completed demonstrates that daylighting the watercourse will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, daylighting the watercourse (Option 1) is recommended as Project No. 23. Project No. 23 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The proposed watercourse improvements are located on Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.4.13 Project No. 24 (Culvert Improvement No. 49 – Anne St. S.)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Anne St. S. The preferred alternative solution included replacing the existing culvert underneath the Anne St. S. with a 5200 mm x 2750 mm reinforced concrete box culvert to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year).

To date, the City has improved the Anne St. S. culvert crossing in accordance with the recommendations of the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update; specifically the City design flood frequency criteria. The culvert



improvements however were limited to the Anne St. S. road allowance and the existing deficient culvert outside of the road allowance remains. To complete the improvements recommended, the culvert needs to be extended upstream and downstream.

The proposed culvert improvement is a Schedule A project. The culvert improvement is located on Hotchkiss within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.14 Project No. 25 (Watercourse Improvement No. 13 – Reach Ho-9)

As discussed, the preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Anne St. S. The Anne St. S. culvert crossing extends east and west of Anne St. S. across private property. Under existing conditions, this system of culverts (upstream of Anne St., underneath Anne St. and downstream of Anne St.) has a conveyance capacity of less than 8.1 m³/s or a design flood frequency of less than 1:2-years.

The previous recommendation was to remove the culvert downstream of Anne St. S. and daylight the watercourse. An opportunity exists to daylight the watercourse downstream of Anne St. S. through 120 Tiffin St. and 108 Tiffin St. Removing the existing culvert and constructing a watercourse of the same size and shape as the open channel section immediately downstream of Tiffin St. will safely convey the 1:100-year return frequency storm event peaks flows. To implement this option, the City would have to acquire portions of 120 Tiffin St., 108 Tiffin St. and a property with an unknown address.

The individual project evaluation completed demonstrates that daylighting the watercourse will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 25 during public consultation. As such, Project No. 25 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

The proposed watercourse improvement is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previous Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). As such, subsequent options were not evaluated.



The proposed watercourse improvements are located on Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and environmental requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

The legal survey completed in the area of Project No. 25 identified existing easements over the culvert across the properties downstream of Anne St. S. However, the 16 m easement is not sufficient to accommodate the proposed watercourse improvements and additional land will need to be acquired. The properties impacted by Project No. 25 are 120 Tiffin St., 108 Tiffin St. and a property with an unknown address.

14.4.15 Project No. 26 (SWMF Creation No. 48 – HT13)

The creation of a peak low attenuation facility on Hotchkiss Creek between Anne St. and Innisfil St. was identified as an opportunity to provide peak flow attenuation in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). The preferred alternative solution was to provide 11,200 m³ of active storage and control downstream discharge through a 3400 mm x 2400 mm reinforced concrete box culvert to convey the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 2A – Retrofit/New Stormwater Management Facilities for Quantity Control to satisfy the City of Barrie requirements for peak flow attenuation.

Under existing conditions, approximately 396 ha drains to Hotchkiss Creek at the Innisfil St. culvert crossing. An opportunity exists to construct a peak flow attenuation facility above a low flow channel to limit the peak flows downstream. The analysis completed as part of this Drainage Master Plan demonstrates that 21,090 m³ of active storage can be created within the pond footprint. By combining the active storage volume with a controlled outlet (3962 mm x 2134 mm concrete box culvert), peak flows will be attenuated by only 3%.

The individual project evaluation completed demonstrates that the proposed SWMF creation will have an overall negative impact on the project environments and not be beneficial to the watershed. As such, Project No. 26 is not recommended for implementation within the Hotchkiss Creek watershed at this time.



14.4.16 Project No. 27 (Culvert Improvement No. 50 – Innisfil St.)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included improvements to the Hotchkiss Creek watercourse crossing at Innisfil St. The preferred alternative solution included replacing the existing culvert with a 3400 mm x 2400 mm reinforced concrete box culvert to provide capacity for the 1:100-year return frequency storm peak flow.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of less than 9.2 m³/s or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3962 mm x 2130 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 37.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that culvert improvement No. 50 provides an overall positive impact on the project environments and will be beneficial to the watershed. No comments were received regarding the Culvert Improvement No. 50 through public consultation. As such, Project No. 27 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

To implement Project No.27, the City will need to acquire a portion of 215 Innisfil St and 108 Tiffin St. The proposed culvert improvement is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previous Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012). As such, subsequent options were not evaluated.

The culvert improvement is located on Hotchkiss within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.4.17 Project No. 28 (Watercourse Improvement No. 14 – Reach Ho-9)

Bank erosion/failures were identified in the lower reaches of Hotchkiss Creek (Reach Ho-9) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommends utilizing bio-



engineered bank treatment to stabilize the bank erosion. It is also recommended that the abandoned concrete box culvert in this reach be removed to prevent possible channel migration.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 28 during public consultation. As such, Project No. 28 is recommended and included in the preferred solution for the Hotchkiss Creek watershed.

To implement Project No. 28, a portion of 233 Innisfil St. will have to be acquired by the City. The proposed watercourse improvements are located on Hotchkiss Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Hotchkiss Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.4.18 Project No. 29 (Allandale Heights Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 3 ha of local road and residential development drains via storm sewer around Allandale Heights Park ultimately draining directly into Hotchkiss Creek untreated. An opportunity exists to install an underground infiltration system in Allandale Heights Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Allandale Heights Park at the location of the proposed centralized LID confirmed that the infiltration rate (111 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 70 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of over 3 kg/year in Lake Simcoe (MECP P-Tool).

Allandale Heights Park is located outside the significant groundwater recharge areas, however is located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are



permitted in Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. As such Project No. 29 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Allandale Heights Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Hotchkiss Creek watershed, the Allandale Heights Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.4.19 Project No. 30 (Trunk Storm Sewer No. 10 – Essa Rd.)

The preferred alternative solution identified in the Hotchkiss Creek Watershed Master Drainage Plan Environmental Assessment Update (City of Barrie, August 2012) included constructing a trunk storm sewer on Essa Rd. from Anne St. S. to Gowan St. The trunk storm sewer was to be designed with a capacity for the 1:100-year return frequency storm peak flow. To date, the trunk storm sewer has been constructed from Innisfil St. to Gowan St. in accordance with the recommendations of the Master Drainage Plan, specifically the design flood frequency criteria. To complete the improvements, the trunk storm sewer needs to be extended to Anne St. S.

The proposed trunk storm sewer improvements are located outside the Hotchkiss Creek Regulated area and will not require a permit from the LSRCA. However, an amendment to the existing Ministry of the Environment, Conservation and Parks environmental compliance approval will be required. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer improvement are presented in Section 15 of this report.

14.5 HURONIA CREEK DRAINAGE AREA

14.5.1 Project No. 164 (Greenfield Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 27 ha of local road and residential development drains via storm sewer around Greenfield Park ultimately draining directly into Hotchkiss Creek untreated. An opportunity exists to install an underground infiltration system in Greenfield Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Greenfield Park at the location of the proposed centralized LID confirmed that the infiltration rate (102 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 1,350 m³ of storage is required in the underground infiltration system. Implementing the underground



infiltration system will result in a phosphorus reduction of nearly 30 kg/year in Lake Simcoe (MECP P-Tool).

Greenfield Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Greenfield Park suitable for infiltration practices. As such Project No. 164 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Greenfield Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Huronia Creek drainage area, the Greenfield Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.5.2 Project No. 184 (SWMF Retrofit No. 85 – HR03)

SWMF HR03 is a dry pond with a contributing drainage area of approximately 58 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF HR03 has an active storage volume of 2,580 m³, however the SWMF provides essentially no peak flow attenuation as the SWMF outlet is a 1650 mm diameter pipe.

An opportunity exists to retrofit SWMF HR03 into a wet pond to improve water quality treatment and phosphorus removal. A wet pond with 6,090 m³ of permanent pool storage (requisite storage volume for 80% TSS removal) will result in a phosphorus reduction of nearly 7 kg/year in Lake Simcoe (MECP P-Tool). A 250 mm diameter orifice (primary outlet) is required to attenuate the 25 mm storm (water quality storm) peak flow and provide the requisite 24 hour drawdown time. The active storage can also be expanded to 12,860 m³ and combined with controlled outlets (250 mm diameter orifice, 5 m wide weir, existing 1680 mm diameter pipe) to attenuate 1:100-years return frequency peak flow by approximately 36%. Existing and future land use condition 1:100-year return frequency peak storm flows were reduced to 3.4 m³/s and 4.1 m³/s, respectively.

The existing SWMF is currently owned and operated by the owner of 265 Burton Ave. To implement Project No. 184 and for long term maintenance of the SWMF, the City will need to acquire a portion of 265 Burton Ave.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 184 outweigh the benefits. However, if a phosphorus offset is required in the Huronia Creek drainage area, Project No. 184 should be re-evaluated in consultation with the LSRCA.



14.5.3 Project No. 185 (SWMF Retrofit No. 28 – HR01)

SWMF HR01 is a dry pond with a contributing drainage area of approximately 77 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF Retrofit No. 28 was identified as an opportunity to provide water quality treatment and phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

An opportunity exists to retrofit SWMF HR01 into a wet pond to improve water quality treatment and phosphorus removal. A 2,160 m³ permanent pool can be excavated within the existing pond footprint to achieve 70% TSS removal and a phosphorus reduction of nearly 21 kg/year in Lake Simcoe (MECP P-Tool). There is no opportunity to expand the active storage volume in the pond. As such, the SWMF retrofit is considered a retrofit for water quality improvement only.

The SWMF is currently owned and operated by the owner of 279 Yonge St. To implement Project No. 184 and for long term maintenance of the SWMF, the City will need to acquire a portion of 279 Yonge St.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 185 outweigh the benefits. However, if a phosphorus offset is required in the Huronia Creek drainage area, Project No. 185 should be re-evaluated in consultation with the LSRCA.

14.6 WHISKEY CREEK WATERSHED

14.6.1 Project No. 64 (Mapleton Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 2 ha of local road and residential development drains via storm sewer around Mapleton Park ultimately draining directly into Whiskey Creek untreated. An opportunity exists to install an underground infiltration system in Mapleton Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Mapleton Park at the location of the proposed centralized LID confirmed that the infiltration rate (72 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 180 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 3 kg/year in Lake Simcoe (MECP P-Tool).



Mapleton Park is located outside the significant groundwater recharge areas, however is located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. As such Project No. 64 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 64 outweigh the benefits. However, if a phosphorus offset is required in the Whiskey Creek watershed, Project No. 64 should be re-evaluated in consultation with the LSRCA.

14.6.2 Project No. 65 (Harvie Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 3 ha of local and arterial roads and residential development drains via storm sewer around Harvie ultimately draining directly into Whiskey Creek untreated. An opportunity exists to install an underground infiltration system in Harvie Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Harvie Park at the location of the proposed centralized LID confirmed that the infiltration rate (58 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 180 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of over 3 kg/year in Lake Simcoe (MECP P-Tool).

Harvie Park is located outside the significant groundwater recharge areas, however is located within Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. The drainage area for Harvie Park consists of arterial roads and so, Project No. 65 is not permitted. Furthermore, the individual project evaluation completed demonstrates that Project No. 65 provides a negative overall benefit to the project environments. As such, Project No. 65 is not permitted and not recommended for implementation within the Whiskey Creek watershed.



14.6.3 Project No. 66 (Montserrand Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 12 ha of local road and residential development drains via storm sewer around Montserrand Park ultimately draining directly into Whiskey Creek untreated. An opportunity exists to install an underground infiltration system in Montserrand Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Montserrand Park at the location of the proposed centralized LID confirmed that the infiltration rate (65 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 960 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of approximately 14 kg/year in Lake Simcoe (MECP P-Tool).

Montserrand Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Montserrand Park suitable for infiltration practices. As such Project No. 66 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 64 outweigh the benefits. However, if a phosphorus offset is required in the Whiskey Creek watershed, Project No. 66 should be re-evaluated in consultation with the LSRCA.

14.6.4 Project No. 67 (SWMF Creation No. 42)

This SWMF creation was also identified as an opportunity for water quality treatment and phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

Under existing conditions, approximately 22 ha of primarily residential development drains to this location and ultimately to Whiskey Creek untreated. An opportunity exists to construct a SWMF to attenuate peak flows, provide water quality treatment and reduce phosphorus loads to Whiskey Creek. Two options were developed and evaluated as part of this Drainage Master Plan. Option 1 is to construct a dry pond with an underground infiltration system and Option 2 is to construct a wet pond. The evaluation of Option 1 and Option 2 is described in the following sections.



Option 1 – Dry Pond and Underground Infiltration System (LID)

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of a dry pond to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted at the location of the proposed infiltration system confirms that the infiltration rate (68 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 605 m³ of storage is required in the underground infiltration system. Constructing a dry pond with an infiltration system will result in a phosphorus reduction of nearly 30 kg/year in Lake Simcoe (MECP P-Tool).

A dry pond with an active storage volume of 7,180 m³ can be created within the pond footprint. By combining the active storage volume with controlled outlets (210 mm diameter orifice and 10 m overflow weir), peak flows will be attenuated by approximately 87% during the 1:5-year design storm and 32% during the 1:100-year design storm; reducing the existing and future land use condition 1:5-year and 1:100-year return frequency storm peak flows to 2.5 m³/s and 3.0 m³/s, respectively.

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m. The drainage area also consists of local roads and residential development making this location suitable for infiltration practices.

Option 2 – Wet Pond

An opportunity exists to construct a wet pond SWMF to provide treatment and peak flow attenuation. A wet pond with a permanent pool of 2,450 m³ can be constructed at this location to achieve the requisite 80% TSS removal and reduce phosphorus loads downstream. Constructing a wet pond SWMF in this location will result in a phosphorus reduction of nearly 22 kg/year in Lake Simcoe (MECP P-Tool).

A dry pond with an active storage volume of 7,180 m³ can be created within the pond footprint. By combining the active storage volume with controlled outlets (210 mm diameter orifice and 10 m overflow weir), peak flows will be attenuated by approximately 87% during the 1:5-year design storm and 32% during the 1:100-year design storm; reducing the existing and future land use condition 1:5-year and 1:100-year return frequency storm peak flows to 2.5 m³/s and 3.0 m³/s, respectively.

Evaluation

The individual project evaluation completed demonstrates that the dry pond with an underground infiltration system (Option 1) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, Option 1 is recommended as Project No. 67. No comments were received regarding SWMF Creation No. 42



through public consultation. As such, Project No. 20 is recommended and included in the preferred solution for the Whiskey Creek watershed.

To implement Project No. 67, a portion of a property on the southeast corner of Montserrand St. and Beacon Rd. (address not available) will need to be acquired by the City. The SWMF creation is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that an MECP Environmental Compliance Approval will also be required for this Project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.6.5 Project No. 68 (Culvert Improvement No. 53 – Harvie Rd.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Harvie Rd. The preferred alternative solution included replacing the existing culvert with a 1200 mm diameter concrete culvert to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of less than 0.7 m³/s or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 2100 mm × 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 3.9 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Harvie Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 53 through public consultation. As such, Project No. 68 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will



require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.6 Project No. 69 (SWMF Retrofit No. 92 - WK05)

SWMF WK05 is a wet pond with a contributing drainage area of approximately 110 ha that provides 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF WK05 has an active storage volume of 77,980 m³ and extended detention volume of 55,640 m³. A review of the LiDAR data obtained by the City confirmed that the as-built pond volumes provided are less than the design volumes specified. As such, an opportunity exists to retrofit the SWMF to enhance the level of treatment and phosphorus removal provided.

An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the second cell of SWMF WK05 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing was not conducted in the base of SWMF KD05, however the infiltrations rates are expected to be suitable for infiltration measures based on the infiltration testing completed in the surrounding area. To provide 80% TSS removal in combination with the existing wet pond cell, 2,125 m³ of storage is required in the underground infiltration system. Adding an underground infiltration system will result in a phosphorus reduction of nearly 45 kg/year in Lake Simcoe (MECP P-Tool).

Although 2,125 m³ of additional active storage can be provided in SWMF WK05, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m. The SWMF is not in a significant groundwater recharge area and outside of Well Head Protection Areas. The contributing drainage area primarily consists of local roads and residential development. However, a section of Veterans Dr. does drain to SWMF WK05. Given that Veterans Dr. is a small percentage of the overall drainage area and the surface runoff will be pre-treated through the initial wet pond cell, the underground infiltration system is considered suitable for infiltration practices.

The SWMF retrofit proposed does not require property acquisition as the works can be completed within the existing footprint of the pond.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 69 outweigh the benefits. However, the SWMF currently doesn't provide the original



design volumes required for water quality and quantity control. As such, if it is confirmed that the as-built volumes provided do not satisfy the original design volumes and the SWMF is out of compliance with its existing MECP Certificate of Approval, the City should re-evaluate Project No. 69 in consultation with the LSRCA. Similarly, if a phosphorus offset is required in the Whiskey Creek watershed, Project No. 69 should be re-evaluated in consultation with the LSRCA.

14.6.7 Project No. 70 (Culvert Improvement No. 54 – Harvie Rd.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Harvie Rd. The preferred alternative solution included replacing the existing culvert with a 4500 mm x 1200 mm hy-span culvert to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 3.4 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with an 1800 mm diameter concrete culvert (embedded 300 mm). The conveyance capacity of the replacement culvert is approximately 6.4 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 54 through public consultation. As such, Project No. 70 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the



applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

It is noted that the City of Barrie has initiated improvements to Harvie Rd. and Big Bay Point Rd. at Highway 400. West of Highway 400, Harvie Rd. will be widened and realigned. The existing roadway will become an access road for Harvie Rd. As such, Project No. 70 is required. We have reviewed the issued for Construction Drawings (Hatch, 2018) for the proposed Harvie Rd. improvements and confirm the proposed culvert size is consistent with the recommendations of this Drainage Master Plan.

14.6.8 Project No. 171 (Watercourse Improvement No. 15 – Reach Wh-3)

As discussed, the City of Barrie has initiated improvements to Harvie Rd. and Big Bay Point Rd. at Highway 400. West of Highway 400, Harvie Rd. will be widened and realigned approximately 40 m north of its current alignment. As part of the works, Harvie Rd. will be raised and a new road crossing (overpass) will be constructed over Highway 400. The new alignment of the Harvie Rd. and the Highway 400 road crossing are located over Whiskey Creek and the existing Whiskey Creek Highway 400 culvert crossing. The existing watercourse and culvert crossing will interfere with the road crossing abutments/footings and need to be relocated. As part of the design of the roadway improvements, the watercourse will be realigned and a new crossing will be constructed under Highway 400 south of the proposed road crossing (overpass).

As part of this Drainage Master Plan, we reviewed and evaluated the proposed watercourse improvements. The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 171 during public consultation. As such, Project No. 171 is recommended and included in the preferred solution for the Whiskey Creek watershed.

14.6.9 Project No. 172 (Culvert Improvement No. 55 – Highway 400)

As discussed, the City of Barrie has initiated improvements to Harvie Rd. and Big Bay Point Rd. at Highway 400. West of Highway 400, Harvie Rd. will be widened and realigned approximately 40 m north of its current alignment. As part of the works, Harvie Rd. will be raised and a new road crossing (overpass) will be constructed over Highway 400. The new alignment of the Harvie Rd. and the Highway 400 road crossing are located over Whiskey Creek and the existing Whiskey Creek Highway 400 culvert crossing. The existing watercourse and culvert crossing will interfere with the road crossing abutments/footings and need to be relocated. As part of the design of the roadway improvements, the watercourse will be realigned and a new crossing will be constructed under Highway 400 south of the proposed road crossing (overpass).



As part of this Drainage Master Plan, we reviewed and evaluated the proposed culvert improvements. The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the existing culvert has a conveyance capacity of approximately 8.2 m³/s or a design flood frequency of 1:100-years. During the Regional (Hurricane Hazel) storm, an interwatershed spill occurs from Whiskey Creek into the Hotchkiss Creek watershed.

The current design proposes to replace the existing culvert with a 2250 mm diameter concrete culvert. The conveyance capacity of the replacement culvert is approximately 21.2 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. The hydraulic analysis confirms that the conveyance capacity of the replacement culvert equals the Regional (Hurricane Hazel) storm peak flow. As such, the interwatershed spill will be eliminated.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 55 through public consultation. As such, Project No. 172 is recommended and included in the preferred solution for the Whiskey Creek watershed.

14.6.10 Project No. 71 (Culvert Improvement No. 56 – Fairview Rd.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Fairview Rd. The preferred alternative solution included maintaining the existing 1200 mm x 1200 mm reinforced concrete box culvert and adding a 1200 mm diameter concrete culvert to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 7.4 m³/s or a design flood frequency of 1:100-years, however safe access/egress is not provided across Fairview Rd. and the existing culvert does not have capacity for the predicted 1:100-year flow under future conditions. To satisfy the safe access/egress criteria and satisfy the design flood frequency criteria for future conditions, the existing culvert can be replaced with an 1800 mm × 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 8.4 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a



reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Fairview Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 56 through public consultation. As such, Project No. 71 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and environmental requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

As discussed, the City of Barrie has initiated improvements to Harvie Rd. and Big Bay Point Rd. at Highway 400. This includes improvements on Fairview Rd. and replacing the existing culvert crossing. The culvert proposed as part of the design of the road improvements is a 2700 mm x 1500 mm concrete box culvert embedded 300 mm. The effective opening size satisfies the design flood frequency criteria recommended in this Drainage Master Plan.

14.6.11 Project No. 72 (Culvert Improvement No. 57 – Bayview Dr.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Bayview Rd. The preferred alternative solution included replacing the existing culverts with a 3600 mm x 1800 mm hy-span structure to provide capacity for the 1:100-year return frequency storm peak flow. This exceeds the City of Barrie flow design guidelines for road crossings (Collector - 1:50-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culverts does not satisfy these criteria. The existing culverts have a conveyance capacity of approximately 6.1 m³/s or a design flood frequency of 1:25-years. To



satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 2400 mm × 900 mm concrete box culverts. The conveyance capacity of the replacement culvert is approximately 8.2 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 57 through public consultation. As such, Project No. 72 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The proposed culvert improvement requires the City to acquire a portion of the property on the downstream end of the culvert (address not available) to install the culvert and its appurtenances. The culvert improvements are a Schedule B project. However, as the previous preferred alternative solution recommended as part of the Master drainage Plan included improving this culvert crossing, subsequent options were not evaluated.

The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.12 Project No. 73 (Watercourse Improvement No. 16 – Reach Wh-4a)

Bed erosion/failures were identified in Whiskey Creek (Reach Wh-4a) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified a knickpoint in the reach and recommended a minor watercourse realignment to stabilize the channel long-term.

This reach is not located in City owned lands. As such, the City would have to acquire a portion of the property east of Bayview Dr. and south of 279 Bayview Dr. (address not available) to implement Project No. 73.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 73 during public consultation. As such, Project No. 73 is recommended and included in the preferred solution for the Whiskey Creek watershed.



The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.13 Project No. 74 (Watercourse Improvement No. 30 – Reaches Wh-4a through Wh-4c)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to Whiskey Creek around 279 Bayview Dr. The preferred alternative solution included widening the channel to convey the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Watercourse Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that this reach of Whiskey Creek does not have capacity to convey the 1:100-year return frequency storm peak flow. Flooding of 279 Bayview Dr. is known to have occurred when the flow in Whiskey Creek exceeds the limiting channel capacity. Two options were developed to address this deficiency. Option 1 is to widen the existing channel to increase capacity consistent with the recommendations of the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document. Option 2 is to construct a trunk storm sewer diversion through 279 Bayview Dr. to limit flows through the deficient reach of Whiskey Creek to the capacity of the existing channel. The evaluation of Option 1 and Option 2 is described in the following sections.

Option 1 – Widen Existing Watercourse

An opportunity exists to widen and regrade the existing watercourse to have a minimum 7.0 m bottom width and minimum 0.25% slope. As part of the watercourse improvements, the existing watercourse crossing at the rear of 279 Bayview Dr. should be removed.

To implement this option, the City will need to acquire lands or interests therein (easement) across the proposed watercourse improvements. Specifically, portions of 50 Welham Rd., 279 Bayview Dr., a property immediately north of 279 Bayview Dr. (address not available) and a property immediately south of 279 Bayview Dr. (address not available) will be impacted.



Option 2 – Trunk Storm Sewer

An opportunity exists to construct a trunk storm sewer through 279 Bayview Dr. to divert flows away from the deficient reach of Whiskey Creek and reduce flooding of 279 Bayview Dr. The limiting capacity of Whiskey Creek through Reach Wh-4c is 8 m³/s. Given the 1:100-year return frequency storm peak flow of 25 m³/s, the trunk storm sewer is to convey 19 m³/s. A 3000 mm x 1800 mm concrete trunk storm sewer at a minimum slope of 0.6% is sufficient to convey the required flow. No changes to the existing watercourse are proposed as part of this option.

To implement this option, the City will need to acquire lands or interests therein (easement) through 279 Bayview Dr. and the property north of 279 Bayview Dr. (address not available) over the proposed trunk storm sewer alignment.

Evaluation

The individual project evaluation completed demonstrates that widening the existing watercourse (Option 1) will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, watercourse widening to increase conveyance capacity is recommended as Project No. 74. No comments were received regarding watercourse Improvement No. 30 through public consultation. As such, Project No. 74 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.14 Project No. 75 (SWMF Creation No. 40)

The lack of an overland flow route on Chieftain Cres. has been identified as a drainage deficiency in the Whiskey Creek watershed. An opportunity exists to construct an overland flow route through 43 Chieftain Cres. to eliminate this deficiency and reduce flooding. To construct the overland flow route, the purchase of 43 Chieftain Cres. by the City is required.

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.



Currently, approximately 7 ha of local road (including Chieftain Cres.) and residential development drains via storm sewer directly into Whiskey Creek (Reach Wh-5) untreated. The storm sewer currently drains through 43 Chieftain Cres. An opportunity exists to install an underground infiltration system on 43 Chieftain Cres. and divert the storm sewer through the LID for treatment.

Infiltration testing was not conducted on 43 Chieftain Cres., however the infiltrations rates are expected to be suitable for infiltration measures based on the infiltration testing completed in the surrounding area. To provide 80% TSS removal, 193 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 34 kg/year in Lake Simcoe (MECP P-Tool).

43 Chieftain Cres. is located within a significant groundwater recharge area and Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted with conditions in significant groundwater recharge areas and Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. As such Project No. 74 is permitted.

110 Fairview Rd. immediately south of 43 Chieftain Cres. is the future site of the emergency services campus. As part of emergency services campus development, a dry pond SWMF is proposed in the northeast corner of the 110 Fairview Rd. This location was also reviewed and evaluated as a potential location for a stormwater management facility as part of this Drainage Master Plan.

The individual project evaluation completed demonstrates that the proposed overland flow route, underground infiltration system and SWMF Creation will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 75 through public consultation. As such, Project No. 75 is recommended and included in the preferred solution for the Whiskey Creek watershed.

It is noted that the underground infiltration system should be designed to provide 80% TSS removal from its contributing drainage area (6.9 ha of existing residential development) and the SWMF should be designed to service the emergency services campus.

14.6.15 Project No. 76 (Watercourse Improvement No. 17 – Reach Wh-5)

Bed and bank erosion/failures were identified in Whiskey Creek (Reach Wh-5) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified a knickpoint in the subject reach and erosion at the location of the confluence of the Whiskey Creek tributary (Reach Wh-



5) and main branch (Reach Wh-4c). The assessment also identified infrastructure at risk at this location. It is recommended to implement step-pool sequence to stabilize the channel bed and to utilize bio-engineered bank treatment to stabilize the confluence of the tributary and main channel.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 76 during public consultation. As such, Project No. 76 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.6.16 Project No. 77 (Watercourse Improvement No. 18 – Reach Wh-6)

Bank erosion/failures were identified in Whiskey Creek (Reach Wh-6) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified bank erosion at this location. It is recommended to utilize bio-engineered bank treatment to stabilize the bank erosion.

The individual evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 77 during public consultation. As such, Project No. 77 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.



14.6.17 Project No. 78 (Culvert Improvement No. 147 – BCRY Railway Crossing)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at the BCRY Railway. The preferred alternative solution included replacing the existing culvert with a 3000 mm x 1500 mm hy-span structure to provide capacity for the 1:100-year return frequency storm peak flow. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 7.6 m³/s or a design flood frequency of 1:5-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 1800 mm diameter concrete culverts. The conveyance capacity of the replacement culverts is approximately 29.2 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual projects evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 147 through public consultation. As such, Project No. 78 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the railway allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.18 Project No. 79 (Assickinack Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes



implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 7 ha of local road and residential development drains via storm sewer around Assickinack Park ultimately draining directly into Whiskey Creek untreated. An opportunity exists to install an underground infiltration system in Assickinack Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Assickinack Park at the location of the proposed centralized LID confirmed that the infiltration rate (93 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 550 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 10 kg/year in Lake Simcoe (MECP P-Tool).

Assickinack Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. Also, the drainage area consists of local roads and residential development making Assickinack Park suitable of infiltration practices. As such Project No. 79 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 79 outweigh the benefits. However, if a phosphorus offset is required in the Whiskey Creek watershed, Project No. 79 should be re-evaluated in consultation with the LSRCA.

14.6.19 Project No. 80 (Culvert Improvement No. 60 – Huronia Rd.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Huronia Rd. The preferred alternative solution included replacing the existing culvert with a 6000 mm × 1500 mm hy-span structure to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 4.5 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10.67 m open bottom span structure with a minimum clear height of 1.2 m. The conveyance capacity of the replacement culvert is approximately 26.1 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the



frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 60 through public consultation. As such, Project No. 80 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. However, this project does require watercourse improvements to accommodate the proposed culvert crossing. The proposed culvert improvement is a Schedule B project. However, as the previous preferred alternative solution recommended as part of the Master drainage Plan included improving this culvert crossing, subsequent options were not evaluated.

The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.20 Project No. 81 (Watercourse Improvement No. 31 – Reach Wh-7b through 7c)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse downstream of Huronia Rd. The preferred alternative solution included widening the floodplain and constructing a low flow channel between Huronia Rd. and SWMF WK01.

Whiskey Creek has meandered north downstream of Huronia Rd. and is encroaching into the Little Ave. road allowance. An opportunity exists to realign the watercourse and armour the channel banks with bio-engineered bank treatments to prevent erosion and further meander. To implement Project No. 81, the City would need to acquire a portion of 205 Huronia Rd.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 81 during public consultation. As such, Project No. 81 is recommended and included in the preferred solution for the Whiskey Creek watershed.



The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.21 Project No. 82 (SWMF Creation No. 26)

The creation of a SWMF in Huronia North park was identified as an opportunity to provide water quality treatment and phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

Under existing conditions, approximately 37 ha of primarily commercial development drains to this location and ultimately to Whiskey Creek. An opportunity exists to construct a wet pond SWMF to attenuate peak flows, provide water quality treatment and reduce phosphorus loadings to Whiskey Creek. A wet pond with a permanent pool of 4,600 m³ can be created to achieve the requisite 80% TSS removal and reduce phosphorus loads downstream. Constructing a wet pond SWMF in this location will result in a phosphorus reduction of nearly 30 kg/year in Lake Simcoe (MECP P-Tool).

An active storage volume of 7,250 m³ can be provided within the pond footprint. By combining the active storage volume with controlled outlets (190 mm diameter orifice and 10 m overflow weir), peak flows will be attenuated by approximately 45% during the 1:5-year design storm and 10% during the 1:100-year design storm reducing the Whiskey Creek (Reach Wh-8) existing and future condition 1:100-year return frequency storm peak flows to 6.6 m³/s and 7.9 m³/s, respectively.

The individual project evaluation completed demonstrates that the proposed SWMF creation will have an overall negative impact on the project environments and not be beneficial to the watershed. As such, Project No. 82 is not recommended within the Whiskey Creek watershed.

14.6.22 Project No. 83 (SWMF Retrofit No. 25 – WK01)

SWMF WK01 is a dry pond with total contributing area of approximately 584 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF No. 25 retrofit was identified as an opportunity to provide water quality treatment and phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus



Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

There are four drainage inlets into the existing dry pond. An opportunity exists to direct the drainage from Firman Dr. and Herrell Ave. (approximately 15 ha) into a proposed wetland cell constructed in the base of the existing dry pond to provide water quality treatment and reduce phosphorus loadings to Whiskey Creek. A permanent pool with 750 m³ of storage can be created within the SWMF to achieve the requisite 80% TSS removal and reduce phosphorus loads downstream. Constructing a wetland cell in the base of the dry pond SWMF will result in a phosphorus reduction of nearly 7 kg/year in Lake Simcoe (MECP P-Tool).

This SWMF retrofit will not increase the active storage volume provided in the pond. As such, this SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Retrofit No. 25 through public consultation. As such, Project No. 83 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The proposed SWMF retrofit does not require property acquisition as the works can be completed within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The SWMF retrofit is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.6.23 Project No. 84 (Culvert Improvement No. 62 – Little Ave.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Little Ave. The preferred alternative solution included replacing the existing culvert with a 9000 mm × 1800 mm reinforced concrete box culvert to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to addressing the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a



conveyance capacity of approximately 16.3 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 7.36 m open bottom span structures with a minimum clear height of 1.3 m. The conveyance capacity of the replacement culvert is approximately 27.1 m³/s or a design flood frequency of 1:25-years. The proposed culvert improvement does not meet the requisite City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). However, a significantly larger culvert is required to convey the 1:100-year return frequency storm peak flow. During the 1:100-year return frequency storm approximately 3.1 m³/s will overtop Little Ave. at depths and velocities that satisfy the safe access/egress criteria for culvert crossings. Safe access/egress is not provided during the Regional (Hurricane Hazel) storm.

Although the proposed culvert crossing does not satisfy the City's design flood frequency criteria, the conveyance capacity of the proposed culvert crossing is twice that of the existing culvert crossing. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

To implement the proposed culvert improvements, watercourse improvements are required downstream. This project is proposed in combination with Project No. 179, which includes widening of the watercourse immediately downstream of this culvert. It is also noted that the existing outlet controls for SWMF WK01 are located immediately upstream of Little Ave. The SWMF outlet controls are to remain.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 62 through public consultation. As such, Project No. 84 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and environmental requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.



14.6.24 Project No. 179 (Watercourse Improvement No. 32 – Reach Wh-9)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse downstream of Little Ave. The preferred alternative solution was to construct a wide floodplain while maintaining a low flow channel.

An opportunity exists to complete watercourse improvements downstream of Little Ave. to increase the conveyance capacity of the watercourse. The floodplain can be regraded immediately downstream of Little Ave. to mimic downstream reaches and increase the capacity of the floodplain. Similarly, the low flow channel can be reshaped and regraded to match the downstream watercourse to improve hydraulics.

The individual project evaluation completed demonstrates that the proposed watercourse improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Watercourse Improvement No. 32 through public consultation. As such, Project No. 179 is recommended and included in the preferred solution for the Whiskey Creek watershed.

To implement Project No. 179, the City needs to acquire 322 Little Ave. The proposed watercourse improvement is a Schedule B project. However, the recommendations of this Drainage Master Plan are consistent with the recommendations of the previously approved Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009). As such, subsequent options were not evaluated.

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.25 Project No. 85 (Culvert Improvement No. 63 – Yonge St.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Yonge St. The preferred alternative solution included replacing the existing culvert with a 3600 mm × 1800 mm hy-span structure to provide capacity for the 1:100-year return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred alternative solution also included designating the natural storage area upstream of Yonge St. as a



stormwater management facility. The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 18.5 m³/s or a design flood frequency of 1:50-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 3000 mm x 1800 mm reinforced concrete box culverts. The conveyance capacity of the replacement culvert is approximately 38.9 m³/s. The culverts have been sized to convey the 1:100-year return frequency storm peak flow while maximizing the storage used upstream of Yonge St. In addition to an increase in the conveyance capacity, a reduction in flooding overtop of Yonge St. will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress is provided across Yonge St.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 63 through public consultation. As such, Project No. 85 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.26 Project No. 86 (Culvert Improvement No. 138 – Metrolink Railway Crossing)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at the Metrolink Railway. The preferred alternative solution included replacing the existing culvert with a 3000 mm x 1800 mm hy-span structure to convey the 1:100-year return frequency storm peak flow. The preferred approach to address



the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 11.3 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria and to maximize floodplain storage upstream of this culvert without overtopping, the existing culvert can be replaced with a 3000 mm diameter concrete culvert. The conveyance capacity of the replacement culvert is approximately 37.6 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

In addition to the culvert improvements, there is an opportunity to shorten the culvert and daylight a section of Whiskey Creek as part of Project No. 86. Approximately 30 m of Whiskey Creek may be daylighted through the implementation of Project No. 86.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 138 through public consultation. As such, Project No. 86 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert is currently owned and maintained by Metrolink. It is recommended that the City approach Metrolink with the recommended solution and discuss a cost sharing agreement as the proposed improvements also benefit the City.

14.6.27 Project No. 87 (SWMF Retrofit No. 20 – WK04)

SWMF WK04 is a wetland with a total contributing drainage area of approximately 11 ha that provides 80% Total Suspended Solids (TSS) removal under existing conditions. SWMF No. 25 retrofit was identified as an opportunity to provide phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

After reviewing the existing SWMF, it was determined that there is limited opportunity to expand the wetland cell to improve the water quality treatment and phosphorus reduction provided due to space limitations. However, it was noted that the SWMF lacks pre-treatment in the form of a sediment forebay. As such, there is an opportunity to install a mechanical device (oil grit separator) on the inlet storm sewer to provide pre-treatment for SWMF WK04.



The individual project evaluation completed demonstrates that the proposed impacts of Project No. 87 outweigh the benefits. However, this wetland SWMF should be monitored to ensure that wetland is functioning as designed, even in the absence of pre-treatment. If there is excessive sediment accumulation in this wetland requiring frequent cleanout and maintenance, SWMF Retrofit No. 20 should be re-evaluated in consultation with the LSRCA.

14.6.28 Project No. 88 (Culvert Improvement No. 64 – Hurst Dr.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Hurst Dr. The preferred alternative solution included replacing the existing culverts with a 3000 mm x 1800 mm hy-span structure to convey the 1:100-years return frequency storm peak flow. This is consistent with the City of Barrie flow design guidelines for road crossings (Arterial - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B – Culvert Improvements to satisfy City Design Flood Frequency Criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of approximately 19.2 m³/s or a design flood frequency of 1:50-years. To satisfy the design flood frequency criteria and to maximize floodplain storage upstream of this culvert without overtopping, the existing culvert can be replaced with a 3600 mm x 2100 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 38.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 64 through public consultation. As such, Project No. 88 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the



applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.29 Project No. 89 (Watercourse Improvement No. 19 – Reach Wh-10)

Bank erosion/failures were identified in Whiskey Creek (Reach Wh-10) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment identified bank erosion at this location. It is recommended to utilize bio-engineered bank treatment to stabilize the bank erosion.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Project No. 77 during public consultation. As such, Project No. 77 is recommended and included in the preferred solution for the Whiskey Creek watershed.

To implement Project No. 89, the City will need to acquire lands or interests therein (easement) over the watercourse across 207, 211, 215, 217, 219, 221, 223 and 225 The Boulevard. The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvements are presented in Section 15 of this report.

14.6.30 Project No. 174 (Culvert Improvement No. 65 – The Boulevard)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at The Boulevard. The preferred alternative solution included replacing the existing culvert with a 8000 mm x 1500 mm hy-span structure to convey the 1:100-year return frequency peak flow which exceeds the City of Barrie flow design guidelines for road crossings (Local - 1:50-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of less than 3.0 m³/s or a design flood frequency of less than 1:2-years.



To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10.67 m open bottom span structure with a minimum clear height of 1.7 m. The conveyance capacity of the replacement culvert is approximately 37.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

To implement the proposed culvert improvements, watercourse improvements are required downstream from Kempenfelt Bay (Lake Simcoe) to The Boulevard. This project is proposed in combination with Projects No. 175, 176 and 177.

Projects No. 174, 175, 176 and 177 were evaluated in combination against the trunk storm sewer improvements developed as part of Project No. 90. Specifically, the culvert and watercourse improvements from The Boulevard to Lake Simcoe were evaluated in combination against Trunk Storm Sewer Improvement No. 90. Two options were developed for Project No. 174 as part of the evaluation process. Specifically, Project No. 174A proposes to upsize the culvert crossing to convey the 1:100-year return frequency storm peak flow and Project No. 174B proposes to upsize the culvert crossing to convey 14.5 m³/s recognizing that the trunk storm sewer proposed under Project No. 90 will divert the remaining 1:100-year return frequency storm peak flow around The Boulevard.

The individual project evaluation completed demonstrates that culvert and watercourse improvements (Projects No. 174A, 175, 176 and 177) produce the greatest positive overall impact on the project environments and are most beneficial to the watershed. Comments requesting that the drainage system downstream of Hurst Dr. be improved to reduce flooding were received through public consultation. As such, Project No. 174A is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

It is noted that the preferred solution selected to address the drainage deficiencies from The Boulevard to Kempenfelt Bay on Whiskey Creek (Project No. 174, 175, 176, 177) involves significant culvert and watercourse improvements, relocation of a sewage pumping station, property acquisition, and raising Brennan Ave. A number of constructability issues have been



identified with the culvert improvements. As part of this Drainage Master Plan, an additional option was identified and discussed. Specifically, the removal of Brennan Ave. which is a major obstruction to flow through this reach of Whiskey Creek. However, this option has transportation and emergency service implications that need to be fully considered and evaluated. The review of the option from a transportation and emergency service perspective is outside the scope of this study. As such, the City of Barrie may proceed with a separate Municipal Class EA to evaluate additional options to address the drainage deficiencies from The Boulevard to Kempenfelt Bay.

14.6.31 Project No. 175 (Watercourse Improvement No. 20 – Reach Wh-10)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse between Brennan Ave. and The Boulevard. The preferred alternative solution was to widen the channel to increase conveyance capacity.

Extensive flooding is known to occur downstream of The Boulevard to Kempenfelt Bay (Lake Simcoe). The existing channel between The Boulevard and Brennan Ave. is deficient and does not have capacity to convey the 1:100-year return frequency storm peak flows downstream without overtopping White Oaks Rd. and flooding private property.

An opportunity exists to improve the watercourse between The Boulevard and Brennan Ave. to convey the 1:100-year return frequency storm peak flow. The watercourse can be widened and regraded at 0% grade from Kempenfelt Bay (Lake Simcoe) to The Boulevard to increase the conveyance capacity of the watercourse and culvert crossings. To implement the proposed culvert improvements (The Boulevard and Brennan Ave.), watercourse improvements are required downstream from Kempenfelt Bay (Lake Simcoe) to The Boulevard. This project is proposed in combination with Projects No. 174, 176 and 177. As Whiskey Creek is a cold water fishery, a low flow channel must be incorporated into the design of the watercourse improvements.

Projects No. 174, 175, 176 and 177 were evaluated in combination against the trunk storm sewer improvements developed as part of Project No. 90. Specifically, the culvert and watercourse improvements from The Boulevard to Lake Simcoe were evaluated in combination against Trunk Storm Sewer Improvement No. 90. The individual project evaluation completed demonstrates that culvert and watercourse improvements (Projects No. 174A, 175, 176 and 177) produce the greatest positive overall impact on the project environments and are most beneficial to the watershed. Comments requesting that the drainage system downstream of Hurst Dr. be improved to reduce flooding were received through public consultation. As such,



Project No. 175 is recommended and included in the preferred solution for the Whiskey Creek watershed.

To implement Project No. 175, the City will need to acquire lands or interests therein (easement) over the proposed watercourse improvements. Specifically, 7 Brennan Ave. and a portion of 199 The Boulevard will be impacted. The proposed watercourse improvement is a Schedule B project. The recommendations of this Drainage Master Plan are consistent with the recommendations of the previously approved Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009).

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.32 Project No. 176 (Culvert Improvement No. 66 – Brennan Ave.)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse crossing at Brennan Ave. The preferred alternative solution included replacing the existing culvert with a 9000 mm x 1800 mm hy-span structure to convey the 1:100-years return frequency peak flow which exceeds the City of Barrie flow design guidelines for road crossings (Local - 1:50-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A – Culvert Improvements to satisfy previous MDP recommended design flood frequency criteria.

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria. The existing culvert has a conveyance capacity of 9.8 m³/s or a design flood frequency of 1:5-years. The existing culvert can be replaced with twin 9.14 m open bottom span structures with a minimum average clear height of 1.3 m. The conveyance capacity of the replacement culvert is approximately 37.4 m³/s or a design flood frequency of 1:100-year. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

To accommodate the proposed structures, Brennan Ave. will need to be raised overtop of the crossing to provide sufficient cover over the culverts. Also, to implement the proposed culvert



improvements, watercourse improvements are required downstream from Kempenfelt Bay (Lake Simcoe) to Brennan Ave. This project is proposed in combination with Projects No. 174, 175 and 177.

Projects No. 174, 175, 176 and 177 were evaluated in combination against the trunk storm sewer improvements developed as part of Project No. 90. Specifically, the culvert and watercourse improvements from The Boulevard to Lake Simcoe were evaluated in combination against Trunk Storm Sewer Improvement No. 90. The individual project evaluation completed demonstrates that culvert and watercourse improvements (Projects No. 174A, 175, 176 and 177) produce the greatest positive overall impact on the project environments and are most beneficial to the watershed. Comments requesting that the drainage system downstream of Hurst Dr. be improved to reduce flooding were received through public consultation. As such, Project No. 175 is recommended and included in the preferred solution for the Whiskey Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.6.33 Project No. 177 (Watercourse Improvement No. 21 – Reach Wh-10)

The preferred alternative solution identified in the Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) included improvements to the Whiskey Creek watercourse from Brennan Ave. to Kempenfelt Bay. The preferred alternative solution was to widen the channel to increase conveyance capacity.

Extensive flooding is known to occur downstream of Brennan Ave. to Kempenfelt Bay (Lake Simcoe). The existing channel between Brennan Ave. and Lake Simcoe is deficient and does not have capacity to convey the 1:100-year return frequency storm peak flows downstream without overtopping White Oaks Rd. and flooding private property.

An opportunity exists to improve the watercourse between Brennan Ave. and Lake Simcoe to convey the 1:100-year return frequency storm peak flow. The watercourse can be widened and regraded at 0% grade from Kempenfelt Bay (Lake Simcoe) to The Boulevard to increase the conveyance capacity of the watercourse and culvert crossings. This project is proposed in



combination with Projects No. 174, 175 and 176. As Whiskey Creek is a coldwater fishery, a low flow channel must be incorporated into the design of the watercourse improvements.

Projects No. 174, 175, 176 and 177 were evaluated in combination against the trunk storm sewer improvements developed as part of Project No. 90. Specifically, the culvert and watercourse improvements from The Boulevard to Lake Simcoe were evaluated in combination against Trunk Storm Sewer Improvement No. 90. The individual project evaluation completed demonstrates that culvert and watercourse improvements (Projects No. 174A, 175, 176 and 177) produce the greatest positive overall impact on the project environments and are most beneficial to the watershed. Comments requesting that the drainage system downstream of Hurst Dr. be improved to reduce flooding were received through public consultation. As such, Project No. 175 is recommended and included in the preferred solution for the Whiskey Creek watershed.

To implement Project No. 175, the City will need to relocate an existing sewage pumping station, a building in Minets Point Park and the entrance to the Park to Lismer Blvd. The proposed watercourse improvement is a Schedule B project. The recommendations of this Drainage Master Plan are consistent with the recommendations of the previously approved Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009).

The proposed watercourse improvements are located on Whiskey Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Whiskey Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.6.34 Project No. 90 (Trunk Storm Sewer No. 13 – Minets Point Rd. and White Oaks Rd.)

The Whiskey Creek Master Drainage Plan Update Environmental Assessment Document (Aecom, October 2009) identified four drainage improvements on Whiskey Creek, downstream of Hurst Dr. to increase conveyance capacity. An option exists to divert flows away from Whiskey Creek by constructing a trunk storm sewer along Minets Point Rd. and White Oaks Rd, thereby improving drainage conditions.

Two options were developed for this trunk storm sewer. Option 1 is to divert flows at Hurst Dr. and construct a trunk storm sewer that ties back into Whiskey Creek upstream of Brennan Ave. (Project No. 90A). Option 2 is to divert flows at Hurst Dr. and construct a trunk storm sewer that outlets directly to Kempenfelt Bay (Project No. 90B).



It is noted that Whiskey Creek is a coldwater fishery and baseflows must be maintained through the main channel of Whiskey Creek. As such, both trunk storm sewer options have been designed to allow baseflows/low flows to continue downstream through Whiskey Creek (Reach Wh-10) by raising the sewers invert above the channel invert of the creek at the Hurst Dr. crossing.

The evaluation of both options is described in the following sections.

Project No. 90A

An opportunity exists to construct a trunk storm sewer on Minets Point Rd. and White Oaks Rd from Hurst Dr. to The Boulevard to divert flow around a reach of Whiskey Creek with active erosion and around the deficient culvert crossing under The Boulevard.

The trunk storm sewer can be constructed commencing at the Hurst Dr. watercourse crossing, running northeast under Minets Point Rd. and White Oaks Rd. terminating at Whiskey Creek upstream of Brennan Ave. Due to grade constraints along White Oaks Rd., the trunk storm sewer can be sized to divert a maximum of 60% of the 1:100-year return frequency peak flow. A 3000 mm x 1800 mm concrete box storm sewer at a minimum slope of 1.0% is sufficient to convey the required flow. This option will reduce the required size for the culvert underneath The Boulevard (Culvert Improvement No. 65). However, the Brennan Ave. watercourse crossing (Culvert Improvement No. 66), and Watercourse Improvement No. 20 and 21 would still have to be upsized to provide the full 1:100-year conveyance capacity.

The trunk storm sewer proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands.

Project No. 90B

An opportunity exists to construct a trunk storm sewer along Minets Point Rd. and White Oaks Rd. to divert flow away from active erosion sites on Whiskey Creek and around the deficient culvert crossings downstream of Hurst Dr.

The trunk storm sewer can be constructed commencing at the Hurst Dr. watercourse crossing, running northwest under Minets Point Rd. and White Oaks Rd. terminating at Kempenfelt Bay. The trunk storm sewer can be sized to divert all flows in excess of the capacity of Whiskey Creek downstream of Hurst Dr (approximately 3.0 m³/s). A 3000 mm x 2400 mm concrete box storm sewer at a minimum slope of 1.2% is sufficient to convey the required flow. This option will eliminate upsizing of The Boulevard watercourse crossing (Culvert Improvement No. 65), Brennan Ave. watercourse crossing (Culvert Improvement No. 66), and Watercourse Improvement No. 20 and 21.



The trunk storm sewer proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands.

Evaluation

The options were evaluated against the culvert improvements and watercourse improvements downstream of Hurst Dr. The individual project evaluation completed demonstrates that the both trunk storm sewer diversion options will have an overall negative impact on the project environments. No comments were received regarding Culvert Improvement No. 65 through public consultation. As such, Project No. 90 is not recommended for implementation within the Whiskey Creek watershed at this time.

14.7 LOVERS CREEK WATERSHED

14.7.1 Project No. 95 (SWMF Retrofit No. 86 – LV16)

SWMF LV16 is a dry pond with a contributing drainage area of approximately 2.6 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV16 has an active storage volume of 4,080 m³ and sufficient extended detention storage.

An opportunity exists to retrofit SWMF LV16 into a wetland to improve water quality treatment and phosphorus removal. Excavating a permanent pool with 225 m³ of storage in the bottom of the existing dry pond will achieve 80% TSS removal and a phosphorus reduction of nearly 3.2 kg/year in Lake Simcoe (MECP P-Tool). The proposed SWMF retrofit does not require property acquisition as the works can be completed within the existing footprint of the SWMF within City owned lands.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 95 outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, Project No. 95 should be re-evaluated in consultation with the LSRCA.

14.7.2 Project No. 96 (SWMF Retrofit No. 87 – LV17)

SWMF LV17 is a dry pond with a contributing drainage area of approximately 15.7 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV17 has an active storage volume of 6,670 m³ and sufficient extended detention storage.

An opportunity exists to retrofit SWMF LV17 into a wetland to improve water quality treatment and phosphorus removal. There is also an opportunity to redirect a storm sewer that currently by-passes the SWMF into the pond, increasing the ponds contributing drainage area to approximately 17.8 ha. Excavating a permanent pool with 1095 m³ of storage in the bottom of the existing dry pond will achieve 80% TSS removal and a phosphorus reduction of nearly 27 kg/year in Lake Simcoe (MECP P-Tool).



The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Retrofit No. 87 through public consultation. As such, Project No. 96 is recommended and included in the preferred solution for the Lovers Creek watershed.

The proposed SWMF retrofit does not require property acquisition as the works can be completed within the footprint of the existing SWMF within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The SWMF retrofit is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.7.3 Project No. 97 (SWMF Retrofit No. 65 – LV07)

SWMF LV07 is a dry pond with a contributing drainage area of approximately 97 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV07 has an active storage volume of 21,760 m³ and extended detention volume of 10,020 m³.

SWMF LV07 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF LV07 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF LV07 confirms that the infiltration rate (86 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 2,910 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 90 kg/year in Lake Simcoe (MECP P-Tool). Excavating a sediment forebay into the base of the dry pond at the pond inlet is recommended to provide pre-treatment and reduce sediment loads entering the underground infiltration system.

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m, the SWMF is located outside a significant groundwater recharge area, outside a Well Head Protection Area and satisfies the peak flow control credits specified by the LSRCA. As such, the storage volume provided underground can be considered active storage.



Although 2,910 m³ of additional active storage can be provided in SWMF LV07, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Retrofit No. 65 through public consultation. As such, Project No. 97 is recommended and included in the preferred solution for the Lovers Creek watershed.

The SWMF retrofit proposed does not require property acquisition as the works can be completed within the existing footprint of the pond within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The SWMF retrofit is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.7.4 Project No. 98 (Culvert Improvement No. 126 – BCRY Railway Crossing)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing railway crossing culvert is deficient. When flows exceed the capacity of the culvert, water backs up onto Lockhart Rd. flooding the roadway. As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City of Barrie flow design guidelines for road crossings (Arterial – 1:100 year).

The existing culvert has a conveyance capacity of approximately 6.7 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 2100 mm diameter concrete culverts. The conveyance capacity of the replacement culverts is approximately 26.0 m³/s. In addition to an increase in the conveyance capacity, a reduction in the flooding will also occur, thereby eliminating overtopping of the Lockhart Rd. during the Regulatory storm event.

To satisfy the design flood frequency criteria, the culverts will be lowered. A driveway culvert immediately upstream of the railway crossing will also have to be replaced with twin 2100 mm diameter concrete culverts. Otherwise, flooding will continue on Lockhart Rd. A section of watercourse upstream of the driveway culverts will have to be regraded to tie into the proposed culvert improvements.



The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 126 through public consultation. As such, Project No. 98 is recommended and included in the preferred solution for the Lovers Creek watershed.

To implement Project No. 98, the City will need to acquire lands or interests therein (easement) on the upstream side of the culvert improvement. Specifically, a portion of 140 Lockhart Rd. will be impacted. The proposed culvert improvement is a Schedule B project. The culvert improvements are located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.5 Project No. 99 (Culvert Improvement No. 89 – Lockhart Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Lockhart Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately 4.0 m³/s or a design flood frequency of 1:5-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10.67 m open span structure with a minimum clear height of 0.7 m. The conveyance capacity of the replacement culvert is approximately 13.5 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Lockhart Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 89 through public consultation. As such, Project No. 99 is recommended and included in the preferred solution for the Lovers Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The



culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.6 Project No. 101 (Culvert Improvement No. 91 – Lockhart Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Lockhart Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately 38.1 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 10.67 m open bottom span structure with a minimum clear height of 2 m. The conveyance capacity of the replacement culvert is approximately 97.6 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 91 through public consultation. As such, Project No. 101 is recommended and included in the preferred solution for the Lovers Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.



14.7.7 Project No. 102 (SWMF Retrofit No. 45 – LV05)

SWMF LV05 has been subjected to significant sedimentation in recent years. The City of Barrie recently cleaned the accumulated sediment from the pond, however, sedimentation continues to be an issue. As such, SWMF LV05 represents a significant maintenance concern for the City. Also, significant erosion is occurring along the watercourse immediately upstream of SWM LV05. Flow crossing Highway 400 via an existing culvert crossing is discharging at high velocities causing bank and bed erosion within the channel downstream. The channel erosion is exacerbating the sedimentation issue in SWMF LV05. As such, an opportunity exists to stabilize the channel bed and banks utilizing bio-engineered bank treatments and cleanout SWMF LV05 reinstating it to its original condition.

An opportunity also exists to construct an energy dissipating plunge pool at the downstream end of the culvert crossing to reduce flow velocities through the watercourse downstream. Reducing the channel velocities will further reduce the potential for bed and bank erosion.

The individual project evaluation completed demonstrates that the proposed watercourse improvements and SWMF cleanout will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 102 through public consultation. As such, Project No. 102 is recommended and included in the preferred solution for the Lovers Creek watershed.

The watercourse improvements and SWMF cleanout proposed do not require property acquisition as the works can be completed within City owned lands. Project No. 102 is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement and SWMF cleanout are presented in Section 15 of this report.

14.7.8 Project No. 103 (Culvert Improvement No. 94 – Welham Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Welham Dr. culvert crossing does not satisfy the City's design flood frequency criteria (Collector – 1:50-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.

The existing culvert has a conveyance capacity of approximately 4.7 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 2400 mm x 1500 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 7.8 m³/s. In addition to an increase in the conveyance



capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

It is noted that the Maplevue Dr. E. and BCRY railway crossings downstream of Welham Rd. are also deficient and the BCRY railway crossing creates a significant backwater condition upstream that extends to Welham Rd. The backwater condition limits the conveyance capacity of the Welham Rd. culvert crossing. As such, two options were developed to evaluate Culvert improvements No. 94, 95 and 123. Specifically, Option 1 is to improve each culvert crossing to satisfy the City's design flood frequency criteria. As discussed, the existing culvert under Welham Rd. can be replaced with a 2400 mm x 1500 mm concrete box culvert to satisfy the City's design criteria. Option 2 is to oversize the culvert under the BCRY railway to eliminate the backwater condition created upstream; reducing the size of the replacement culverts required under Welham Rd. and Maplevue Dr. E.

Under Option 2, the BCRY railway crossing culvert can be replaced with a 3000 mm diameter concrete culvert with a capacity of 19.6 m³/s. The replacement culvert has sufficient capacity to convey the Regional (Hurricane Hazel) storm peak flow without overtopping the railway and eliminates the backwater condition created upstream at Welham Rd. and Maplevue Dr. E. Eliminating the backwater condition eliminates the upstream deficiencies in the Welham Rd. and Maplevue Dr. E. culvert crossings. As such, the existing culverts at these two locations have sufficient capacity to satisfy the City's design flood frequency criteria under this option and would no longer need to be replaced.

The individual project evaluation completed for the two options developed demonstrates that Option 2 – oversizing the BCRY railway culvert will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. No comments were received regarding Culvert Improvements No. 94, 95 or 123 through public consultation. As such, Option 2 (Project No. 105) is recommended and included in the preferred solution for the Lovers Creek watershed. Project No. 94 is not included as part of the preferred solution.

14.7.9 Project No. 104 (Culvert Improvement No. 95 – Maplevue Dr. E.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Maplevue Dr. E. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately 4.7 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3000 mm x 2100 mm concrete box culvert. The conveyance capacity of the



replacement culvert is approximately 7.8 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

It is noted that the BCRY railway crossing downstream of Maplevue Dr. E. is also deficient and the BCRY railway crossing creates a significant backwater condition upstream that extends to Welham Rd. The backwater condition limits the conveyance capacity of the Maplevue Dr. E. culvert crossing. As such, two options were developed to evaluate Culvert improvements No. 94, 95 and 123. Specifically, Option 1 is to improve each culvert crossing to satisfy the City's design flood frequency criteria. As discussed, the existing culvert under Maplevue Dr. E. can be replaced with a 3000 mm x 2100 mm concrete box culvert to satisfy the City's design criteria. Option 2 is to oversize the culvert under the BCRY railway to eliminate the backwater condition created upstream; reducing the size of the replacement culverts required under Welham Rd. and Maplevue Dr. E.

Under Option 2, the BCRY railway crossing culvert can be replaced with a 3000 mm diameter concrete culvert with a capacity of 19.6 m³/s. The replacement culvert has sufficient capacity to convey the Regional (Hurricane Hazel) storm peak flow without overtopping the railway and eliminates the backwater condition created upstream at Welham Rd. and Maplevue Dr. E. Eliminating the backwater condition eliminates the upstream deficiencies in the Welham Rd. and Maplevue Dr. E. culvert crossings. As such, the existing culverts at these two locations have sufficient capacity to satisfy the City's design flood frequency criteria under this option and would no longer need to be replaced.

The individual project evaluation completed for the two options developed demonstrates that Option 2 – oversizing the BCRY railway culvert will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. No comments were received regarding Culvert Improvements No. 94, 95 or 123 through public consultation. As such, Option 2 (Project No. 105) is recommended and included in the preferred solution for the Lovers Creek watershed. Project No. 95 is not included as part of the preferred solution.

14.7.10 Project No. 105 (Culvert Improvement No. 123 – BCRY Railway Crossing)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing railway crossing culvert does not satisfy the City's design flood frequency criteria for the upstream and downstream road crossings (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.



The existing culvert has a conveyance capacity of approximately $5.8 \text{ m}^3/\text{s}$ or a design flood frequency of 1:25-years. The BCRY railway crossing creates a significant backwater condition upstream that extends to Welham Rd. The backwater condition limits the conveyance capacity of the Welham Rd. and Mapleview Dr. E. culvert crossings. As such, two options were developed to evaluate Culvert improvements No. 94, 95 and 123. Specifically, Option 1 is to improve each culvert crossing to satisfy the City's design flood frequency criteria. The existing culvert under the BCRY railway can be replaced with a 1500 mm diameter concrete culvert to satisfy the City's design criteria. Option 2 is to oversize the culvert under the BCRY railway to eliminate the backwater condition created upstream; reducing the size of the replacement culverts required under Welham Rd. and Mapleview Dr. E. The evaluation of both options is discussed in the following sections.

Project No. 105A

To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 1500 mm diameter concrete culvert. The conveyance capacity of the replacement culvert is approximately $10.2 \text{ m}^3/\text{s}$. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

Project No. 105B

The BCRY railway crossing culvert can be replaced with a 3000 mm diameter concrete culvert with a capacity of $19.6 \text{ m}^3/\text{s}$. The replacement culvert has sufficient capacity to convey the Regional (Hurricane Hazel) storm peak flow without overtopping the railway and eliminates the backwater condition created upstream at Welham Rd. and Mapleview Dr. E. Eliminating the backwater condition eliminates the upstream deficiencies in the Welham Rd. and Mapleview Dr. E. culvert crossings. As such, the existing culverts at these two locations have sufficient capacity to satisfy the City's design flood frequency criteria under this option and would no longer need to be replaced.

Evaluation

The individual project evaluation completed for the two options developed demonstrates that Project No. 105B will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. No comments were received regarding Culvert Improvement No. 123 through public consultation. As such, Project No. 105B is recommended and included in the preferred solution for the Lovers Creek watershed.



The culvert improvement proposed does not require property acquisition as the works can be completed within the railway allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNR should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.11 Project No. 106 (SWMF Retrofit No. 32 – LV12)

SWMF LV12 is a dry pond with a contributing drainage area of approximately 17 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV12 has an active storage volume of 3,350 m³ and no extended detention storage.

SWMF LV12 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF LV12 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF LV12 confirms that the infiltration rate (72 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 560 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of nearly 31 kg/year in Lake Simcoe (MECP P-Tool).

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m. However, the SWMF is within a significant groundwater recharge area and Well Head Protection Area D. As such, this SWMF retrofit is not permitted. Furthermore, the individual project evaluation completed demonstrates that Project No. 106 provides a negative overall benefit to the project environments. As such, Project No. 106 is not permitted and not recommended for implementation within the Lovers Creek watershed.

14.7.12 Project No. 107 (Culvert Improvement No. 92 – Huronia Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Huronia Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.



The existing culvert has a conveyance capacity of less than 3.0 m³/s or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3600 mm x 1500 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 13.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Huronia Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 92 through public consultation. As such, Project No. 107 is recommended and included in the preferred solution for the Lovers Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.13 Project No. 109 (Culvert Improvement No. 99 – Ellis Dr.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Ellis Dr. culvert crossing does not satisfy the City's design flood frequency criteria (Urban Local – 1:50-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.

The existing culvert has a conveyance capacity of approximately 5.3 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3000 mm x 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 8.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of



overtopping during the Regulatory event such that safe access/egress will be provided across Ellis Dr.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 99 through public consultation. As such, Project No. 109 is recommended and included in the preferred solution for the Lovers Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.14 Project No. 110 (Culvert Improvement No. 98 – Welham Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Welham Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Minor Collector – 1:50-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.

The existing culvert has a conveyance capacity of approximately 17.7 m³/s or a design flood frequency of 1:10-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with twin 3000 mm x 1200 mm concrete box culverts. The conveyance capacity of the replacement culverts is approximately 30.9 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 98 through public consultation. As such, Project No. 110 is recommended and included in the preferred solution for the Lovers Creek watershed.



To implement Project No. 110, the City will need to acquire lands or interests therein (easement) on the downstream side of the culvert improvement. Specifically, a portion of 455 Welham Rd. will be impacted. The proposed culvert improvement is a Schedule B project. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.15 Project No. 111 (SWMF Retrofit No. 30 - LV02)

SWMF LV02 is a wet pond with a contributing drainage area of approximately 212 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV02 has an active storage volume of 73,060 m³ and 46,370 m³ of extended detention storage.

SWMF LV02 was evaluated as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013), however it was not recommended for enhancement as the SWMF is located online and recognized as a provincially significant wetland. However, As part of this Drainage Master Plan, the MNRF was consulted and confirmed that SWMF LV02 is not considered a provincially significant wetland. Also, the LSRCA was consulted and noted that the LSRCA does not generally support the construction of online SWMF's. However, the LSRCA recognizes the opportunity for water quality treatment and phosphorus removal in this location. To advance any discussions regarding Project No. 111 the LSRCA requires a site walk and a review by a natural heritage ecologist.

An opportunity exists to retrofit SWMF LV12 expanding the wet pond cell to improve water quality treatment and phosphorus removal. Expanding the permanent pool storage volume provided to 8,210 m³ will achieve 80% TSS removal and a phosphorus reduction of nearly 143 kg/year in Lake Simcoe (MECP P-Tool). The proposed SWMF retrofit does not require property acquisition as the works can be completed within the existing footprint of the SWMF within City owned lands.

The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Retrofit No. 30 through public consultation. As such, Project No. 111 is recommended and included in the preferred solution for the Lovers Creek watershed.



The proposed SWMF retrofit does not require property acquisition as the works can be completed within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The SWMF retrofit is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. The MNRF should be consulted to establish the applicable fishery timing windows for the nearby tributary of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.7.16 Project No. 112 (SWMF Retrofit No. 31 - LV03)

SWMF LV03 is a dry pond with a contributing drainage area of approximately 8 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV03 has an active storage volume of 2,063 m³ and 1,460 m³ of extended detention storage.

The retrofit of SWMF LV03 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

An opportunity exists to retrofit SWMF LV03 into a wet pond to improve water quality treatment and phosphorus removal. Excavating a permanent pool storage volume of 2,090 m³ in the base of the existing dry pond will achieve 80% TSS removal and a phosphorus reduction of approximately 7 kg/year in Lake Simcoe (MECP P-Tool).

The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding SWMF Retrofit No. 31 through public consultation. As such, Project No. 112 is recommended and included in the preferred solution for the Lovers Creek watershed.

The proposed SWMF retrofit does not require property acquisition as the works can be completed within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. As such, subsequent options were not evaluated. The SWMF retrofit is located within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.



14.7.17 Project No. 113 (Culvert Improvement No. 97 – Huronia Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Huronia Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's design criteria.

The existing culvert has a conveyance capacity of approximately 3.7 m³/s or a design flood frequency of 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 3000 mm x 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 8.0 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Huronia Rd.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 97 through public consultation. As such, Project No. 113 is recommended and included in the preferred solution for the Lovers Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.7.18 Project No. 114 (Trunk Storm Sewer No. 7)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Esther Dr. from Dean Ave. to SWMF LV19. The depth and velocity of overland flow exceeds the safe access/egress criteria established by the LSRCA. As such, there is an opportunity exists to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

The existing local storm sewer on Esther Dr. from Dean Ave. to SWMF LV19 can be replaced with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As



a result, flooding will be reduced during minor and major storm events along Esther Dr. The existing local storm sewer can be replaced with 1800 mm diameter to 3000 mm x 1500 mm concrete trunk storm sewer to convey the required flow. The pond inlet can be replaced with a twin 2400 mm x 1500 mm concrete trunk storm sewer.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 114 through public consultation. As such, Project No. 114 is recommended and included in the preferred solution for the Lovers Creek watershed.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 7 is a Schedule A+ project. As such, subsequent options were not evaluated. The trunk storm sewer is located outside the LSRCA Regulated area and will not require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

14.7.19 Project No. 115 (Madelaine Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 6 ha of local road and residential development drains via storm sewer around Madelaine Park ultimately draining directly into Lovers Creek untreated. An opportunity exists to install an underground infiltration system in Madelaine Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Madelaine Park at the location of the proposed centralized LID confirmed that the infiltration rate (80 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 490 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 7 kg/year in Lake Simcoe (MECP P-Tool).

Madelaine Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Madelaine Park suitable for infiltration practices. As such Project No. 115 is permitted.



The individual project evaluation completed demonstrates that the proposed impacts of the Madelaine Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, the Madelaine Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.7.20 Project No. 129 (Kuzmich Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 1 ha of local road and residential development drains via storm sewer around Kuzmich Park ultimately draining directly into Lovers Creek untreated. An opportunity exists to install an underground infiltration system in Kuzmich Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Kuzmich Park at the location of the proposed centralized LID confirmed that the infiltration rate (122 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 116 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 1 kg/year in Lake Simcoe (MECP P-Tool).

Kuzmich Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Kuzmich Park suitable for infiltration practices. As such Project No. 129 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Kuzmich Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, the Kuzmich Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.7.21 Project No. 116 (Golden Meadow Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 34 ha of local road and residential development drains via storm sewer around Golden Meadow Park ultimately draining directly into Lovers Creek untreated. An opportunity exists to install an underground infiltration system in Golden Meadow Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Golden



Meadow Park at the location of the proposed centralized LID confirmed that the infiltration rate (72 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 2,380 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 42 kg/year in Lake Simcoe (MECP P-Tool).

Golden Meadow Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Golden Meadow Park suitable for infiltration practices. As such Project No. 116 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Golden Meadow Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, the Golden Meadow Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.7.22 Project No. 117 (Carter Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 5 ha of local road and residential development drains via storm sewer around Carter Park ultimately draining directly into Lovers Creek untreated. An opportunity exists to install an underground infiltration system in Carter Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Carter Park at the location of the proposed centralized LID confirmed that the infiltration rate (85 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 314 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 6 kg/year in Lake Simcoe (MECP P-Tool).

Carter Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of local roads and residential development making Carter Park suitable for infiltration practices. As such Project No. 117 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Carter Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, the Carter Park centralized LID should be re-evaluated in consultation with the LSRCA.



14.7.23 Project No. 118 (SWMF Retrofit No. 37 – LV10)

SWMF LV10 is a dry pond with a contributing drainage area of approximately 18 ha that provides 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV10 has an active storage volume of 3,940 m³ and extended detention volume of 2,460 m³.

SWMF LV10 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). An opportunity exists to construct an underground infiltration system (LSRCA's preferred enhancement method) within the base of SWMF LV10 to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. Infiltration testing conducted in the base of SWMF LV10 confirms that the infiltration rate (77 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 436 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of approximately 19 kg/year in Lake Simcoe (MECP P-Tool).

The groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is greater than 2 m, the SWMF is located outside a significant groundwater recharge area, outside a Well Head Protection Area and satisfies the peak flow control credits specified by the LSRCA. As such, the storage volume provided underground can be considered active storage.

Although 436 m³ of additional active storage can be provided in SWMF KD06, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed impacts of the Project No. 118 outweigh the benefits. However, if a phosphorus offset is required in the Lovers Creek watershed, Project No. 118 should be re-evaluated in consultation with the LSRCA.

14.7.24 Project No. 119 (SWMF Retrofit No. 68 – LV01)

SWMF LV01 was designed as a constructed wetland with a contributing drainage area of approximately 72 ha that provides 60% Total Suspended Solids (TSS) removal under existing conditions. SWMF LV01 has an active storage volume of 17,150 m³ and extended detention volume of 7,030 m³.

SWMF LV01 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum



(AMEC, October 2013). However, the SWMF was incorrectly classified as a water quantity pond only. SWMF LV01 was designed as a constructed wetland with a permanent pool ranging in depth from 0.3 m to 1.0 m (average 0.3 m). As such, water quality treatment and phosphorus removal is provided.

When comparing the permanent pool storage volumes specified on the design drawings and provided in the stormwater management report for SWMF LV01 against estimated values from the available LiDAR data (as-built condition of the pond), it was estimated that the actual permanent pool volume provided is significantly less than the design volume. As such, an opportunity exists to increase the permanent pool volume of the SWMF to provide the requisite enhanced level (80% TSS) of treatment and enhanced phosphorus removal.

The SWMF can be converted into a wet pond and expanded to provide 80% TSS removal. Specifically, the bottom of the SWMF can be excavated to a depth of 1.5 m and expanded to provide 6,660 m³ of permanent pool storage. Expanding the permanent pool will result in a 7,780 m³ increase in active storage volume. To expand the permanent pool volume, the City will need to acquire 277 Cox Mill Rd. Also, the existing SWMF outlet controls would need to be relocated to accommodate the expansion.

The individual project evaluation completed demonstrates that the proposed impacts of the SWMF retrofit outweigh the benefits. As the SWMF already provides water quality treatment and phosphorus removal, Project No. 119 is not recommended for implementation.

14.7.25 Project No. 120 (Watercourse Improvement No. 22 – Reach Lo-19)

The City has identified bank erosion/failures in the lower reaches of Lovers Creek (Reach Lo-19) causing the watercourse to meander towards Brunton Cres. If this reach is not stabilized, there is a risk the watercourse will undercut the road. As such, there is an opportunity to realign the watercourse and stabilize the channel banks by utilizing bio-engineered treatment methods to prevent further erosion and migration of the watercourse.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 22 during public consultation. As such, Project No. 120 is recommended and included in the preferred solution for the Lovers Creek watershed.

The proposed watercourse improvements are located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNR should be consulted to establish the applicable fishery timing windows for this reach of Lovers



Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.7.26 Project No. 121 (Watercourse Improvement No. 23 – Reach Lo-20)

The City has identified bank erosion/failures in the lower reaches of Lovers Creek (Reach Lo-19) causing the watercourse to meander towards and undercut Tollendal Rd. If this reach is not stabilized, there is a risk the channel will continue to undermine the roadway. As such, there is an opportunity to realign the watercourse and stabilize the channel banks by utilizing bio-engineered treatment methods to prevent further erosion and migration of the watercourse.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 23 during public consultation. As such, Project No. 121 is recommended and included in the preferred solution for the Lovers Creek watershed.

The proposed watercourse improvements are located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.7.27 Project No. 122 (Culvert Improvement No. 105 – Tollendal Mill Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Tollendal Mill Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Minor Collector – 1:50-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing culvert has a conveyance capacity of approximately 34.0 m³/s or a design flood frequency of 1:5-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10356 mm x 3892 mm Low Profile Bridge Plate culvert. The conveyance capacity of the replacement culvert is approximately 119.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial



to the watershed. No comments were received regarding Culvert Improvement No. 105 through public consultation. As such, Project No. 122 is recommended and included in the preferred solution for the Lovers Creek watershed. It is recommended that Project No. 122 be implemented at the same time as Project No. 121 immediately upstream.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Lovers Creek within the LSRCA Regulated area and will require a permit from the LSRCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Lovers Creek. Additional cultural heritage, archeological and environmental requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.8 HEWITTS CREEK WATERSHED

14.8.1 Project No. 125 (Culvert Improvement No. 83 – Maplevue Dr. E.)

The preferred alternative solution identified in Hewitt's Secondary Plan Area Subwatershed Impact Study – Lover's, Hewitt's and Sandy Cove Creeks (R.J. Burnside & Associates Limited, September 2016) recommended upgrading of the existing 4800 mm × 1650 mm concrete box culvert crossing at Maplevue Dr. E. with a 6.0 m open bottom span structure to increase the conveyance capacity of the culvert to satisfy the City of Barrie flow design guidelines for road crossings (Arterial Road - 1:100-year). The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy these criteria.

The existing crossing has a conveyance capacity of approximately 27.9 m³/s or a design flood frequency of 1:25-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 10.67 m open span structure. The conveyance capacity of the replacement structure is approximately 70.8 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 83 through public consultation. As such, Project No. 125 is recommended and included in the preferred solution for the Hewitt's Creek watershed.



As part of this Drainage Master Plan, the subject culvert crossing was identified as deficient and improvements to the crossing are recommended as part of the preferred solution. However, the subject culvert crossing is located in the Hewitts Secondary Planning Area. It is recommended that the culvert improvements implement be consistent with the recommendations of the Hewitts Secondary Plan.

14.8.2 Project No. 126 (Queensway/Hyde Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 42 ha of local road and residential development drains via storm sewer around Queensway/Hyde Park ultimately draining directly into Hewitt's Creek untreated. An opportunity exists to install an underground infiltration system in Queensway/Hyde Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Queensway/Hyde Park at the location of the proposed centralized LID confirmed that the infiltration rate (73 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 2,242 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 65 kg/year in Lake Simcoe (MECP P-Tool).

Queensway/Hyde Park is located outside the significant groundwater recharge areas and outside any Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Queensway/Hyde Park suitable for infiltration practices. As such Project No. 129 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Queensway/Hyde Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Hewitts Creek watershed, the Queensway/Hyde Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.8.3 Project No. 127 (Sandringham Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses and Lake Simcoe.

Currently, approximately 79 ha of local road and residential development drains via storm sewer around Sandringham Park ultimately draining directly into Hewitt's Creek untreated. An



opportunity exists to install an underground infiltration system in Sandringham Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Sandringham Park at the location of the proposed centralized LID confirmed that the infiltration rate (77 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 3,900 m³ of storage is required in the underground infiltration system. However, a maximum of 2,345 m³ can be provided underground within the available footprint. Implementing the underground infiltration system will result in a phosphorus reduction of approximately 100 kg/year in Lake Simcoe (MECP P-Tool).

Sandringham Park is located outside the significant groundwater recharge areas and well head protection areas. However, the groundwater separation estimated from the LSRCA Simulated Groundwater Elevation Model is less than 1 m. In addition, the contributing drainage area includes Sandringham Dr.; a minor collector road. The City of Barrie applies salt to minor collector roads in the winter. For these reasons, Sandringham Park is not suitable for infiltration practices and not recommended as part of the preferred solution for the Hewitts Creek watershed.

14.8.4 Project No. 128 (SWMF Creation No. 27)

This SWMF creation was also identified as an opportunity for water quality treatment and phosphorus reduction in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). As part of this Drainage Master Plan, this opportunity was explored further.

Under existing conditions, approximately 35 ha of primarily local roads and residential development drains to this location and ultimately to Hewitts Creek. Two mechanical treatment devices (oil grit separators) have been installed in the storm sewer network downstream of Walnut Cres. to reduce sediment loads to Hewitts Creek. However, the mechanical devices do not remove phosphorus from stormwater. An opportunity exists to construct a SWMF to provide water quality treatment and reduce phosphorus loads to Hewitts Creek.

An opportunity exists to construct a wet pond SWMF east of Walnut Cres., west of Hewitts Creek. A wet pond with 3,117 m³ of permanent pool storage (required storage volume for 80% TSS removal) can be constructed in this location. Constructing a wet pond SWMF in this location will result in a phosphorus reduction of approximately 29 kg/year in Lake Simcoe (MECP P-Tool).

A 140 mm diameter orifice (primary outlet) is required to attenuate the 25 mm storm (water quality storm) peak flow and provide the requisite 24 hour drawdown time. During minor storms, the SWMF will attenuate peak flows. However, the storage available in the SWMF is



exceeded during major storm events. During major storms, an overflow spillway will be used to discharge flow downstream. However, no peak flow attenuation will be provided during major storm events. As such, the SWMF is considered a SWMF creation for water quality control only.

The LSRCA was consulted regarding the construction of a wet pond SWMF at this location. The LSRCA identified this location as wetland and within the Hewitt Creek regulated area. As such, the LSRCA does not support the construction of a SWMF at this location.

The individual project evaluation completed demonstrates that SWMF Creation No. 27 produces a negative overall impact on the project environments. As such, Project No. 128 is not recommended as part of the preferred solution for the Hewitts Creek watershed.

14.8.5 Project No. 130 (Trunk Storm Sewer No. 6)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Princess Margaret Gate and the north leg of Camelot Sq. The depth and velocity of overland flow exceeds the safe access/egress criteria established by the LSRCA. As such, there is an opportunity to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

The existing local storm sewer on Princess Margaret Gate and Camelot Square can be replaced from Loyalist Court to SWMF HW06 with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As a result, flooding will be reduced during minor and major storm events along Princess Margaret Gate and Camelot Sq. The existing local storm sewer on Princess Margaret Gate and Camelot Square can be replaced with 1200 mm diameter, 1350 mm diameter, and 1650 mm diameter storm sewer to convey the required flow. The pond inlet can be replaced with a 2400 mm × 1200 mm concrete box culvert.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 130 through public consultation. As such, Project No. 130 is recommended and included in the preferred solution for the Hewitt's Creek watershed.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 6 is a Schedule A+ project. As such, subsequent options were not evaluated. The trunk storm sewer is located outside the LSRCA Regulated area and will not require a permit from the LSRCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.



14.9 GEORGIAN CREEK WATERSHED

14.9.1 Project No. 133 (Strabane Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 5 ha of local road and residential development drains via storm sewer around Strabane Park ultimately draining directly into Georgian Creek untreated. An opportunity exists to install an underground infiltration system in Strabane Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Strabane Park at the location of the proposed centralized LID confirmed that the infiltration rate (101 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 243 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of approximately 8 kg/year (NVCA P-Tool).

Strabane Park is located outside any significant groundwater recharge area and outside all Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Strabane Park suitable for infiltration practices. As such Project No. 133 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Strabane Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Georgian Creek watershed, the Strabane Park centralized LID should be re-evaluated in consultation with the NVCA.

14.9.2 Project No. 134 (SWMF Retrofit No. 76 – GR04)

SWMF GR04 is a dry pond with a contributing drainage area of approximately 62 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. Overall, SWMF GR04 attenuates peak flows by 64% and 83% during the 1:5-year and 1:100-year return frequency storm events, respectively.

An opportunity exists to retrofit SWMF GR04 into a wet pond to improve water quality treatment and phosphorus removal. Excavating a permanent pool with 3,310 m³ of storage in the bottom of the existing dry pond will achieve 80% TSS removal and a phosphorus reduction of approximately 75 kg/year in the Nottawasaga River (NVCA P-Tool). There is no opportunity to provide additional active storage volume within the SWMF. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only.



The individual project evaluation completed demonstrates that the proposed impacts of Project No. 134 outweigh the benefits. However, if a phosphorus offset is required in the Georgian Creek watershed, the retrofit to SWMF GR04 should be re-evaluated in consultation with the NVCA.

14.9.3 Project No. 135 (Trunk Storm Sewer No. 3)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Johnson St., Grove St. E., and Hickling Tr. from SWMF GR04 to GR01. The depth and velocity of overland flow exceeds the safe access/egress criteria established by the NVCA. As such, there is an opportunity to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

To address these deficiencies the recommended solution involves replacing the existing storm sewer on Johnson St., Grove St. E., and Hickling Tr. from SWMF GR04 to GR01 with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As a result, flooding will be reduced during minor and major storm events. The existing local storm sewer on Johnson St., Grove St. E., and Hickling Tr. can be replaced with a 3000 mm × 1200 mm diameter concrete trunk storm sewer to convey the required flow.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall neutral impact on the project environments. No comments were received regarding Project No. 135 through public consultation. It is recommended that consideration be given to upsizing the local storm sewer as part of future road renewal/reconstruction projects. As such, Project No. 135 is included in the preferred solution for the Georgian Creek watershed.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 3 is a Schedule A+ project. As such, subsequent options were not evaluated. A portion of the trunk storm sewer is located within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

14.9.4 Project No. 136 (Dunsmore Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.



Currently, approximately 16 ha of local road and residential development drains via storm sewer around Dunsmore Park ultimately draining directly into Georgian Creek untreated. An opportunity exists to install an underground infiltration system in Dunsmore Park and divert the storm sewer through the LID for treatment.

Infiltration testing completed in Dunsmore Park at the location of the proposed centralized LID confirmed that the infiltration rate (64 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 928 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 15 kg/year (NVCA P-Tool).

Dunsmore Park is located outside the significant groundwater recharge areas. However, Dunsmore Park is located in Well Head Protection Area C and the estimated groundwater separation is less than 1 m. For these reasons, Dunsmore Park is not suitable for infiltration practices and not recommended as part of the preferred solution for the Georgian Creek watershed.

14.9.5 Project No. 137 (Trunk Storm Sewer No. 4)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Harrogate Ct., Johnson St., Cheltenham Rd., Larkin Dr., and Quinlan Rd. from Dunsmore Park to Penetanguishene Rd. The depth and velocity of overland flow exceeds the safe access/egress criteria established by the NVCA. As such, there is an opportunity to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

The existing local storm sewer on Harrogate Ct., Johnson St., Cheltenham Rd., Larkin Dr., and Quinlan Rd. Dunsmore Park to Penetanguishene Rd can be replaced with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As a result, flooding will be reduced during minor and major storm events. The existing local storm sewer can be replaced with 1245 mm × 813 mm and 3000 mm × 1500 mm diameter concrete trunk storm sewer to convey the required flow.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall neutral impact on the project environments. No comments were received regarding Project No. 137 through public consultation. It is recommended that consideration be given to upsizing the local storm sewer as part of future road renewal/reconstruction projects. As such, Project No. 137 is included in the preferred solution for the Georgian Creek watershed.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 4 is a Schedule A+ project. As such,



subsequent options were not evaluated. A portion of the trunk storm sewer is located within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

14.9.6 Project No. 138 (SWMF Retrofit No. 75 – GR01)

SWMF GR01 is a dry pond with a contributing drainage area of approximately 135 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. Overall, SWMF GR01 attenuates peak flows by 44% and 53% during the 1:5-year and 1:100-year return frequency storm events, respectively.

An opportunity exists to retrofit SWMF GR01 into a wet pond to improve water quality treatment and phosphorus removal. Excavating a permanent pool with 3,403 m³ of storage in the bottom of the existing dry pond will achieve 60% TSS removal and a phosphorus reduction of approximately 36 kg/year in the Nottawasaga River (NVCA P-Tool). There is no opportunity to provide additional active storage volume within the SWMF. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 138 outweigh the benefits. However, if a phosphorus offset is required in the Georgian Creek watershed, the retrofit to SWMF GR01 should be re-evaluated in consultation with the NVCA.

14.9.7 Project No. 139 (Culvert Improvement No. 82– Penetanguishene Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing Penetanguishene Rd. culvert crossing does not satisfy the City's design flood frequency criteria (Arterial – 1:100-year). As such, an opportunity exists to replace the existing culvert to increase the conveyance capacity of the culvert to satisfy the City's criteria.

The existing 1000 mm diameter CSP culvert crossing has a conveyance capacity of approximately 1.9 m³/s or a design flood frequency of 1:2-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 2400 mm × 1200 mm concrete box culvert. The conveyance capacity of the replacement culvert is approximately 5.1 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event such that safe access/egress will be provided across Penetanguishene Rd.



The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 82 through public consultation. As such, Project No. 139 is recommended and included in the preferred solution for the Georgian Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Georgian Creek within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Georgian Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.10 LITTLE LAKE WATERSHED

14.10.1 Project No. 140 (Cartwright Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 3 ha of local road and residential development drains via storm sewer around Cartwright Park ultimately draining directly into Little Lake Creek untreated. An opportunity exists to install an underground infiltration system in Cartwright Park and divert the storm sewer through the LID for treatment. Infiltration testing completed in Cartwright Park at the location of the proposed centralized LID confirmed that the infiltration rate (82 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 209 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 6 kg/year (NVCA P-Tool).

Cartwright Park is located outside of any significant groundwater recharge area and outside of any Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Cartwright Park suitable for infiltration practices. As such Project No. 140 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Cartwright Park Centralized LID outweigh the benefits. However, if a phosphorus offset is



required in the Little Lake watershed, the Cartwright Park centralized LID should be re-evaluated in consultation with the NVCA.

14.10.2 Project No. 141 (Trunk Storm Sewer No. 5)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Cardinal St. from SWMF LT02 to SWMF LT01. The depth and velocity of overland flow exceeds the safe access/egress criteria established by the NVCA. As such, there is an opportunity to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

The existing storm sewer on Cardinal St. from SWMF LT02 to SWMF LT01 can be replaced with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As a result, flooding will be reduced during minor and major storm events. The existing local storm sewer can be replaced with a twin 2400 mm × 1200 mm diameter concrete trunk storm sewer to convey the required flow.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Project No. 141 through public consultation. As such, Project No. 141 is recommended and included in the preferred solution for the Little Lake watershed.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 5 is a Schedule A+ project. As such, subsequent options were not evaluated. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

14.10.3 Project No. 142 (SWMF Retrofit No. 77 – LT01)

SWMF LT01 is a dry pond with a contributing drainage area of approximately 107 ha that provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. Overall, SWMF LT01 attenuates peak flows by 27% and 9% during the 1:5-year and 1:100-year return frequency storm events, respectively.

SWMF LT01 was identified as an opportunity for enhancement in the Assessment of Stormwater Management Facilities to Reduce Phosphorus Discharges Technical Memorandum (AMEC, October 2013). Also, Bank widening and aggradation was identified in the reach of Little Lake Creek (Reach Li-1) immediately downstream of SWMF LT01 as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018). The Little Lake



SWM Pond LT1 Drainage Improvements: Class Environmental Assessment (Greenland International Consulting, 2013) identified a deficiency in the active storage volume provided, specifically the active storage volume provided in SWMF LT01 as constructed does not satisfy the original design criteria of the pond. Also, flooding has occurred immediately downstream of SWMF LT01 on 496 and 500 St. Vincent St. as a result of a deficient overland flow route and obstructed outlets. As such, an opportunity exists to retrofit SWMF LT01 to enhance water quality treatment, reduce phosphorus and attenuate peak flows to reduce downstream erosion.

The preferred alternative solution recommended in the Little Lake SWM Pond LT1 Drainage Improvements: Class Environmental Assessment (Greenland International Consulting, 2013) is to modify SWMF LT01 within its existing footprint. This included excavating a wet pond cell in the base of the SWMF, increasing the extended detention storage volume and installing a low flow outlet orifice to enhance the level of treatment provided in the pond. Also, the outlet controls were to be replaced and the outlet spillway improved.

As part of this Drainage Master Plan, this alternative was reevaluated against two new options as follows:

1. Expand the SWMF east onto private property, install an underground infiltration system in the base of SWMF LT01, excavate a sediment forebay with a permanent pool into the base of the SWMF at the pond inlet, and expand the active storage volume to reduce discharges downstream to Little Lake Creek.
2. Expand the SWMF east onto private property, excavate a sediment forebay and wet pond cell into the base of the SWMF at the pond inlet, and expand the active storage volume to reduce discharges downstream to Little Lake Creek.

The evaluation of the options is discussed in the following sections.

Option 1 – SWMF Expansion and Underground Infiltration System

An opportunity exists to expand SWMF LT01 east onto 496, 500 and 504 St. Vincent St. to install an underground infiltration system for water quality treatment and phosphorus removal, excavate a sediment forebay into the base of the pond at the inlet, and expand the active storage volume to attenuate peak flows and reduce downstream erosion.

Infiltration testing conducted in the base of SWMF LT01 confirms that the infiltration rate (101 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 1,250 m³ of storage is required in the underground infiltration system. Converting the dry pond into an infiltration system will result in a phosphorus reduction of approximately 94 kg/year in Little Lake (NVCA P-Tool).



The groundwater separation estimated is greater than 2 m, the SWMF is located outside a significant groundwater recharge area, outside the well head protection areas and satisfies the peak flow control credits specified by the NVCA. As such, the storage volume provided underground can be considered active storage.

The active storage volume of the pond can also be expanded. The SWMF expansion can increase the active storage provided to approximately 21,500 m³. The increased active storage volume combined with the existing SWMF outlets will attenuate peak flows by 45% and 39% during the 1:5-year and 1:100-year return frequency storm events, respectively. The reduction in peak flows will help reduce erosion downstream in Little Lake Creek.

The existing SWMF outlet controls will remain. However, they will have to be relocated to accommodate the SWMF expansion. As part of this option, the flooding on 496 and 500 St. Vincent St. will be eliminated.

Option 2 – SWMF Expansion and Retrofit to Wet Pond

An opportunity exists to expand SWMF LT01 east onto 496 and 500 St. Vincent St. and retrofit the dry pond into a wet pond for water quality treatment and phosphorus removal, excavate a sediment forebay into the base of the pond at the inlet for enhanced treatment and improved maintenance, and expand the active storage volume to attenuate peak flows and reduce downstream erosion.

To enhance the level of treatment provided to basic level treatment (60% TSS removal), 3,110 m³ of permanent pool storage is required in the wet pond cell. Converting the dry pond into a wet pond will result in a phosphorus reduction of approximately 69 kg/year in Little Lake (NVCA P-Tool).

The active storage volume of the pond can also be expanded. The SWMF expansion can increase the active storage provided to approximately 19,000 m³. The increased active storage volume combined with the existing SWMF outlets will attenuate peak flows by 45% and 39% during the 1:5-year and 1:100-year return frequency storm events, respectively. The reduction in peak flows will help reduce erosion downstream in Little Lake Creek.

The existing SWMF outlet controls will remain. However, they will have to be relocated to accommodate the SWMF expansion. As part of this option, the flooding on 496 and 500 St. Vincent St. will be eliminated.

Option 3 – MDP Recommended Improvements

As per the recommendations of the Little Lake SWM Pond LT1 Drainage Improvements: Class Environmental Assessment (Greenland International Consulting, 2013) an opportunity exists to



modify SWMF LT01 within its existing footprint. The modification includes excavating a wet pond cell in the base of the SWMF, increase the extended detention storage volume, and install a low flow outlet orifice to enhance the level of treatment provided in the pond. Also, the outlet controls can be replaced, and the outlet spillway improved.

The level of treatment provided will only be enhanced through this option and TSS removal will remain at less than 60%. Although the extended detention storage volume will be increase, there will be no resultant improvement in the peak flow attenuation provided by the SWMF. However, as part of this option, the flooding on 496 and 500 St. Vincent St. will be eliminated.

Evaluation

The individual project evaluation completed demonstrates that Option 2 – SWMF Expansion and Retrofit to Wet Pond will have the greatest overall positive impact on the project environments and be most beneficial to the watershed. As such, Option 2 is recommended as Project No. 142. Project No. 142 is recommended and included in the preferred solution for the Little Lake watershed.

To implement the recommended solution the City will need to acquire 496 and 500 St. Vincent St. The SWMF retrofit is located within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that an amendment to the MECP Environmental Compliance Approval will also be required for this SWMF retrofit. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.10.4 Project No. 143 (Watercourse Improvement No. 24 – Reach Li-1)

Bank widening and aggradation was identified in Little Lake Creek (Reach Li-1) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommended localized bank treatments using bio-engineering measures to address bank erosion.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 24 during public consultation. As such, Project No. 143 is recommended and included in the preferred solution for the Little Lake Creek watershed.

The bank improvements proposed do not require property acquisition as the works can be completed within City owned lands. The proposed watercourse improvements are located on Little Lake Creek within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this



project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Little Lake Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.10.5 Project No. 144 (SWMF Retrofit No. 89 - LT05)

SWMF LT05 is a wet pond which provides less than 80% Total Suspended Solids (TSS) removal under existing conditions. The permanent pool volume provided in SWMF LT05 is unknown, however, it's estimated to be less than required to provide enhance level treatment. SWMF LT05 has an active storage volume of 630 m³ and extended detention volume of 346 m³. Overall, SWMF LT05 attenuates peak flows by 7% and 6% during the 1:5-year and 1:100-year return frequency storm events, respectively. It is understood that SWMF LT05 was designed as a water quality SWMF only and only minor flows are directed into the pond.

An opportunity exists to expand the existing SWMF to increase the permanent pool volume to provide the requisite 80% TSS removal. To provide 80% TSS removal, the SWMF can be expanded to provide 2,590 m³ of permanent pool volume. In addition to the permanent pool volume, approximately 4,090 m³ of additional active storage can be provided. The proposed SWMF outlet controls consist of a 135 mm orifice primary low flow outlet, ditch inlet catch basin secondary outlets, and a 4.5 m wide emergency overland flow weir.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF LT05 will have a negative impact on the project environments and the watershed. As such, Project No. 144 is not recommended for implementation within the Little Lake watershed.

14.10.6 Project No. 145 (SWMF Retrofit No. 84 - LTGM)

SWMF LTGM is a wet pond which provides less than 80% Total Suspended Solids (TSS) removal under existing conditions. SWMF LTGM has an existing permanent pool volume of 3,217 m³, active storage volume of 4,583 m³ and extended detention volume of 983 m³. Overall, SWMF LTGM attenuates peak flows by 14% and 8% during the 1:5-year and 1:100-year return frequency storm events, respectively. Under existing conditions SWMF LTGM has a drainage area of approximately 8 ha. An opportunity exists to divert additional drainage into the SWMF from an additional 41 ha and enhance the level of treatment and peak flow attenuation provided.

The SWMF may be expanded east to increase the permanent pool volume and active storage volumes provided to 12,100 m³ and 15,530 m³, respectively. The increase in permanent pool volume is sufficient to provide enhance level 80% TSS removal for the additional contributing drainage area. The increase in active storage volume will attenuate peak flows by 29% and 9% during the 1:5-year and 1:100-year return frequency storm events, respectively.



The individual project evaluation completed demonstrates that the proposed SWMF retrofit will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding SWMF Retrofit No. 84 during public consultation. As such, Project No. 145 is recommended and included in the preferred solution for the Little Lake Creek watershed.

The SWMF retrofit requires the acquisition lands, specifically a portion of 509 Bayfield St. It is anticipated that an amendment to the SWMF's existing Environmental Compliance Approval will be required from the MECP. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.10.7 Project No. 178 (SWMF Retrofit No. 91 – LT04)

SWMF LT04 is a wet pond which provides less than 60% Total Suspended Solids (TSS) removal under existing conditions. The permanent pool and extended detention volumes provided in SWMF LT04 are 7,925 m³ and 15,900 m³, respectively. Overall, SWMF LT04 attenuates peak flows by 92% and 84% during the 1:5-year and 1:100-year return frequency storm events, respectively.

An opportunity exists to expand the existing SWMF to increase the permanent pool volume to provide the requisite 80% TSS removal in combination with SWMF LTGM. To provide 80% TSS removal, the SWMF can be expanded to provide 9,075 m³ of permanent pool volume. Cell 1 of SWMF LT04 can be expanded to the north and excavated deeper to provide the increased permanent pool volume. Although the permanent pool volume can be expanded, the active storage volume is sufficient and no additional active storage is proposed.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF LT04 will have a negative impact on the project environments and the watershed. As such, Project No. 178 is not recommended for implementation within the Little Lake watershed.

14.11 BEAR CREEK WATERSHED

14.11.1 Project No. 147 (Lougheed Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 15 ha of local road and residential development drains via storm sewer around Lougheed Park ultimately draining directly into Bear Creek untreated. An



opportunity exists to install an underground infiltration system in Lougheed Park and divert the storm sewer through the LID for treatment.

Infiltration testing completed in Lougheed Park at the location of the proposed centralized LID confirmed that the infiltration rate (64 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 1,000 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of approximately 28 kg/year in Bear Creek (NVCA P-Tool).

Lougheed Park is located outside of any significant groundwater recharge area and outside of any Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Lougheed Park suitable for infiltration practices. As such Project No. 147 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Lougheed Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Bear Creek watershed, the Lougheed Park centralized LID should be re-evaluated in consultation with the NVCA.

14.11.2 Project No. 148 (Wessenger Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 9 ha of local road and residential development drains via storm sewer around Wessenger Park ultimately draining directly into Bear Creek untreated. An opportunity exists to install an underground infiltration system in Wessenger Park and divert the storm sewer through the LID for treatment.

Infiltration testing completed in Wessenger Park at the location of the proposed centralized LID confirmed that the infiltration rate (57 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 635 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 17 kg/year in Bear Creek (MECP P-Tool).

Wessenger Park is located outside of any significant groundwater recharge area and outside of any Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Wessenger Park suitable for infiltration practices. As such Project No. 148 is permitted.



The individual project evaluation completed demonstrates that the proposed impacts of the Wessenger Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Bear Creek watershed, the Wessenger Park centralized LID should be re-evaluated in consultation with the NVCA.

14.11.3 Project No. 149 (Bear Creek Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 73 ha of local road and residential development drains via storm sewer around Bear Creek Park ultimately draining directly into Bear Creek untreated. An opportunity exists to install an underground infiltration system in Bear Creek Park and divert the storm sewer through the LID for treatment.

Infiltration testing completed in Bear Creek Park at the location of the proposed centralized LID confirmed that the infiltration rate (64 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 4,600 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of nearly 130 kg/year in Bear Creek (MECP P-Tool).

Bear Creek Park is located outside of any significant groundwater recharge area and outside of any Well Head Protection Areas. The drainage area also consists of primarily local roads and residential development making Bear Creek Park suitable for infiltration practices. As such Project No. 149 is permitted.

The individual project evaluation completed demonstrates that the proposed impacts of the Bear Creek Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Bear Creek watershed, the Bear Creek Park centralized LID should be re-evaluated in consultation with the NVCA.

14.11.4 Project No. 150 (SWMF Retrofit No. 61 – BR08b)

SWMF BR08b is a wet pond which provides less than 80% Total Suspended Solids (TSS) removal under existing conditions. SWMF BR08b has an existing permanent pool volume of 2,649 m³ active storage volume of 33,210 m³ and extended detention volume of 18,336 m³. Overall, SWMF BR08b attenuates peak flows by 80% and 76% during the 1:5-year and 1:100-year return frequency storm events, respectively.



An opportunity exists to expand the existing SWMF to increase the permanent pool volume to provide the requisite 80% TSS removal and reduce phosphorus loads downstream. To provide 80% TSS removal, 5,314 m³ of storage is required. Expanding the pond footprint will increase the permanent pool volume to 5,314 m³ to satisfy the water quality treatment requirements.

Although some additional active storage will be provided in SWMF BR08 by expanding the permanent pool, the additional peak flow attenuation provided is insignificant. As such, the SWMF retrofit is considered a retrofit for water quality enhancement only. It is noted that improvements to the existing outlet are not proposed.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF BR08b will have a positive impact on the project environments and the watershed. No comments were received regarding SWMF Retrofit No. 61 during public consultation. As such, Project No. 150 is recommended and included in the preferred solution for the Bear Creek watershed.

No property acquisition is required as part of Project No. 150 as the works can be completed within the existing footprint of the pond within City owned lands. The proposed SWMF retrofit is a Schedule A+ project. SWMF BR08b is within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that an amendment to the SWMF's existing Environmental Compliance Approval will be required from the MECP. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the SWMF retrofit are presented in Section 15 of this report.

14.11.5 Project No. 151 (SWMF Retrofit No. 69 – BR13)

SWMF BR13 is a dry pond which provides less than 60% water quality treatment under existing conditions. Overall, SWMF BR13 attenuates peak flows by 46% and 32% during the 1:5-year and 1:100-year return frequency storm events, respectively. It is noted that no deficiencies have been identified in the conveyance systems downstream.

An opportunity exists to convert SWMF BR13 into a wet pond by expanding on the existing SWMF to provide a permanent pool volume for water quality treatment. Additional active storage will also be provided. To provide 80% TSS removal for the nearly 79 ha drainage area, 8,072 m³ of storage is required. Expanding the pond footprint will increase the permanent pool volume to 8,072 m³ to satisfy the water quality treatment requirements.

The proposed SWMF outlet controls consist of a 220 mm orifice, a double ditch inlet catchbasin, and a 15 m wide emergency overland flow weir. The wet pond will provide peak flow attenuation and control for the 1:2-year through 1:100-year frequency storm events. The SWMF retrofit will improve attenuated peak flows by 35% and 23% during the 1:5-year and 1:100-year return frequency storm events, respectively.



To provide the requisite permanent pool storage volume, the SWMF would have to be expanded onto 183, 185, 189 and 191 Ardagh Rd., nearly doubling the size of SWMF BR13.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF BR13 will have a negative impact on the project environments and the watershed. As such, Project No. 151 is not recommended for implementation within the Bear Creek watershed.

14.11.6 Project No. 152 (SWMF Retrofit No. 90 – BR14)

SWMF BR14 is a wet pond which provides less than 60% water quality treatment under existing conditions. Overall, SWMF BR14 attenuates peak flows by 49% and 36% during the 1:5-year and 1:100-year return frequency storm events, respectively.

An opportunity exists to regrade the existing SWMF to provide additional permanent pool volume for water quality treatment. Additional active storage will not be provided. To provide 80% TSS removal for the nearly 50 ha drainage area, 5,564 m³ of storage is required. Regrading the pond will increase the permanent pool volume to 5,564 m³ to satisfy the water quality treatment requirements.

The individual project evaluation completed demonstrates that the proposed retrofit to SWMF BR14 will have a negative impact on the project environments and the watershed. As such, Project No. 152 is not recommended for implementation within the Bear Creek watershed.

14.11.7 Project No. 153 (SWMF Retrofit No. 62 – BR05)

SWMF BR05 is a dry pond which provides less than 60% water quality treatment under existing conditions. Overall, SWMF BR05 attenuates peak flows by 77% and 82% during the 1:5-year and 1:100-year return frequency storm events, respectively.

An opportunity exists to convert SWMF BR05 into a wet pond by regrading the existing SWMF to provide a permanent pool volume for water quality treatment. To provide 70% TSS removal for the nearly 19 ha drainage area, 1,108 m³ of storage is required. Excavating a permanent pool cell in the bottom of the pond within the existing SWMF footprint will create a permanent pool volume to 1,108 m³ to satisfy the water quality treatment requirements. No additional active storage will be provided and the existing SWMF outlet controls will remain.

The individual project evaluation completed demonstrates that the proposed impacts of Project No. 153 outweigh the benefits. As such, Project No. 152 is not recommended for implementation within the Bear Creek watershed.



14.11.8 Project No. 154 (Culvert Improvement No. 78 – Ardagh Rd.)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy the City of Barrie flow design guidelines for road crossings (Arterial Road - 1:100-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3B to satisfy previous MDP recommended design flood frequency criteria.

The existing 750 mm diameter CSP culvert crossing has a conveyance capacity of approximately 1.9 m³/s or a design flood frequency of 1:50-years. To satisfy the design flood frequency criteria, the existing culvert can be replaced with a 900 mm diameter concrete culvert. The conveyance capacity of the replacement structure is approximately 2.3 m³/s. In addition to an increase in the conveyance capacity, a reduction in flooding will also occur. There will be a reduction in the frequency of flooding and the increased conveyance capacity will reduce the depth and velocity of overtopping during the Regulatory event.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were received regarding Culvert Improvement No. 78 through public consultation. As such, Project No. 154 is recommended and included in the preferred solution for the Bear Creek watershed.

The culvert improvement proposed does not require property acquisition as the works can be completed within the road allowance and City owned lands. The proposed culvert improvement is a Schedule A project. As such, subsequent options were not evaluated. The culvert improvement is located on Bear Creek (Be-14) within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that a self assessment will satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bear Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the culvert improvement are presented in Section 15 of this report.

14.11.9 Project No. 155 (Watercourse Improvement No. 33 – Reach Be-14)

Basal erosion and knickpoints were identified in this reach of Bear Creek (Reach Be-14) as part of the Fluvial Geomorphological & Threshold Assessment (Water's Edge, January 2018) completed in support of this Drainage Master Plan. The assessment recommends mitigating further knickpoint development by improving the channel capacity in a manner that the watercourse still has access to its existing floodplain. Existing knickpoint stabilisation can be achieved by regrading and providing scour treatment to the downstream scour pool for this



section of Bear Creek. In this Drainage Master Plan, bio-engineered scour treatment is recommended to stabilize the existing bed scour.

The individual project evaluation completed demonstrates that the proposed watercourse improvements will have an overall positive impact on the project environments and be beneficial to the watershed. No comments were provided regarding Watercourse Improvement No. 33 during public consultation. As such, Project No. 155 is recommended and included in the preferred solution for the Bear Creek watershed.

The watercourse improvements proposed do not require property acquisition as the works can be completed within City owned lands. The proposed watercourse improvements are located on Bear Creek within the NVCA Regulated area and will require a permit from the NVCA. It is anticipated that a DFO Request for Review will be required to satisfy the requirements of the DFO for this project. The MNRF should be consulted to establish the applicable fishery timing windows for this reach of Bear Creek. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the watercourse improvement are presented in Section 15 of this report.

14.11.10 Project No. 156 (Culvert Improvement No. 134 – BCRY Railway Crossing)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy the City of Barrie flow design guidelines for railway crossings (Railway Crossing - 1:50-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A to satisfy previous MDP recommended design flood frequency criteria.

The existing 500 mm diameter CSP culvert crossing has a conveyance capacity of less than 0.2 m³/s or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert would need to be replaced with a significantly larger culvert. However, due to site constraints (depth of cover), improvements to the crossing are limited. The existing culvert can be replaced with three 525 mm diameter HDPE culverts to improve the conveyance capacity. The conveyance capacity of the replacement structure is approximately 0.2 m³/s. This improvement does not satisfy the City's design frequency criteria. However, the improvement does increase the conveyance capacity of the culvert and will reduce the frequency of flooding over the railway.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall negative impact on the project environments and will not be beneficial to the watershed. As such, Project No. 156 is not recommended and is not included in the preferred solution for the Bear Creek watershed at this time. However, if in the future an



opportunity presents itself to raise the grade of the railway then Project No. 156 should be reevaluated.

14.11.11 Project No. 157 (Culvert Improvement No. 80 – Count Rd. 27)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that the capacity of the existing culvert does not satisfy the City of Barrie flow design guidelines for road crossings (Local Road - 1:50-year). The preferred approach to address the drainage deficiencies developed in this Drainage Master Plan includes Alternative 3A to satisfy previous MDP recommended design flood frequency criteria.

The existing 500 mm diameter CSP culvert crossing has a conveyance capacity of less than 0.3 m³/s or a design flood frequency of less than 1:2-years. To satisfy the design flood frequency criteria, the existing culvert would need to be replaced with a significantly larger culvert. However, due to site constraints (depth of cover), improvements to the crossing are limited. The existing culvert can be replaced with three 525 mm diameter HDPE culverts to improve the conveyance capacity. The conveyance capacity of the replacement structure is approximately 1.1 m³/s. This improvement does not satisfy the City's design frequency criteria. However, the improvement does increase the conveyance capacity of the culvert and will reduce the frequency of flooding over the railway.

The individual project evaluation completed demonstrates that the proposed culvert improvement will have an overall negative impact on the project environments and will not be beneficial to the watershed. As such, Project No. 157 is not recommended and is not included in the preferred solution for the Bear Creek watershed at this time. However, if in the future an opportunity presents itself to raise the grade of County Rd. 127 then Project No. 157 should be reevaluated.

14.12 JOHNSON DRAINAGE AREA

14.12.1 Project No. 159 (Trunk Storm Sewer No. 8)

The existing conditions analysis completed as part of this Drainage Master Plan confirmed that overland flow deficiencies exist on Johnson St. from Steel St. to Kempenfelt Bay (Lake Simcoe). The depth and velocity of overland flow exceeds the safe access/egress criteria established by the LSRCA. As such, there is an opportunity to eliminate the overland flow deficiencies by replacing the minor storm sewer system with a trunk storm sewer in this area.

The existing storm sewer on Johnson St. from Steel St. to Lake Simcoe can be replaced with a trunk storm sewer sized to convey the 1:100-year return frequency storm peak flow. As a result, flooding will be reduced during minor and major storm events. The existing local storm



sewer can be replaced with trunk storm sewer ranging from 900 mm diameter to 2000 mm x 1800 mm concrete trunk storm sewer to convey the required flow.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have an overall positive impact on the project environments and be beneficial to the watershed. As such, Project No. 159 is recommended and included in the preferred solution for the Johnson Drainage Area. No comments were received regarding Project No. 159 through public consultation.

It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects. Trunk Storm Sewer No. 8 is a Schedule A+ project. As such, subsequent options were not evaluated. The proposed trunk storm sewer will outlet directly to Lake Simcoe and will require a permit from the LSRCA. It is anticipated that a Request for Review will satisfy the requirements of the DFO for this project. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.

14.12.2 Project No. 160 (Shoreview Park Centralized LID)

As discussed, locations to implement centralized LIDs to improve water quality and reduce phosphorus loads were explored as part of this Drainage Master Plan. This includes implementing centralized LIDs as end-of-pipe solutions where storm sewers drain untreated directly into watercourses.

Currently, approximately 20 ha of local road and residential development drains via storm sewer around Shoreview Park ultimately draining directly into Lake Simcoe. An opportunity exists to install an underground infiltration system in Shoreview Park and divert the storm sewer through the LID for treatment.

Infiltration testing completed in Shoreview Park at the location of the proposed centralized LID confirmed that the infiltration rate (104 mm/hr) of the native soil is suitable for infiltration measures. To provide 80% TSS removal, 950 m³ of storage is required in the underground infiltration system. Implementing the underground infiltration system will result in a phosphorus reduction of approximately 29 kg/year (MECP P-Tool).

Shoreview Park is located outside the significant groundwater recharge areas. However, Shoreview Park is located in Well Head Protection Area D. As per the recommendations of the Low Impact Development Stormwater Management Planning and Design Guide and City of Barrie Infiltration Low Impact Development Screening Process document, infiltration-based practices are permitted in Well Head Protection Area D when the contributing drainage area consists of local roads and residential development. As such Project No. 160 is permitted.



The individual project evaluation completed demonstrates that the proposed impacts of the Shoreview Park Centralized LID outweigh the benefits. However, if a phosphorus offset is required in the Johnson drainage area, the Shoreview Park centralized LID should be re-evaluated in consultation with the LSRCA.

14.13 NELSON DRAINAGE AREA

14.13.1 Project No. 180 (Trunk Storm Sewer No. 12)

Currently, there is no minor drainage system on Blake St. from Johnson St. to Puget St. and the major drainage system is deficient. During storm events surface runoff spills south through private property to Shanty Bay Rd. As such, there is an opportunity to install a trunk storm sewer on Blake St. to service the area and eliminate the overland flow deficiencies.

To address these deficiencies a trunk storm sewer can be installed on Blake St. from Downsview Dr. to Puget St.. 600 mm diameter to 750 mm diameter storm sewer can be installed underneath the roadway to convey the requisite flow. The storm sewer can be tied into the existing storm sewer on Puget St. which will convey the flow downstream to Lake Simcoe. It has been confirmed through hydraulic analysis that the existing Puget St. storm sewer has capacity to convey the additional flows.

The individual project evaluation completed demonstrates that the proposed trunk storm sewer will have a positive impact on the project environments and the watershed. As such, Project No. 180 is recommended and included in the preferred solution for the Nelson Drainage Area. It is recommended that the trunk storm sewer be constructed as part of road renewal or reconstruction projects.

Project No. 180 does not require property acquisition as the works can be completed in the road allowance. Trunk Storm Sewer No. 5 is a Schedule A+ project. As such, subsequent options were not evaluated. It is anticipated that an amendment to the MECP Environmental Compliance Approval will be required for this project. Additional cultural heritage, archeological and natural heritage requirements related to the detailed design of the trunk storm sewer are presented in Section 15 of this report.



15 Preferred Solution / Individual Drainage Projects

The general recommendations applicable to each watershed and drainage area in the City as well as the individual projects included as part of the preferred solution developed through this Drainage Master Plan are outlined in the following section.

15.1 GENERAL RECOMMENDATIONS

As a general requirement for all capital projects, it is recommended that upsizing the local storm sewers to satisfy current design standards be considered as part of future road reconstruction projects. The minor drainage system deficiencies are illustrated on Figure 1A through 5A – Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

Similarly, relocating storm sewer to the municipal road allowance should also be considered as part of future road reconstruction projects. There are sections of storm sewer throughout the City that are currently located outside the municipal road allowance on private property. As local improvement projects proceed these storm sewers should be relocated to municipal lands for access and maintenance.

It is also recommended that the streets identified as being absent of a minor drainage system throughout the study area include storm sewers as part of road reconstruction projects. Study results have shown the absence of minor drainage systems results in frequent flooding and causes safety concerns. The areas/streets absent of minor drainage systems are illustrated on Figure 1A through 5A – Minor Drainage System Deficiencies included in the *Hydrologic & Hydraulic Modelling Technical Memorandum* enclosed in Appendix B for reference.

For this study, the major overland deficiencies have been evaluated using the dual drainage system in PCSWMM and standardized road cross-sections between storm structures. The cross-sections do not necessarily mimic existing conditions, however, they do provide an estimate of the overland flow depths and velocities that will be experienced along the roadway during major storm events. It is recommended that solutions to address the identified major overland deficiencies also be evaluated as part of future road reconstruction projects where feasible through oversizing the storm sewer and/or adjusting the road profile/cross-section.

The implementation of lot level Low Impact Development (LID) measures on private property across the City to increase infiltration, improve the water balance and watershed water quality



and will provide an overall benefit. The City should promote the use of rain barrels and implementation of soakaway pits by residents and property owners in the City.

The City should implement perforated pipe systems or infiltration systems as part of local road reconstruction projects and intensification in the City of Barrie. The target runoff volume captured in each watershed/drainage area should be consistent with objectives identified in Table 39. It is understood the City of Barrie is currently developing Low Impact Development design standards and the linear Low Impact Development (LID) measures implemented should remain consistent with these standards and the Low Impact Development Stormwater Management Planning and Design Guide developed by Credit Valley Conservation and Toronto and Region Conservation.

In accordance with By-law 90-92, it is recommended that the City proactively acquire lands or interest therein (easements) over the various Creeks and their tributaries throughout the City. The City currently owns lands or has interest therein (easements) over portions of various watercourses in the City. Additional lands will be dedicated to the City from future developments through Subdivision Agreements and Site Plan Conditions. However, lands or easements over the remaining reaches of each creek will have to be purchased or expropriated from the existing land owners.

As mentioned, the City currently has easements over portions of various watercourses in the City. An easement grants the City access to lands owned by others for a specific purpose such as maintenance. However, the City routinely encounters issues accessing lands through an easement due to fences, sheds, other structures and landscaping constructed/installed by the property owner. As the Creeks convey drainage from Municipal lands, maintenance of the conveyance systems is generally the responsibility of the City. As such, it is recommended that the City acquire the lands over the watercourses rather than interests therein (easements) when it is in the City's interest to do so. The width of land to acquire over each watercourse should be determined on a reach by reach basis considering the channel width, erosion threshold, meander belt width and existing floodplain.

15.2 INDIVIDUAL DRAINAGE SOLUTIONS (PROJECTS)

The individual projects recommended as part of the preferred solution along with their cost, EA status, archeological, cultural and natural heritage constraints and approval requirements are summarized in the following table. Overall maps illustrating the locations of each recommended projects are included in Appendix A. Conceptual design drawing for each recommended project are provided in Appendix N. Project cost estimates are included in Appendix O. The third party (MTO and Metrolink) project conceptual design drawings and project cost estimates are included in Appendix P for reference.



Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Kidd's Creek Watershed (Refer to Figure 23)	1	SWMF Retrofit No. 11 (KD06)	Livingstone St. W. and Ford St.	Construct underground infiltration system for water quality treatment, erosion control and active storage offset (SWMF KD02).	2B	-	\$3,970,038	A+	Pre-Approved
	2	SWMF Retrofit No. 18 (KD05)	Livingstone St. W. and Neelands St.	Construct underground infiltration system for water quality treatment and phosphorus removal. Grade major overland flow route to prevent private property flooding.	2B		\$1,409,538	A+	Pre-Approved
	3	SWMF Retrofit No. 13 (KD03)	Between Irwin Dr. and Sunnidale Rd.	Construct underground infiltration system for water quality treatment, phosphorus removal and active storage offset (SWMF KD02).	2B	-	\$1,649,080	A+	Pre-Approved
	4	Watercourse Improvement No. 1	Kidd's Creek between Lilian Cres. and Cundles Rd. W. (Reaches Ki-1 through Ki-2)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	3A/3B	-	\$1,584,898	B	New Project
	5	Culvert Improvement No. 13	Cundles Rd. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,090,797	A	Pre-Approved
	161	Watercourse Improvement No. 34	Kidd's Creek between Cundles Rd. and Highway 400 (Reach Ki-3 through Ki-6)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion	3A/3B	-	\$1,766,852	B	New Project
	8A	Culvert Improvement No. 16	Thomson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP).	3A	27 Thomson St. 22 Thomson St. (portion of)	\$1,452,335	B	New Project
	162A	Trunk Storm Sewer No. 9	Thomson St., Sophia St. W. and Florence St.	Thomson St., Sophia St. W., Florence St., Park St. and Eccles St. N.	3A/3B	-	\$1,790,457	B	New Project
	163	Watercourse Improvements No. 2	Kidd's Creek between Thomson St. and Eccles St. (Reach Ki-8a)	Watercourse improvements along Kidd's Creek to stabilize existing bank failures/erosion.	3A/3B	22 Thomson St. (portion of) 18 Thomson St. (portion of) 14 Thomson St. (portion of) 77 Eccles St. N. (portion of) 75 Eccles St. N. (portion of)	\$1,601,080	B	New Project
	9	Culvert Improvement No. 18	Wellington St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$178,464	A	Pre-Approved
	10	Watercourse Improvement No. 3	Kidd's Creek between Eccles St. and Henry St. (Reaches Ki-10b through Ki-10c)	Watercourse improvements on Kidd's Creek to stabilize existing bank failures/erosion.	3A/3B	Address Not Available (portion of) 19 Donald St. (portion of) 11 Donald St. (portion of) 38 Eccles St. N. (portion of) 10 Henry St. (portion of) 17 Eccles St. N.	\$1,751,137	B	New Project
	165	Watercourse Improvement No. 25	Kidd's Creek between Eccles St. and Dunlop St. W. (Reach Ki-11)	Daylight watercourse through 150 Dunlop St. W.	3A/3B	150 Dunlop St. W. (portion of)	\$2,639,671	B	New Project
	166	Culvert Improvement No. 145	Dunlop St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	150 Dunlop St. W. (portion of)	\$4,233,858	B	New Project
	167	Watercourse Improvement No. 26	Kidd's Creek between Dunlop St. W. and Bradford St. (Reach Ki-11)	Daylight watercourse through 125 Dunlop St. W.	3A/3B	-	\$887,618	B	New Project
	11A	Trunk Storm Sewer No. 11	Bradford St.	Trunk storm sewer extension to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,473,926	A+	Pre-Approved

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Kidd's Creek Watershed (Refer to Figure 23)	1	SWMF Retrofit No. 11 (KD06)	Uncertain Potential	Stage 2AA	None	None	Low	None Identified (subject to SAR Assessment)	SAR Assessment	ECA Amendment
	2	SWMF Retrofit No. 18 (KD05)	Elevated Potential	Stage 2AA	None	None	Low	None Identified (subject to SAR Assessment)	SAR Assessment	ECA Amendment
	3	SWMF Retrofit No. 13 (KD03)	Elevated Potential	Stage 2AA	Listed Property	Heritage Impact Assessment	Low	None Identified (subject to SAR Assessment)	SAR Assessment	ECA Amendment
	4	Watercourse Improvement No. 1	Elevated Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	5	Culvert Improvement No. 13	Disturbed Area	None	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
	161	Watercourse Improvement No. 34	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	8A	Culvert Improvement No. 16	Disturbed Area	None	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	162A	Trunk Storm Sewer No. 9	Historic Town of Barrie	Stage 2AA	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA
	163	Watercourse Improvements No. 2	Historic Town of Barrie	Stage 2AA	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	9	Culvert Improvement No. 18	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat	None	LSRCA Permit
	10	Watercourse Improvement No. 3	Historic Town of Barrie	Stage 2AA	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	165	Watercourse Improvement No. 25	Historic Town of Barrie	Stage 2AA	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	166	Culvert Improvement No. 145	Disturbed Area	None	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	167	Watercourse Improvement No. 26	Historic Town of Barrie	Stage 2AA	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	11A	Trunk Storm Sewer No. 11	Disturbed Area	None	Listed, Inventoried and Newly Identified Properties	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Bunkers Creek Watershed (Refer to Figure 23)	31	SWMF Retrofit No. 10 (BK03)	Northwest of Shelley Ln. and Anne St. N. Intersection	Construct underground infiltration system for water quality treatment and phosphorus removal. SWMF outlet modifications for peak flow attenuation.	2A/2B	-	\$2,917,720	A+	Pre-Approved
	32	Trunk Storm Sewer No. 1	Anne St. N. from BK03 to Edgehill Dr.	Construct trunk storm sewer on Anne St. N. to divert flows reducing downstream flooding and erosion on Bunkers Creek (Reach Bu-3).	3A/3B	-	\$4,613,860	A+	Pre-Approved
	34	Watercourse Improvement No. 4	Bunkers Creek downstream of Shirley Ave. (Reach Bu-3)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-3).	3A/3B	-	\$1,015,852	B	New Project
	35	Watercourse Improvement No. 5	Bunkers Creek downstream of Edgehill Rd. (Reach Bu-7)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-7).	3A/3B	-	\$366,016	B	New Project
	36	Culvert Improvement No. 143	Highway 400 - Bunkers Creek (North Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$877,848	MTO Project	
	37	Culvert Improvement No. 142	Highway 400 - Bunkers Creek (Central Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$1,955,101	MTO Project	
	38	Culvert Improvement No. 141	Highway 400 - Bunkers Creek (South Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$699,116	MTO Project	
	39	SWMF Retrofit No. 94	New SWMF within future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south/central branches of Bunkers Creek.	2A		\$3,247,879	MTO Project	
	40B	Trunk Storm Sewer No. 2	Dunlop St. W. and Anne St. S. from Highway 400 E/W-N-ramp to Perry St.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	3A/3B	-	\$2,908,081	A+	Pre-Approved
	41	Watercourse Improvement No. 8	Bunkers Creek between Anne St. S. and Innisfil St. (Reaches Bu-11 and Bu-15)	Toe treatment to mitigate bank scour and undercutting on Bunkers Creek (Reach Bu-11 and Bu-15).	3A/3B	130 Vespra St. (portion of)	\$1,051,863	B	New Project
	42	Pond Retrofit No. 95 (Milligan's Pond)	Milligan's Pond between Boyz St. and Innisfil St.	Cleanout accumulated sediment from Milligans Pond and reinstate watercourse.	2B	-	\$2,020,838	A	Pre-Approved
	43	Culvert Improvement No. 22	Innisfil St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Bunkers Creek MDP).	3A	80 Bradford St. (portion of)	\$3,129,638	B	Time Lapse
	44	Culvert Improvement No. 23	Commercial Plaza Entrance Road	Remove existing culvert and daylight watercourse. Install pedestrian bridge for access to paking lot.	3A	80 Bradford St. (portion of)	\$1,729,121	B	Time Lapse
	45	Culvert Improvement No. 24	Bradford St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	100 Bradford St. (portion of)	\$5,172,158	B	Time Lapse
	46	Watercourse Improvement No. 27	Bunkers Creek (Reach Bu-16)downstream of Bradford St. to Lakeshore Dr.	Natural watercourse enhancement on Bunkers Creek (Reach Bu-16) to increase conveyance capacity, habitat and canopy.	3A/3B	93 Bradford St. 20 Checkley St. (portion of)	\$3,533,104	B	Time Lapse
Dyments Creek Watershed (Refer to Figure 23)	49	Watercourse Improvement No. 29	Downstream of Sproule Dr. to SWMF Retrofit No. 78	Realign Dyments Creek from Sproule Dr. into SWMF Retrofit No. 78.	3A/3B	-	\$809,778	B	New Project
	181	SWMF Retrofit No. 78	Between Sproule Dr. and Dunlop St. W.	Construct peak flow attenuation SWMF.	2A	Address Not Available	\$5,359,588	B	Time Lapse
	182	Culvert Improvement No. 28	Dunlop St. W.	Relocate and upgrade culvert to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$978,965	A	Pre-Approved
	183	Watercourse Improvement No. 9	Dunlop St. W. to Ferndale Dr. N. (Reach Dy-2a)	Realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. to facilitate SWMF retrofit (No. 78) and increase conveyance capacity.	3A/3B	Address Not Available (portion of) Address Not Available (portion of) 461 Dunlop St. W. (portion of) 100 Ferndale Dr. N. (portion of)	\$4,203,944	B	Time Lapse
	50	Culvert Improvement No. 29	Ferndale Dr. N.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,763,208	A	Pre-Approved
	51	Watercourse Improvement No. 10	Ferndale Dr. N. to Sarjeant Dr. (Reach Dy-2b)	Regrade/reshape Dyments Creek from Ferndale Dr. N. to Sarjeant Dr. to provide positive drainage and increased conveyance capacity.	3A/3B	425 Dunlop St W. (portion of) 433 Dunlop St. W. (portion of) 441 Dunlop St. W. (portion of) 97 Ferndale Dr. N. (portion of) 105 Ferndale Dr. N. (portion of) 30 Elliott Ave. (portion of) 20 Elliott Ave. (portion of) 8 Sarjeant Dr. (portion of)	\$4,757,426	B	Time Lapse

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Bunkers Creek Watershed (Refer to Figure 23)	31	SWMF Retrofit No. 10 (BK03)	Historic Town of Barrie	Stage 2AA	None	None	High	None Identified (subject to SAR Assessment)	SAR Assessment	LSRCA Permit / ECA Amendment
	32	Trunk Storm Sewer No. 1	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	None Identified (subject to SAR Assessment)	SAR Assessment	LSRCA Permit / ECA Amendment
	34	Watercourse Improvement No. 4	Historic Town of Barrie	Stage 2AA	None	None	High	Indirect Warm/Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	35	Watercourse Improvement No. 5	Historic Town of Barrie	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	Medium	Direct Warm/Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	36	Culvert Improvement No. 143	MTO Project							
	37	Culvert Improvement No. 142	MTO Project							
	38	Culvert Improvement No. 141	MTO Project							
	39	SWMF Retrofit No. 94	MTO Project							
	40B	Trunk Storm Sewer No. 2	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	None Identified (subject to SAR Assessment)	SAR Assessment	LSRCA Permit / ECA
	41	Watercourse Improvement No. 8	Historic Town of Barrie	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Warm/Cool Water Fish Habitat; Unevaluated Wetland	SAR Assessment	LSRCA Permit / DFO Request for Review
	42	Pond Retrofit No. 95 (Milligan's Pond)	Historic Town of Barrie	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Warm/Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	43	Culvert Improvement No. 22	Disturbed Area	None	None	None	Medium	Direct Warm/Cool Water Fish Habitat; Non-PSW	Potential Bat Habitat	LSRCA Permit / DFO Request for Review
	44	Culvert Improvement No. 23	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	Medium	Direct Warm/Cool Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Request for Review
	45	Culvert Improvement No. 24	Disturbed Area	None	None	None	Medium	Direct Warm/Cool Water Fish Habitat	Potential Bat, Amphibian Breeding and Turtle Habitat	LSRCA Permit / DFO Request for Review
	46	Watercourse Improvement No. 27	Historic Town of Barrie	Stage 2AA	None	None	High	Direct Warm/Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
Dyments Creek Watershed (Refer to Figure 23)	49	Watercourse Improvement No. 29	Elevated Potential	Stage 2AA	None	None	High	Direct Cool Water Fish Habitat / Unevaluated Wetland	SAR Assessment	LSRCA Permit / DFO Request for Review
	181	SWMF Retrofit No. 78	Elevated Potential	Stage 2AA	None	None	High	Direct Cool Water Fish Habitat / Unevaluated Wetland	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA
	182	Culvert Improvement No. 28	Disturbed Area	None	None	None	Medium	Direct Cool Water Fish Habitat / Unevaluated Wetland	Potential Bat, Amphibian Breeding and Bird Breeding Habitat	LSRCA Permit / DFO Request for Review
	183	Watercourse Improvement No. 9	Elevated Potential	Stage 2AA	None	None	Medium	Direct Cool Water Fish Habitat / Unevaluated Wetland	SAR Assessment	LSRCA Permit / DFO Request for Review
	50	Culvert Improvement No. 29	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	Low	Direct Cool Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	51	Watercourse Improvement No. 10	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	Medium	Direct Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Dyments Creek Watershed (Refer to Figure 23)	52	Culvert Improvement No. 30	Sarjeant Dr. and Dunlop St. W.	Realign and upgrade culvert to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$8,294,081	A	Pre-Approved
	53	Culvert Improvement No. 31	Highway 400 E/W-S and N-E/W Ramps	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$2,253,740	MTO Project	
	54	Culvert Improvement No. 33	Highway 400	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	3B	-	\$5,851,055	MTO Project	
	55	Culvert Improvement No. 32	Hart Dr.	Extend Highway 400 Culvert under Hart Dr.	3B	-	\$2,338,970	A	Pre-Approved
	56	Watercourse Improvement No. 11	Downstream of Hart Dr. (Reach Dy-3)	Daylight watercourse (through 55 Hart Dr.)	3A/3B	55 Hart Dr. (portion of)	\$916,057	B	New Project
	57	Culvert Improvement No. 34	George St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$1,254,767	A	Pre-Approved
	169	Culvert Improvement No. 35	Victoria St.	Remove roadway and culvert crossing daylighting channel	2A	-	\$1,137,960	A+	New Project
	170B	SWMF Retrofit No. 79 (DY01)	Between George St. and Anne St. S.	Remove Victoria Street culvert crossing, channel improvements through SWMF DY01 from Georga St. to Anne St. S and utilize floodplain storage for peak flow attenuation during major storms.	2A	-	\$5,049,510	B	Time Lapse
	58	Culvert Improvement No. 36	Anne St. S. and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	71 Anne St. S. (portion of)	\$5,146,253	B	Time Lapse
	59	Watercourse Improvement No. 12	Dyments Creek between Anne St. S. and Innisfil St. (Reach Dy-5)	Toe treatment to mitigate bank scouring and undercutting.	3A/3B	-	\$138,866	B	New Project
	60	Culvert Improvement No. 37	Innisfil Street	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	-	\$4,149,088	A	Pre-Approved
	61	Culvert Improvement No. 38	Sanford St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	100 Sanford St. (portion of) 95 Sanford St. (portion of)	\$2,912,991	B	Time Lapse
	62	Culvert Improvement No. 39	Bradford St.	Culvert upgrades to satisfy Regulatory flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	3A	176 Bradford St.	\$7,063,031	B	Time Lapse
	63	Watercourse Improvement No. 28	Dyments Creek downstream of Bradford St. to Lakeshore Dr. (Reach Dy-6)	Watercourse improvements to increase conveyance capacity and decrease flooding.	3A/3B	-	\$1,241,691	B	Time Lapse
Hotchkiss Creek Watershed (Refer to Figure 20)	12	Culvert Improvement No. 41	Mayfair Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	3B	-	\$292,820	A	Pre-Approved
	13	Culvert Improvement No. 42	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$307,285	A	Pre-Approved
	16	Culvert Improvement No. 44	Essa Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,321,039	MTO Project	
	17	SWMF Retrofit No. 44	85 Morrow Rd.	Construct wetland SWMF for water quality treatment, erosion control and peak flow attenuation.	2B	85 Morrow Rd. (portion of)	\$7,355,787	B	New Project
	19	SWMF Retrofit No. 81	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	2A	50 Wood St. (portion of)	\$11,125,634	B	Time Lapse
	20	SWMF Retrofit No. 96	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	2A	50 Wood St. (portion of)	\$1,011,112	B	Time Lapse
	21	Culvert Improvement No. 135	BCRY Railway Crossing (between Wood St. and Tiffin St.)	Construct proposed SWMF Retrofit No. 96 outlet controls.	2A	155 Tiffin St. (portion of) 47 Alfred St.	\$3,272,716	B	Time Lapse
	22	Culvert Improvement No. 48	Tiffin St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,286,009	A	Pre-Approved
	23	Watercourse Improvement No. 6	Hotchkiss Creek between Tiffin St. and Anne St. S. (Reach Ho-8)	Daylight watercourse through 115 Brock St., 128 Anne St. S. and 134 Tiffin St.	3A/3B	128 Anne St. S. (portion of) 134 Tiffin St. 115 Brock St. (portion of)	\$3,593,757	B	New Project

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Dyments Creek Watershed (Refer to Figure 23)	52	Culvert Improvement No. 30	Elevated Potential	Stage 2AA	None	None	Low	Direct Cool Water Fish Habitat	Potential Amphibian Breeding Habitat	LSRCA Permit / DFO Self Assessment
	53	Culvert Improvement No. 31	MTO Project							
	54	Culvert Improvement No. 33	MTO Project							
	55	Culvert Improvement No. 32	Disturbed Area	None	None	None	Low	Direct Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	56	Watercourse Improvement No. 11	Historic Town of Barrie	Stage 2AA	None	None	Medium	Direct Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	57	Culvert Improvement No. 34	Disturbed Area	None	None	None	Low	Direct Cool Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	169	Culvert Improvement No. 35	Elevated Potential	Stage 2AA	None	None	High	Direct Cool Water Fish Habitat	Potential Bat, Amphibian Breeding and Turtle Habitat	LSRCA Permit / DFO Self Assessment
	170B	SWMF Retrofit No. 79 (DY01)	Elevated Potential	Stage 2AA	None	None	High	Direct Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA
	58	Culvert Improvement No. 36	Disturbed Area	None	None	None	High	Direct Cool Water Fish Habitat	Potential Bat, Amphibian Breeding and Turtle Habitat	LSRCA Permit / DFO Self Assessment
	59	Watercourse Improvement No. 12	Historic Town of Barrie	Stage 2AA	Listed and Newly Identified Property	Heritage Impact Assessment	High	Direct Cool Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	60	Culvert Improvement No. 37	Disturbed Area	None	Listed and Newly Identified Property	Heritage Impact Assessment	Medium	Direct Cool Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Request for Review
	61	Culvert Improvement No. 38	Disturbed Area	None	Listed and Newly Identified Property	Heritage Impact Assessment	Medium	Direct Cool Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Srequest for Review
	62	Culvert Improvement No. 39	Disturbed Area	None	Listed and Newly Identified Property	Heritage Impact Assessment	Medium	Direct Cool Water Fish Habitat	Potential Bat Habitat and Amphibian Breeding Habitat	LSRCA Permit / DFO Request for Review
	63	Watercourse Improvement No. 28	Historic Town of Barrie	None	Listed and Newly Identified Property	Heritage Impact Assessment	High	Direct Cool Water Fish Habitat / Unevaluated Wetland	SAR Assessment	LSRCA Permit / DFO Request for Review
Hotchkiss Creek Watershed (Refer to Figure 20)	12	Culvert Improvement No. 41	Disturbed Area	None	None	None	Low	Indirect Cool/Cold Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	13	Culvert Improvement No. 42	Disturbed Area	None	None	None	Low	Indirect Cool/Cold Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	16	Culvert Improvement No. 44	MTO Project							
	17	SWMF Retrofit No. 44	Elevated Potential	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA
	19	SWMF Retrofit No. 81	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA
	20	SWMF Retrofit No. 96	Historic Town of Barrie	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA
	21	Culvert Improvement No. 135	Elevated Potential	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA
	22	Culvert Improvement No. 48	Disturbed Area	None	None	None	High	Direct Cool/Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / Request for Review
	23	Watercourse Improvement No. 6	Historic Town of Barrie	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Hotchkiss Creek Watershed (Refer to Figure 20)	24	Culvert Improvement No. 49	Anne St. S.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,377,484	A	Pre-Approved
	25	Watercourse Improvement No. 13	Hotchkiss Creek between Anne St. S. and Innisfil St. (Reach Ho-9)	Daylight watercourse through 108 and 120 Tiffin St.	3A/3B	Address Not Available 120 Tiffin St.	\$2,325,960	B	New Project
	27	Culvert Improvement No. 50	Innisfil St.	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Hotchkiss Creek MDP).	2A	215 Innisfil St. (portion of) 108 Tiffin St. (portion of)	\$1,814,946	B	Time Lapse
	28	Watercourse Improvement No. 14	Hotchkiss Creek between Innisfil St. and Bradford St. (Reach Ho-9)	Watercourse improvements along Hotchkiss Creek to stabilize existing bank erosion.	3A/3B	Address Not Available (portion of)	\$659,474	B	New Project
	30	Trunk Storm Sewer No. 10	Essa Rd. (Fairview Rd. to Gowan St.)	Construct trunk storm sewer to convey 100 year peak flows.	3A/3B	-	\$1,165,584	A+	Pre-Approved
Whiskey Creek Watershed (Refer to Figure 24)	67	SWMF Retrofit No. 42	Between Beacon Rd. and Montserrand St.	Construct combination underground infiltration system and dry SWMF for water qaulity treatment, erosion control and peak flow attenuation.	2B	Address Not Available (portion of)	\$3,605,747	B	New Project
	68	Culvert Improvement No. 53	Harvie Road	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$916,477	A	Pre-Approved
	70	Culvert Improvement No. 54	Harvie Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$401,685	A	Pre-Approved
	171	Watercourse Improvement No. 15	From Harvie Road to Highway 400 (Reach Wh-3)	Realign Whiskey Creek (Reach Wh-3) from Harvie Road to Highway 400.	3A/3B	-	\$354,167	B	New Project
	172A	Culvert Improvement No. 55	Highway 400	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$5,521,851	A	Pre-Approved
	71	Culvert Improvement No. 56	Fairview Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,794,391	A	Pre-Approved
	72	Culvert Improvement No. 57	Bayview Dr.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	Address not Available (portion of)	\$1,693,030	A	Pre-Approved
	73	Watercourse Improvement No. 16	Downstream of Bayview Dr. (Reach Wh-4a)	Minor watercourse realignment for long-term channel bed stabilization.	3A/3B	Address Not Available (portion of)	\$1,560,499	B	New Project
	74	Watercourse Improvement No. 30	Downstream of Bayview Dr. (Reaches Wh-4a through 4C)	Watercourse improvements to increase conveyance capacity and decrease flooding.	3A/3B	50 Welham Rd. (portion of) 279 Bayview Dr. (portion of) Address Not Available (portion of) Address Not Available (portion of)	\$7,395,846	B	Active
	75	SWMF Retrofit No. 40	43 Chieftain Cres. and 110 Fairview Rd.	Construct combination underground infiltration system and dry SWMF in combination with Emergency Services Campus SWMF.	2B	43 Chieftain Cres.	\$1,117,889	B	New Project
	76	Watercourse Improvement No. 17	Downstream of Bayview Drive (Reach Wh-5)	Watercourse improvements along Whiskey Creek to stabilize existing bed and bank erosion.	3A/3B	-	\$406,294	B	New Project
	77	Watercourse Improvement No. 18	Downstream of Bayview Drive (Reach Wh-6)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	3A/3B	-	\$246,352	B	New Project
	78	Culvert Improvement No. 147	BCRY Railway Crossing	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$702,657	A	Pre-Approved
	80	Culvert Improvement No. 60	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,974,559	B	Active
	81	Watercourse Improvement No. 31	Downstream of Huronia Rd. (Reach Wh-7b through 7c)	Watercourse realignment between Huronia Rd. and SWMF WK01.	3A/3B	205 Huronia Rd. (portion of)	\$875,742	B	Active
	83	SWMF Retrofit No. 25 (WK01)	Little Ave. and Firman Dr.	Construct a wetland permanent pool cell to provide water quality treatment.	2B	-	\$1,117,353	A+	Pre-Approved
	84	Culvert Improvement No. 62	Little Ave.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$4,326,677	A	Pre-Approved
	179	Watercourse Improvement No. 32	Downstream of Little Ave. (Reach Wh-9)	Watercourse improvements downstream of Little Ave. to improve conveyance capacity.	3A/3B	322 Little Ave.	\$3,208,658	B	Active
	85	Culvert Improvement No. 63	Yonge St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$1,904,903	A	Pre-Approved
	86	Culvert Improvement No. 138	Metrolink Railway Crossing (between Yonge St. and Tollendal Mill Rd.)	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$1,109,522	Metrolink Project	

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Hotchkiss Creek Watershed (Refer to Figure 20)	24	Culvert Improvement No. 49	Disturbed Area	None	None	None	High	Direct Cool/Cold Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	25	Watercourse Improvement No. 13	Historic Town of Barrie	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	27	Culvert Improvement No. 50	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cool/Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Self Assessment
	28	Watercourse Improvement No. 14	Historic Town of Barrie	Stage 2AA	None	None	Medium	Direct Cool/Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	30	Trunk Storm Sewer No. 10	Disturbed Area	None	Listed and Newly Identified Property	Heritage Impact Assessment	Low	Indirect Unknown Fish Habitat	SAR Assessment	ECA Amendment
Whiskey Creek Watershed (Refer to Figure 24)	67	SWMF Retrofit No. 42	Historic Town of Barrie	Stage 2AA	None	None	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA
	68	Culvert Improvement No. 53	Disturbed Area	None	None	None	Low	Indirect Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Self Assessment
	70	Culvert Improvement No. 54	Disturbed Area	None	None	None	Low	Indirect Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Self Assessment
	171	Watercourse Improvement No. 15	Elevated Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	172A	Culvert Improvement No. 55	Disturbed Area	None	None	None	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	71	Culvert Improvement No. 56	Disturbed Area	None	None	None	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
	72	Culvert Improvement No. 57	Disturbed Area	None	None	None	Low	Indirect Cold Water Fish Habitat	None	LSRCA Permit / DFO Self Assessment
	73	Watercourse Improvement No. 16	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	74	Watercourse Improvement No. 30	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	75	SWMF Retrofit No. 40	Elevated Potential	Stage 2AA	None	None	Low	None	SAR Assessment	ECA
	76	Watercourse Improvement No. 17	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	77	Watercourse Improvement No. 18	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	78	Culvert Improvement No. 147	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
	80	Culvert Improvement No. 60	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	None	LSRCA Permit / DFO Request for Review
	81	Watercourse Improvement No. 31	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	83	SWMF Retrofit No. 25 (WK01)	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA Amendment
	84	Culvert Improvement No. 62	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	Potential Bat, Turtle and Amphibian Breeding Habitat	LSRCA Permit / DFO Request for Review
	179	Watercourse Improvement No. 32	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	85	Culvert Improvement No. 63	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Request for Review
	86	Culvert Improvement No. 138	Metrolink Project							

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Whiskey Creek Watershed (Refer to Figure 24)	88	Culvert Improvement No. 64	Hurst Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$2,102,238	A	Pre-Approved
	89	Watercourse Improvement No. 19	Between Tollendal Mill Rd. and The Boulevard (Reach Wh-10)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	3A/3B	207 The Boulevard 211 The Boulevard (portion of) 215 The Boulevard (portion of) 217 The Boulevard (portion of) 219 The Boulevard (portion of) 221 The Boulevard (portion of) 223 The Boulevard (portion of) 225 The Boulevard (portion of)	\$2,016,053	B	New Project
	174A	Culvert Improvement No. 65	The Boulevard	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$1,496,483	A	Pre-Approved
	175	Watercourse Improvement No. 20	Between The Boulevard and Brennan Avenue (Reach Wh-10)	Reconstruct/regrade the watercourse between The Boulevard and Brennan Avenue to increase conveyance capacity.	3A/3B	7 Brennan Ave. 199 The Boulevard (portion of)	\$1,709,277	B	Active
	176	Culvert Improvement No. 66	Brennan Ave.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	3A	-	\$2,459,821	A	Pre-Approved
	177	Watercourse Improvement No. 21	Downstream of Brennan Ave. to Kempenfelt Bay (Reach Wh-10)	Reconstruct/regrade the watercourse downstream of Brennan Avenue to increase conveyance capacity.	3A/3B	-	\$2,038,261	B	Active
Lovers Creek Watershed (Refer to Figure 24)	96	SWMF Retrofit No. 87 (LV17)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	2B	-	\$519,831	A+	Pre-Approved
	97	SWMF Retrofit No. 65 (LV07)	Between Bayview Dr. and Saunders Rd.	Retrofit existing SWMF to include a sediment forebay and underground infiltration system for water quality treatment.	2B	-	\$3,958,825	A+	Pre-Approved
	98	Culvert Improvement No. 126	BCRY Railway Crossing (north of Lockhart Rd.)	Culvert upgrades to satisfy 100 Year design flood frequency criteria.	3A	140 Lockhart Rd. (portion of)	\$1,608,745	B	New Project
	99	Culvert Improvement No. 89	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	211 Lockhart Rd. (portion of)	\$3,215,731	A	Pre-Approved
	101	Culvert Improvement No. 91	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$3,666,069	A	Pre-Approved
	102	SWMF Retrofit No. 45 (LV05)	Between Highway 400 and Bayview Drive	SWMF cleanout and channel improvements to repair and stabilize existing bed and bank erosion.	2B	-	\$2,192,882	B	New Project
	105B	Culvert Improvement No. 123	BCRY Railway Crossing (south of Mapleview Dr. E.)	Culvert upgrades to convey Regional (Hurricane Hazel) peak flows to reduce backwater impacts on Culvert Improvements No. 94 and 95 eliminating these deficiencies.	3A	-	\$1,172,712	A	Pre-Approved
	107	Culvert Improvement No. 92	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$985,793	A	Pre-Approved
	109	Culvert Improvement No. 99	Ellis Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	3B	-	\$593,489	A	Pre-Approved
	110	Culvert Improvement No. 98	Welham Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	3B	455 Welham Rd. (portion of)	\$2,345,989	B	New Project
	111	SWMF Retrofit No. 30 (LV02)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$2,077,734	A+	Pre-Approved

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Whiskey Creek Watershed (Refer to Figure 24)	88	Culvert Improvement No. 64	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	Potential Bird Breeding Habitat	LSRCA Permit / DFO Self Assessment
	89	Watercourse Improvement No. 19	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	174A	Culvert Improvement No. 65	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	None	LSRCA Permit / DFO Request for Review
	175	Watercourse Improvement No. 20	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	176	Culvert Improvement No. 66	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	Potential Bat Habitat	LSRCA Permit / DFO Request for Review
	177	Watercourse Improvement No. 21	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
Lovers Creek Watershed (Refer to Figure 24)	96	SWMF Retrofit No. 87 (LV17)	Uncertain Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA Amendment
	97	SWMF Retrofit No. 65 (LV07)	Elevated Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA Amendment
	98	Culvert Improvement No. 126	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	SAR Assessment	LSRCA Permit / DFO Request for Review
	99	Culvert Improvement No. 89	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	Potential Amphibian Breeding Habitat	LSRCA Permit / DFO Self Assessment
	101	Culvert Improvement No. 91	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	Potential Bat, Turtle, Amphibian Breeding and Bird Breeding Habitat	LSRCA Permit / DFO Request for Review
	102	SWMF Retrofit No. 45 (LV05)	Elevated Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	105B	Culvert Improvement No. 123	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
	107	Culvert Improvement No. 92	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	Potential Bat, Turtle, Amphibian Breeding and Bird Breeding Habitat	LSRCA Permit / DFO Self Assessment
	109	Culvert Improvement No. 99	Disturbed Area	None	None	None	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
	110	Culvert Improvement No. 98	Disturbed Area	None	None	None	Medium	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	111	SWMF Retrofit No. 30 (LV02)	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review / ECA Amendment

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Lovers Creek Watershed (Refer to Figure 24)	112	SWMF Retrofit No. 31 (LV03)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$401,489	A+	Pre-Approved
	113	Culvert Improvement No. 97	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$722,056	A	Pre-Approved
	114	Trunk Storm Sewer No. 7	Esther Drive from Dean Ave. to SWMF LV19	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	3A/3B	-	\$12,441,728	A+	Pre-Approved
	120	Watercourse Improvement No. 22	Between Yonge St. and Hurst Dr. (Reach Lo-19)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and Watercourse meander.	3A/3B	-	\$1,297,799	B	New Project
	121	Watercourse Improvement No. 23	Upstream of Tollendal Mill Rd. (Reach Lo-20)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and Watercourse meander.	3A/3B	-	\$1,597,880	B	New Project
	122	Culvert Improvement No. 105	Tollendal Mill Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	3B	-	\$1,041,132	A	Pre-Approved
Hewitts Creek Watershed (Refer to Figure 26)	125	Culvert Improvement No. 83	Mapleview Dr. E.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	793 Mapleview Dr. E. (portion of)	\$2,047,524	A	Pre-Approved
	130	Trunk Storm Sewer No. 6	Princess Margaret Gate and Camelot Sq. from Loyalist Crt. to SWMF HW06	Construct a trunk storm sewer to eliminate overland flow deficiency.	3A/3B	-	\$2,056,274	A+	Pre-Approved
Georgian Creek Watershed (Refer to Figure 22)	135	Trunk Storm Sewer No. 3	SWMF GR04 to SWMF GR01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF GR04 to GR01.	3A/3B	-	\$11,671,180	A+	Pre-Approved
	137	Trunk Storm Sewer No. 4	Dunsmore Park to Penetanguishene Rd.	Construct a trunk storm sewer to convey the 100 year peak flow from Dunsmore Park to Penetanguishene Rd..	3A/3B	-	\$13,723,594	A+	Pre-Approved
	139	Culvert Improvement No. 82	Penetanguishene Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$623,484	A	Pre-Approved
Little Lake Watershed (Refer to Figure 22)	141	Trunk Storm Sewer No. 5	SWMF LT02 to SWMF LT01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF LT02 to LT01 to eliminate overland flow route deficiencies.	3A/3B	-	\$6,118,979	A+	Pre-Approved
	142	SWMF Retrofit No. 77 (LT01)	Between Cardinal St. and St. Vincent St.	SWMF expansion for water quality treatment (wet pond), erosion control and peak flow attenuation.	2A	496 St. Vincent St. 500 St. Vincent St.	\$4,009,233	B	New Project
	143	Watercourse Improvement No. 24	Downstream of Livingstone St. E. (Reach Li-1)	Watercourse improvements along Little Lake Creek to stabilize existing bank erosion.	3A/3B	-	\$151,980	B	New Project
	145	SWMF Retrofit No. 84 (LTGM)	509 Bayfield St.	Expand existing SWMF to increase the permanent pool and active storage volume for water quality treatment and peak flow attenuation.	2B	509 Bayfield St. (portion of)	\$6,767,642	B	New Project
Bear Creek Watershed (Refer to Figure 25)	150	SWMF Retrofit No. 61 (BR08b)	Between Red Oak Dr. and County Rd. 27	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment.	2B	-	\$815,679	A+	Pre-Approved
	154	Culvert Improvement No. 78	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$362,726	A	Pre-Approved
	155	Watercourse Improvement No. 33	Downstream of Ardagh Rd. (Reach Be-14)	Watercourse improvements along Bear Creek to stabilize existing bed erosion.	3A/3B	-	\$292,719	B	New Project
Johnson Drainage Area (Refer to Figure 22)	159	Trunk Storm Sewer No. 8	Johnson St. from Steel St. to Kempenfelt Bay	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	3A/3B	-	\$4,523,034	A+	Pre-Approved
Nelson Drainage Area (Refer to Figure 22)	180	Trunk Storm SewerNo. 12	Blake St. from Johnson St. to Puget St.	Construct trunk storm sewer to service Blake St. and eliminate overland flow deficiencies.	3A/3B	-	\$308,259	A+	Pre-Approved

Table 61: Final Preferred Solutions Summary

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Anticipated Approval Requirements
Lovers Creek Watershed (Refer to Figure 24)	112	SWMF Retrofit No. 31 (LV03)	Elevated Potential	Stage 2AA	None	None	Low	Indirect Cold Water Fish Habitat	SAR Assessment	ECA Amendment
	113	Culvert Improvement No. 97	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	Potential Amphibian Breeding Habitat	LSRCA Permit / DFO Self Assessment
	114	Trunk Storm Sewer No. 7	Disturbed Area	None	None	None	Low	Indirect Unknown Fish Habitat	SAR Assessment	ECA Amendment
	120	Watercourse Improvement No. 22	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	121	Watercourse Improvement No. 23	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	122	Culvert Improvement No. 105	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Self Assessment
Hewitts Creek Watershed (Refer to Figure 26)	125	Culvert Improvement No. 83	Elevated Potential	Stage 2AA	None	None	High	Direct Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / DFO Request for Review
	130	Trunk Storm Sewer No. 6	Disturbed Area	None	None	None	High	Unknown Fish Habitat	SAR Assessment	ECA Amendment
Georgian Creek Watershed (Refer to Figure 22)	135	Trunk Storm Sewer No. 3	Disturbed Area	None	None	None	Low	None	SAR Assessment	NVCA Permit / ECA Amendment
	137	Trunk Storm Sewer No. 4	Disturbed Area	None	None	None	Medium	None	SAR Assessment	NVCA Permit / ECA Amendment
	139	Culvert Improvement No. 82	Disturbed Area	None	None	None	Low	Indirect Unknown Fish Habitat	None	NVCA Permit / DFO Self Assessment
Little Lake Watershed (Refer to Figure 22)	141	Trunk Storm Sewer No. 5	Disturbed Area	None	None	None	Low	Indirect Unknown Fish Habitat	SAR Assessment	ECA Amendment
	142	SWMF Retrofit No. 77 (LT01)	Elevated Potential	Stage 2AA	None	None	Low	Indirect Unknown Fish Habitat	SAR Assessment	NVCA Permit / ECA Amendment
	143	Watercourse Improvement No. 24	Elevated Potential	Stage 2AA	None	None	High	Indirect Unknown Fish Habitat	SAR Assessment	NVCA Permit / DFO Request for Review
	145	SWMF Retrofit No. 84 (LTGM)	Uncertain Potential	Stage 2AA	None	None	Low	Indirect Unknown Fish Habitat	SAR Assessment	NVCA Permit / ECA Amendment
Bear Creek Watershed (Refer to Figure 25)	150	SWMF Retrofit No. 61 (BR08b)	Elevated Potential	Stage 2AA	None	None	High	Direct Unknown Fish Habitat	SAR Assessment	NVCA Permit / ECA Amendment
	154	Culvert Improvement No. 78	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	NVCA Permit / DFO Self Assessment
	155	Watercourse Improvement No. 33	Elevated Potential	Stage 2AA	Newly Identified Property	Heritage Impact Assessment	High	Direct Cold Water Fish Habitat	SAR Assessment	NVCA Permit / DFO Request for Review
Johnson Drainage Area (Refer to Figure 22)	159	Trunk Storm Sewer No. 8	Disturbed Area	None	None	None	Low	None	SAR Assessment	ECA Amendment
Nelson Drainage Area (Refer to Figure 22)	180	Trunk Storm SewerNo. 12	Disturbed Area	None	Newly Identified Property	Heritage Impact Assessment	N/A	N/A	SAR Assessment	ECA

15.3 PROJECT COSTS

The costs of the general recommendations and individual projects recommended as part of the preferred solution developed through this Drainage Master Plan are summarized in the following table:

Table 62: Project Costs Summary - Preferred Solution

COST ITEM	COST
General Recommendations	
a) Minor Drainage System Improvements	\$48,421,000
b) New Storm Sewer (where absent/required)	\$9,827,000
c) Linear Low Impact Development	\$20,017,000
Subtotal – General Recommendations	\$78,265,000
Individual Projects	
d) Kidd's Creek Watershed	\$28,480,000
e) Bunkers Creek Watershed	\$35,239,000
f) Dyments Creek Watershed	\$65,621,000
g) Hotchkiss Creek Watershed	\$37,910,000
h) Whiskey Creek Watershed	\$53,057,000
i) Lovers Creek Watershed	\$39,840,000
j) Hewitts Creek Watershed	\$4,104,000
k) Georgian Creek Watershed	\$26,019,000
l) Little Lake Watershed	\$17,048,000
m) Bear Creek Watershed	\$1,472,000
n) Johnson Drainage Area	\$4,524,000
o) Nelson Drainage Area	\$309,000
Subtotal – Individual Projects	\$313,623,000
Total	\$391,888,000



15.4 PROPERTY ACQUISITION

To implement the preferred solution, a number of properties or portions thereof have been identified for acquisition by the City. The properties recommended for acquisition under the preferred solution are summarized in the following table

Table 63: Property Acquisition Summary – Preferred Solution

PROJECT	ADDRESS	PROJECT	ADDRESS
125	793 Mapleview Dr. E. ¹	8A	22 Thomson St. ¹ 27 Thomson St.
163	14 Thomson St. ¹ 18 Thomson St. ¹ 22 Thomson St. ¹ 75 Eccles St. N. ¹ 77 Eccles St. N. ¹	10	Address Not Available ¹ 11 Donald St. ¹ 19 Donald St. ¹ 17 Eccles St. N. 38 Eccles St. N. ¹ 10 Henry St. ¹
165	150 Dunlop St. W. ¹	166	150 Dunlop St. W. ¹
41	130 Vespra St. ¹	43	80 Bradford St. ¹
44	80 Bradford St. ¹	45	100 Bradford St. ¹
46	93 Bradford St. 20 Checkley St. ¹	181	Address Not Available
183	Address Not Available Address Not Available 461 Dunlop St. W. ¹ 100 Ferndale Dr. N. ¹	51	425 Dunlop St. W. ¹ 433 Dunlop St. W. ¹ 441 Dunlop St. W. ¹ 97 Ferndale Dr. N. ¹ 105 Ferndale Dr. N. ¹ 20 Elliott Ave. ¹ 30 Elliott Ave. ¹ 8 Sarjeant Dr. ¹
56	55 Hart Dr.	58	71 Anne St. S. ¹
61	95 Sanford St. ¹ 100 Sanford St. ¹	62	176 Bradford St.
17	85 Morrow Rd. ¹	19	50 Wood St. ¹
20	50 Wood St. ¹	21	155 Tiffin St. ¹ 47 Alfred St.
23	128 Anne St. S. ¹ 115 Brock St. ¹ 134 Tiffin St.	25	Address Not Available 120 Tiffin St.



PROJECT	ADDRESS	PROJECT	ADDRESS
27	215 Innisfil St. ¹ 108 Tiffin St. ¹	28	Address Not Available ¹
67	Address Not Available ¹	72	Address Not Available ¹
75	43 Chieftain Cres.	81	205 Huronia Rd. ¹
73	Address Not Available ¹	74	Address Not Available ¹ Address Not Available ¹ 50 Welham Rd. ¹ 279 Bayview Dr. ¹
175	7 Brennan Ave. 199 The Boulevard ¹	98	140 Lockhart Rd. ¹
99	211 Lockhart Rd. ¹	110	455 Welham Rd. ¹
179	322 Little Ave.	89	207 The Boulevard ¹ 211 The Boulevard ¹ 215 The Boulevard ¹ 217 The Boulevard ¹ 219 The Boulevard ¹ 221 The Boulevard ¹ 223 The Boulevard ¹ 225 The Boulevard ¹
142	496 St. Vincent St. 500 St. Vincent St.	145	509 Bayfield St. ¹

¹ only a portion of the property is required

As per *By-Law 90-92*, the City may acquire land where it is considered to be in the City's interest to do so. Purchasing the identified properties will allow for the implementation of the preferred solution resulting in reduced private property flooding, reduced maintenance requirements and improved maintenance access throughout the watershed.



16 Conditional Projects

Through the individual project evaluation, it was demonstrated that the impacts of a number of projects outweigh the benefits. However, if a phosphorus offset is required in the project watershed or drainage area, it is recommended that the projects be re-evaluated in consultation with the appropriate Conservation Authority.

As the City implements capital works projects such as road renewal/reconstruction projects, there may be a need to implement a conditional project to provide a phosphorus offset for the net increase in phosphorus generated by the works. It is recommended that the City first try and treat the runoff on-site using linear low impact development measures or through one the SWMF retrofit projects included in the preferred solution. However, if these options are not suitable or will not address the net gain in phosphorus, the City should review the list of conditional projects for an appropriate option. The list of conditional projects is provided in the following table.



Table 64: Conditional Projects

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Kidd's Creek Watershed (Refer to Figure 18)	7	SWMF Creation No. 17	Between Coulter St. and Highway 400	Construct wet pond SWMF for water quality treatment and erosion control.	2B	-	\$2,935,405	B	New Project
Bunkers Creek Watershed (Refer to Figure 18)	33	Gibbon Park Centralized LID	Gibbon Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2B	-	\$459,683	B	New Project
Dyments Creek Watershed	48	Cloughley Park Centralized LID	Cloughley Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$622,518	B	New Project
Hotchkis Creek Watershed (Refer to Figure 20)	29	Allandale Heights Park Centralized LID	Allandale Heights Park	Construct underground infiltration system for water quality treatment and groundwater recharge.	2E	-	\$368,719	B	New Project
Huronía Creek Drainage Area (Refer to Figure 21)	164	Greenfield Park Centralized LID	Greenfield Park	Construct underground infiltration system for water quality treatment and groundwater recharge.	2E	-	\$2,245,443	B	New Project
Whiskey Creek Watershed (Refer to Figure 19)	64	Mapleton Park Centralized LID	Mapleton Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$401,077	B	New Project
	66	Montserrand Park Centralized LID	Montserrand Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$1,654,650	B	New Project
	69	SWMF Retrofit No. 92 (WK05)	Between Beacon Rd. and Harvie Rd.	Consturct underground infiltration system for water quality control.	2B	-	\$2,753,338	A+	Pre-Approved
	79	Assikinack Park Centralized LID	Assikinack Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$1,057,338	B	New Project
Lovers Creek Watershed (Refer to Figure 19)	95	SWMF Retrofit No. 86 (LV16)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	2B	-	\$315,574	A+	Pre-Approved
	115	Madelaine Park Centralized LID	Madelaine Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$1,009,135	B	New Project
	129	Kuzmich Park Centralized LID	Kuzmich Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$361,260	B	New Project
	116	Golden Meadow Park Centralized LID	Golden Meadow Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$3,702,304	B	New Project
	117	Carter Park Centralized LID	Carter Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$712,985	B	New Project
	118	SWMF Retrofit No. 37 (LV10)	North of Mary Anne Dr.	Retrofit the existing SWMF to include an underground infiltration system for water quality treatment.	2B	-	\$1,124,959	A+	Pre-Approved
Hewitts Creek Watershed (Refer to Figure 21)	126	Queensway/Hyde Park Centralized LID	Queensway/Hyde Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$3,816,305	B	New Project
Georgian Creek Watershed (Refer to Figure 17)	133	Strabane Park Centralized LID	Strabane Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$676,354	B	New Project
	134	SWMF Retrofit No. 76 (GR04)	Douglas Dr. and Johnson St.	Retrofit existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$1,251,507	A+	Pre-Approved
	138	SWMF Retrofit No. 75 (GR01)	Between Hickling Tr. And Penetanguishene Rd.	Retrofit existing SWMF to include a permanent pool wet pond cell for water quality treatment.	2B	-	\$620,962	A+	Pre-Approved
Little Lake Watershed (Refer to Figure 17)	140	Cartwright Park Centralized LID	Cartwright Park	Construct underground infiltration system for water quality treatment and phosporus removal.	2E	-	\$367,185	B	New Project

Table 64: Conditional Projects

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Approval Requirements
Kidd's Creek Watershed (Refer to Figure 18)	7	SWMF Creation No. 17	Elevated Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA / DFO Request for Review
Bunkers Creek Watershed (Refer to Figure 18)	33	Gibbon Park Centralized LID	Historic Town of Barrie	Stage 2AA	None	None	Low	None	None	ECA
Dyments Creek Watershed	48	Cloughley Park Centralized LID	Uncertain Potential	Stage 2AA	None	None	Low	None	None	ECA
Hotchkis Creek Watershed (Refer to Figure 20)	29	Allandale Heights Park Centralized LID	Uncertain Potential	Stage 2AA	None	None	Low	None	None	ECA
Huronian Creek Drainage Area (Refer to Figure 21)	164	Greenfield Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	SAR Assessment	ECA
Whiskey Creek Watershed (Refer to Figure 19)	64	Mapleton Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
	66	Montserrand Park Centralized LID	Historic Town of Barrie	Stage 2AA	None	None	Low	None	None	ECA
	69	SWMF Retrofit No. 92 (WK05)	Historic Town of Barrie	Stage 2AA	None	None	High	Indirect Unknown Fish Habitat	SAR Assessment	LSRCA Permit / ECA Amendment
	79	Assikinack Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
Lovers Creek Watershed (Refer to Figure 19)	95	SWMF Retrofit No. 86 (LV16)	Uncertain Potential	Stage 2AA	None	None	High	Indirect Cold Water Fish Habitat	SAR Assessment	LSRCA Permit / ECA Amendment
	115	Madelaine Park Centralized LID	Uncertain Potential	Stage 2AA	None	None	Low	None	None	ECA
	129	Kuzmich Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
	116	Golden Meadow Park Centralized LID	Elevated Potential	Stage 2AA	None	None	N/A	N/A	SAR Assessment	ECA
	117	Carter Park Centralized LID	Elevated Potential	Stage 2AA	None	None	N/A	N/A	SAR Assessment	ECA
	118	SWMF Retrofit No. 37 (LV10)	Elevated Potential	Stage 2AA	None	None	Low	Indirect Unknown Fish Habitat	SAR Assessment	ECA Amendment
Hewitts Creek Watershed (Refer to Figure 21)	126	Queensway/Hyde Park Centralized LID	Uncertain Potential	Stage 2AA	None	None	Low	None	None	ECA
Georgian Creek Watershed (Refer to Figure 17)	133	Strabane Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
	134	SWMF Retrofit No. 76 (GR04)	Elevated Potential	Stage 2AA	None	None	Low	None	SAR Assessment	ECA Amendment
	138	SWMF Retrofit No. 75 (GR01)	Elevated Potential	Stage 2AA	None	None	Low	Unknown Fish Habitat	SAR Assessment	NVCA Permit / ECA Amendment
Little Lake Watershed (Refer to Figure 17)	140	Cartwright Park Centralized LID	Uncertain Potential	Stage 2AA	None	None	Low	None	None	ECA

Table 64: Conditional Projects

Watershed	Project No.	Opportunity (ID)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
Bear Creek Watershed (Refer to Figure 20)	147	Lougheed Park Centralized LID	Lougheed Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$2,430,981	B	New Project
	148	Wessenger Park Centralized LID	Wessenger Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$1,405,979	B	New Project
	149	Bear Creek Park Centralized LID	Bear Creek Park	Construct underground infiltration system for water quality treatment and phosphorus removal.	2E	-	\$10,728,475	B	New Project
	153	SWMF Retrofit No. 62 (BR05)	Between Red Oak Dr. and County Rd. 28	Expand existing SWMF to increase the permanent pool volume provided for water quality treatment.	2B	-	\$416,167	A+	Pre-Approved
	156	Culvert Improvement No. 134	BCRY Railway Crossing	Culvert upgrades to satisfy 50 Year design flood frequency criteria.	3A	-	\$158,021	A	Pre-Approved
	157	Culvert Improvement No. 80	County Rd. 27	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	3B	-	\$93,625	A	Pre-Approved
Johnson Drainage Area (Refer to Figure 17)	160	Shoreview Park Centralized LID	Shoreview Park	Construct underground infiltration system for water quality treatment and groundwater recharge.	2E	-	\$1,718,730	B	New Project

Table 64: Conditional Projects

Watershed	Project No.	Opportunity (ID)	Archeological Land Classification	Archeological Requirements	Cultural Heritage Constraints	Cultural Heritage Requirements	Natural Heritage Sensitivity	Natural Heritage Constraints	Natural Heritage Requirements	Approval Requirements
Bear Creek Watershed (Refer to Figure 20)	147	Lougheed Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	NVCA Permit / ECA Amendment
	148	Wessenger Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
	149	Bear Creek Park Centralized LID	Elevated Potential	Stage 2AA	None	None	Low	None	None	ECA
	153	SWMF Retrofit No. 62 (BR05)	Elevated Potential	Stage 2AA	None	None	High	Direct Unknown Fish Habitat / Non-PSW	SAR Assessment	NVCA Permit / ECA Amendment
	156	Culvert Improvement No. 134	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	SAR Assessment	NVCA Permit / DFO Self Assessment
	157	Culvert Improvement No. 80	Disturbed Area	None	None	None	High	Direct Cold Water Fish Habitat / PSW	SAR Assessment	NVCA Permit / DFO Self Assessment
Johnson Drainage Area (Refer to Figure 17)	160	Shoreview Park Centralized LID	Historic Town of Barrie	Stage 2AA	None	None	Low	None	None	ECA

17 Project Prioritization

The individual projects included as part of the preferred solution have been prioritized in order of importance through a risk assessment consistent with the methodology outlined in the City of Barrie Corporate Asset Management Plan (November 2011). Specifically, a probability of failure has been assigned to each project based on the frequency of occurrence. The economic, social and environmental consequence of failure has been evaluated for each project. The risk assessment matrix was applied to establish the risk associated with each project based on the probability and consequence of failure.

The projects were prioritized for each watershed and drainage area to assist the City in the development of their capital plans. Other factors were considered when prioritizing the projects such as current capital plans, the MTO proposed Highway 400 improvements, neighbourhood renewal programs, and condition assessments. The priority of each project within its watershed is provided in the following table.



Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Kidd's Creek Watershed (Refer to Figure 23)	1	SWMF Retrofit No. 11 (KD06)	Livingstone St. W. and Ford St.	Construct underground infiltration system for water quality treatment, erosion control and active storage offset (SWMF KD02).	8	40	7	48	8	Enhancement	2020 - 2024	N/A	1
	2	SWMF Retrofit No. 18 (KD05)	Livingstone St. W. and Neelands St.	Construct underground infiltration system for water quality treatment and phosphorus removal. Grade major overland flow route to prevent private property flooding.	3	37	9	40	14	Inspection / Maintenance		N/A	14
	3	SWMF Retrofit No. 13 (KD03)	Between Irwin Dr. and Sunnisdale Rd.	Construct underground infiltration system for water quality treatment, phosphorus removal and active storage offset (SWMF KD02).	11	40	7	51	8	Not Identified	2020 - 2024	N/A	2
	4	Watercourse Improvement No. 1	Between Lilian Cres. and Cundles Rd. W. (Reach Ki-1 through Ki-2)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	10	34	11	44	11	Not Identified		N/A	11
	5	Culvert Improvement No. 13	Cundles Rd. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	13	35	10	48	8	Not Identified		N/A	10
	161	Watercourse Improvement No. 34	Kidd's Creek between Cundles Rd. and Highway 400 (Reach Ki-3 through Ki-6)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	14	34	11	48	7	Not Identified		N/A	9
	8A	Culvert Improvement No. 16	Thomson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP).	-6	21	15	15	15	Not Identified	2023 - 2025	162A - 8A	15
	162A	Trunk Storm Sewer No. 9 (Option 1)	Thomson St., Sophia St. W. and Florence St.	Construct trunk storm sewer to reduce flows through Kidd's Creek from Thomson St. to Eccles St. N.	14	45	6	59	6	N/A	2023 - 2025		8
	163	Watercourse Improvement No. 2	Between Thomson St. and Eccles St. (Reach Ki-8a)	Watercourse improvements along Kidd's Creek to stabilize existing bank failures/erosion.	8	34	11	42	12	Not Identified	Not Identified	N/A	13
	9	Culvert Improvement No. 18	Wellington St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	24	65	1	89	1	Maintenance Only		N/A	7
	10	Watercourse Improvement No. 3	Between Eccles St. and Henry St. (Reaches Ki-10b through Ki-10c)	Watercourse improvements on Kidd's Creek to stabilize existing bank failures/erosion.	8	34	11	42	12	Not Identified		N/A	12
	165	Watercourse Improvement No. 25	Between Eccles St. and Dunlop St. W. (Reach Ki-11)	Daylight watercourse through 150 Dunlop St. W.	16	53	4	69	3	Not Identified	2019 - 2020	11A - 167 - 166 - 165	6
	166	Culvert Improvement No. 145	Dunlop St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	5	59	2	64	5	Not Identified	2019 - 2020		5
	167	Watercourse Improvement No. 26	Between Dunlop St. W. and Bradford St. (Reach Ki-11)	Daylight watercourse through 125 Dunlop St. W.	31	53	4	84	2	Not Identified	2019 - 2020		4
	11A	Trunk Storm Sewer No. 11	Bradford St.	Trunk storm sewer extension to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	10	59	2	69	3	Not Identified	2019 - 2020		3

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Bunkers Creek Watershed (Refer to Figure 23)	31	SWMF Retrofit No. 10 (BK03)	Northwest of Shelley Ln. and Anne St. N. Intersection	Construct underground infiltration system for water quality treatment and phosphorus removal. SWMF outlet modifications for peak flow attenuation.	18	40	9	58	7	Not Identified		35 - 32 - 31	7
	32	Trunk Storm Sewer No. 1	Anne St. N. from BK03 to Edgehill Dr.	Construct trunk storm sewer on Anne St. N. to divert flows reducing downstream flooding and erosion on Bunkers Creek (Reach Bu-3).	28	52	5	80	1	Not Identified			6
	34	Watercourse Improvement No. 4	Bunkers Creek downstream of Shirley Ave. (Reach Bu-3)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-3).	8	34	10	42	11	Not Identified		N/a	11
	35	Watercourse Improvement No. 5	Bunkers Creek downstream of Edgehill Rd. (Reach Bu-7)	Scour treatment and bank stabilization to remediate existing scour and bank failure/erosion on Bunkers Creek (Reach Bu-7).	13	34	10	47	10	Not Identified		35 - 32 - 31	10
	36	Culvert Improvement No. 143	Highway 400 - Bunkers Creek (North Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO Project (2020 - 2022)							
	37	Culvert Improvement No. 142	Highway 400 - Bunkers Creek (Central Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO Project (2020 - 2022)							
	38	Culvert Improvement No. 141	Highway 400 - Bunkers Creek (South Branch)	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	7	MTO Project (2020 - 2022)							
	39	SWMF Retrofit No. 94	New SWMF within future Highway 400 E/W-N ramp	Construct SWMF to provide peak flow attenuation to maintain peak flows through south and central branches of Bunkers Creek.	38	MTO Project (2020 - 2022)							
	40B	Trunk Storm Sewer No. 2	Dunlop St. W. and Anne St. S. from Highway 400 E/W-N-ramp to Perry St.	Construct trunk storm sewer to convey flows from Dunlop St. W. on Anne St. to Bunkers Creek (Reach Bu-11).	15	53	4	68	5	Not Identified		N/A	5
	41	Watercourse Improvement No. 8	Bunkers Creek between Anne St. S. and Innisfil St. (Reaches Bu-11 and Bu-15)	Toe treatment to mitigate bank scour and undercutting on Bunkers Creek (Reach Bu-11 and Bu-15).	3	49	7	52	8	Not Identified		N/A	8
	42	SWMF Retrofit No. 95 (Milligan's Pond)	Milligan's Pond between Boyz St. and Innisfil St.	Cleanout accumulated sediment from Milligans Pond and reinstate watercourse.	6	42	8	48	9	Not Identified		N/A	9
	43	Culvert Improvement No. 22	Innisfil St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Bunkers Creek MDP).	11	68	1	79	2	Not Identified		46 - 45 - 44 - 43	4
	44	Culvert Improvement No. 23	Commercial Plaza Entrance Road	Remove existing culvert and daylight watercourse. Install pedestrian bridge for access to paking lot.	17	52	5	69	4	Not Identified			3
	45	Culvert Improvement No. 24	Bradford St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	6	68	1	74	3	Maintenance Only			2
	46	Watercourse Improvement No. 27	Bunkers Creek (Reach Bu-16) downstream of Bradford St. to Lakeshore Dr.	Natural watercourse enhancement on Bunkers Creek (Reach Bu-16) to increase conveyance capacity, habitat and canopy.	5	56	3	61	6	Not Identified			1

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Dyments Creek Watershed (Refer to Figure 23)	49	Watercourse Improvement No. 29	Downstream of Sproule Dr. to SWMF Retrofit No. 78	Realign Dyments Creek from Sproule Dr. to SWMF Retrofit No. 78.	-2	12	17	10	17	Not Identified		183 - 182 - 181 - 49	4
	181	SWMF Retrofit No. 78	Between Sproule Dr. and Dunlop St. W.	Construct SWMF above low flow channel for peak flow attenuation during major storms.	15	53	6	68	7	N/A			3
	182	Culvert Improvement No. 28	Dunlop St. W.	Relocate and upgrade culvert to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	20	59	3	79	1	Not Identified			2
	183	Watercourse Improvement No. 9	Dunlop St. W. to Ferndale Dr. N	Realign Dyments Creek from Dunlop St. W. to Ferndale Dr. N. to facilitate SWMF retrofit (No. 78) and increase conveyance capacity.	-17	12	17	-5	18	N/A			1
	50	Culvert Improvement No. 29	Ferndale Dr. N.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	16	56	5	72	6	Not Identified		N/A	13
	51	Watercourse Improvement No. 10	Ferndale Dr. N. to Sarjeant Dr. (Reach Dy-2b)	Regrade/reshape Dyments Creek from Ferndale Dr. N. to Sarjeant Dr. to provide positive drainage and increased conveyance capacity.	2	53	6	55	12	Not Identified		N/A	16
	52	Culvert Improvement No. 30	Sarjeant Dr. and Dunlop St. W.	Realign and upgrade culvert to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	5	29	16	34	16	Not Identified		N/A	18
	53	Culvert Improvement No. 31	Highway 400 E/W-S and N-E/W Ramps	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	15	MTO Project (2020 - 2022)							
	54	Culvert Improvement No. 33	Highway 400	Culvert upsizing consistent with proposed MTO Highway 400 Improvements.	5	MTO Project (2020 - 2022)							
	55	Culvert Improvement No. 32	Hart Dr.	Extend Highway 400 Culvert under Hart Dr.	15	60	2	75	5	Not Identified		56 - 55- 54	12
	56	Watercourse Improvement No. 11	Downstream of Hart Dr. (Reach Dy-3)	Daylight watercourse (through 55 Hart Dr.)	26	50	8	76	3	N/A			11
	57	Culvert Improvement No. 34	George St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	11	48	9	59	9	Not Identified		N/A	15
	169	Culvert Improvement No. 35	Victoria St.	Culvert removal	28	48	9	76	3	Not Identified		169B - 170B	9
	170B	SWMF Retrofit No. 79 (DY01)	Between George St. and Anne St. S.	Peak flow attenuation and quality SWMF expansion	14	44	13	58	11	Not Identified			10
	58	Culvert Improvement No. 36	Anne St. S. and John St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	-3	44	13	41	15	Not Identified	2024 - 2025	N/A	17
	59	Watercourse Improvement No. 12	Between Anne St. S. and Innisfil St. (Reach Dy-5)	Toe treatment to mitigate bank scouring and undercutting.	23	45	11	68	7	Not Identified		N/A	14
	60	Culvert Improvement No. 37	Innisfil St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	12	65	1	77	2	Not Identified		N/A	8
	61	Culvert Improvement No. 38	Sanford St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	2	57	4	59	9	Not Identified	2021	N/A	7
	62	Culvert Improvement No. 39	Bradford St.	Culvert upgrades to satisfy Regulatory flood frequency criteria (as per the recommendations of the Dyments Creek MDP).	8	45	11	53	13	Priority	2019 - 2020	63 - 62	6
	63	Watercourse Improvement No. 28	Downstream of Bradford St. to Lakeshore Dr. (Reach Dy-6)	Watercourse improvements to increase conveyance capacity and decrease flooding.	11	42	15	53	13	Priority	2019 - 2020		5

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Hotchkiss Creek (Refer to Figure 25)	12	Culvert Improvement No. 41	Mayfair Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	7	42	9	49	11	Not Identified		N/A	11
	13	Culvert Improvement No. 42	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	7	51	3	58	9	Not Identified		N/A	10
	16	Culvert Improvement No. 44	Essa Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	11	MTO Project							
	17	SWMF Retrofit No. 44	85 Morrow Rd.	Construct wetland SWMF for water quality treatment and phosphorus removal.	8	33	12	41	12	N/A		N/A	12
	19	SWMF Retrofit No. 81	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	28	36	10	64	6	N/A		N/A	8
	20	SWMF Retrofit No. 96	50 Wood St.	Construct peak flow attenuation SWMF for erosion control and peak flow attenuation.	17	36	10	53	10	N/A		21 - 20	7
	21	Culvert Improvement No. 135	BCRY Railway Crossing (between Wood St. and Tiffin St.)	Construct proposed SWMF Retrofit No. 96 outlet controls.	13	57	1	70	2	Not Identified			6
	22	Culvert Improvement No. 48	Tiffin St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	16	51	3	67	5	Not Identified		N/A	5
	23	Watercourse Improvement No. 6	Reach Ho-8 between Tiffin St. and Anne St. S	Daylight watercourse through 115 Brock St., 128 Anne St. S. and 134 Tiffin St.	13	51	3	64	6	Not Identified		25 - 24 - 23	4
	24	Culvert Improvement No. 49	Anne St. S.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	17	51	3	68	4	Not Identified			3
	25	Watercourse Improvement No. 13	Reach Ho-9 between Anne St. S. and Innisfil St.	Daylight watercourse through 108 and 120 Tiffin St.	20	51	3	71	1	Not Identified			2
	27	Culvert Improvement No. 50	Innisfil St.	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Hotchkiss Creek MDP).	3	57	1	60	8	Priority		N/A	1
	28	Watercourse Improvement No. 14	Reach Ho-9 between Innisfil St. and Bradford St.	Watercourse improvements along Hotchkiss Creek to stabilize existing bank erosion.	13	26	13	39	13	Not Identified		N/A	13
	30	Trunk Storm Sewer No. 10	Essa Rd. (between Fariview Rd. and Grove St.)	Construct trunk storm sewer to convey 100 year peak flows.	24	45	8	69	3	N/A		N/A	9

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Whiskey Creek Watershed (Refer to Figure 24)	67	SWMF Retrofit No. 42	Between Beacon Rd. and Montserrand St.	Construct combination underground infiltration system and dry SWMF for water quality treatment, erosion control and peak flow attenuation.	20	44	8	64	5	Not Identified		N/A	12
	68	Culvert Improvement No. 53	Harvie Road	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	26	43	11	69	3	Not Identified	2019 - 2020	N/A	10
	70	Culvert Improvement 54	Harvie Road	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	29	21	25	50	11	Not Identified	2019 - 2020	172A - 171 - 70	9
	171	Watercourse Improvement No. 15	From Harvie Road to Highway 400 (Reach Wh-3)	Realign Whiskey Creek (Reach Wh-3) from Harvie Road to Highway 400.	17	24	24	41	19	Not Identified	2019 - 2020		8
	172A	Culvert Improvement No. 55	Highway 400	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	-9	29	19	20	25	Not Identified	2019 - 2020		7
	71	Culvert Improvement No. 56	Fairview Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	13	29	19	42	18	Not Identified	2019 - 2020	N/A	6
	72	Culvert Improvement No. 57	Bayview Dr.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	5	41	12	46	15	Scour Protection	2022 - 2023	N/A	19
	73	Watercourse Improvement No. 16	Downstream of Bayview Dr. (Reach Wh-4a)	Minor watercourse realignment for long-term watercourse bed stabilization.	4	30	16	34	20	Not Identified		N/A	21
	74	Watercourse Improvement No. 30	Downstream of Bayview Dr. (Reaches Wh-4a through 4C)	Watercourse improvements to increase conveyance capacity and decrease flooding.	7	26	21	33	22	Not Identified		N/A	22
	75	SWMF Retrofit No. 40	43 Chieftain Cres. and 110 Fairview Rd.	Construct combination underground infiltration system and dry SWMF in combination with Emergency Services Campus SWMF.	30	41	12	71	2	Not Identified	2018 - 2020	N/A	5
	76	Watercourse Improvement No. 17	Downstream of Bayview Drive (Reach Wh-5)	Watercourse improvements along Whiskey Creek to stabilize existing bed and bank erosion.	14	44	8	58	6	Not Identified		N/A	14
	77	Watercourse Improvement No. 18	Downstream of Bayview Drive (Reach Wh-6)	Watercourse improvements along Whiskey Creek to stabilize existing bank erosion.	14	30	16	44	17	Not Identified		N/A	20
	78	Culvert Improvement No. 147	BCRY Railway Crossing	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	10	48	3	58	6	Not Identified		N/A	13
	80	Culvert Improvement No. 60	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	7	47	6	54	10	Not Identified		81 - 80	17
	81	Watercourse Improvement No. 31	Downstream of Huronia Rd. (Reach Wh-7b through 7c)	Watercourse realignment between Huronia Rd. and SWMF WK01.	6	26	21	32	24	Not Identified			24
	83	SWMF Retrofit No. 25 (WK01)	Little Ave. and Firman Dr.	Construct a wetland permanent pool cell to provide water quality treatment.	5	44	8	49	3	Not Identified		N/A	11
	84	Culvert Improvement No. 62	Little Ave.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	14	41	12	55	8	Inspected		179 - 84	16
	179	Watercourse Improvement No. 32	Downstream of Little Ave. (Reach Wh-9)	Watercourse improvements downstream of Little Ave. to improve conveyance capacity.	-6	26	21	20	25	Not Identified			25
	85	Culvert Improvement No. 63	Yonge St.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	15	35	15	50	11	Not Identified		N/A	18
	86	Culvert Improvement No. 138	Metrolink Railway Crossing	Culvert upgrades to satisfy 100 Year flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	14	Metrolink Project							
	88	Culvert Improvement No. 64	Hurst Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	47	6	55	8	Not Identified		N/A	15
	89	Watercourse Improvement No. 19	Between Tollendal Mill Rd. and The Boulevard (Reach Wh-10)	Watercourse improvements on Whiskey Creek to stabilize existing bank erosion.	2	30	16	32	22	Not Identified		N/A	22
	174A	Culvert Improvement No. 65	The Boulevard	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	16	57	1	73	1	Not Identified		177 - 176 - 175 - 174A	4
	175	Watercourse Improvement No. 20	Between The Boulevard and Brennan Avenue (Reach Wh-10)	Reconstruct/regrade the watercourse between The Boulevard and Brennan Avenue to increase conveyance capacity.	-14	48	3	34	20	Not Identified			3
	176	Culvert Improvement No. 66	Brennan Ave.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Whiskey Creek MDP).	16	51	2	67	4	2023 - 2027			2
	177	Watercourse Improvement No. 21	Downstream of Brennan Ave. to Kempenfelt Bay (Reach Wh-10)	Reconstruct/regrade the watercourse downstream of Brennan Avenue to increase conveyance capacity.	1	48	3	49	13	Not Identified			1

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Lovers Creek Watershed (Refer to Figure 24)	96	SWMF Retrofit No. 87 (LV17)	East of Bryne Dr.	Construct wetland permanent pool cell for water quality treatment.	11	37	11	48	8	Not Identified		N/A	10
	97	SWMF Retrofit No. 65 (LV07)	Between Bayview Dr. and Saunders Rd.	Retrofit existing SWMF to include a sediment forebay and underground infiltration system for water quality treatment.	1	44	5	45	10	Maintenance Only		N/A	12
	98	Culvert Improvement No. 126	BCRY Railway Crossing (north of Lockhart Rd.)	Culvert upgrades to satisfy 100 Year design flood frequency criteria.	4	25	14	29	15	Maintenance Only		N/A	17
	99	Culvert Improvement No. 89	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	9	56	2	65	4	Maintenance Only		N/A	5
	101	Culvert Improvement No. 91	Lockhart Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	1	41	8	42	12	Repairs (2023 - 2027)		N/A	13
	102	SWMF Retrfit No. 45 (LV05)	Between Highway 400 and Bayview Drive	SWMF cleanout and channel improvements to repair and stabilize existing bed and bank erosion.	4	44	5	48	8	Priority		N/A	9
	105B	Culvert Improvement No. 123	BCRY Railway Crossing (south of Mapleview Dr. E.)	Culvert upgrades to convey Regional (Hurricane Hazel) peak flows to reduce backwater impacts on Culvert Improvements No. 94 and 95 eliminating these deficiencies.	26	25	14	51	7	Inspected		N/A	8
	107	Culvert Improvement No. 92	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	20	59	1	79	1	Not Identified		N/A	1
	109	Culvert Improvement No. 99	Ellis Dr.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Local Road - 50 Year design flood frequency).	12	33	13	45	10	Not Identified		N/A	11
	110	Culvert Improvement No. 98	Welham Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	1	39	10	40	14	Maintenance Only		N/A	15
	111	SWMF Retrofit No. 30 (LV02)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	13	44	5	57	5	Priority		N/A	6
	112	SWMF Retrhoit No. 31 (LV03)	East of Welham Rd.	Retrofit the existing SWMF to include a permanent pool wet pond cell for water quality treatment.	19	37	11	56	6	Enhancement		N/A	7
	113	Culvert Improvement No. 97	Huronia Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	22	56	2	78	2	Not Identified		N/A	2
	114	Trunk Storm Sewer No. 7	Esther Drive from Dean Ave. to SWMF LV19	Construct a trunk storm sewer (upsize local sewer) to eliminate overland flow deficiency.	0	41	8	41	13	Not Identified		N/A	14
	120	Watercourse Improvement No. 22	Between Yonge St. and Hurst Dr. (Reach Lo-19)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander.	7	22	16	29	15	Not Identified		N/A	16
	121	Watercourse Improvement No. 23	Upstream of Tollendal Mill Rd. (Reach Lo-20)	Watercourse improvements on Lovers Creek to stabilize existing bed and bank erosion and channel meander.	7	22	16	29	15	Not Identified		122 - 121	4
	122	Culvert Improvement No. 105	Tollendal Mill Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Collector Road - 50 Year design flood frequency).	12	56	2	68	3	2018 - 2022			3
Hewitts Creek Watershed (Refer to Figure 26)	125	Culvert Improvement No. 83	Mapleview Dr. E.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	41	1	49	1	Not Identified		N/A	1
	130	Trunk Storm Sewer No. 6	Princess Margaret Gate and Camelot Sq. from Loyalist Crt. to SWMF HW06	Construct a trunk storm sewer to eliminate overland flow deficiency.	9	26	2	35	2	Not Identified		N/A	2
Georgian Creek Watershed (Refer to Figure 22)	135	Trunk Storm Sewer No. 3	SWMF GR04 to SWMF GR01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF GR04 to GR01.	0	48	2	48	3	Not Identified		N/A	3
	137	Trunk Storm Sewer No. 4	Dunsmore Park to Penetanguishene Rd	Construct a trunk storm sewer to convey the 100 year peak flow from Dunsmore Park to Penetanguishene Rd.	0	59	1	59	2	Not Identified		N/A	2
	139	Culvert Improvement No. 82	Penetanguishene Rd	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	30	40	3	70	1	Maintenance Only		N/A	1
Little Lake Watershed (Refer to Figure 22)	141	Trunk Storm Sewer No. 5	SWMF LT02 to SWMF LT01	Construct a trunk storm sewer to convey the 100 year outflow from SWMF LT02 to LT01 to eliminate overland flow route deficiencies.	7	47	2	54	3	Not Identified		N/A	3
	142	SWMF Retrofit No. 77 (LT01)	Between Cardinal St. and St. Vincent St.	SWMF expansion for water quality treatment (wet pond), erosion control and peak flow attenuation.	26	42	3	68	1	Not Identified		N/A	1
	143	Watercourse Improvement No. 24	Downstream of Livingstone St. E. (Reach Li-1)	Watercourse improvements along Little Lake Creek to stabilize existing bank erosion.	14	30	4	44	4	Not Identified		N/A	4
	145	SWMF Retrofit No. 84 (LTGM)	509 Bayfield St.	Expand existing SWMF to increase the permanent pool and active storage volume for water quality treatment and peak flow attenuation.	7	48	1	55	2	Not Identified		N/A	2

Table 65: Preferred Solution Prioritization Summary

Watershed	Project No.	Opportunity (ID)	Location	Description	Evaluation Score	Prioritization Score (Risk Assessment)	Prioritization Rank	Total Score (Evaluation + Prioritization)	Final Rank	Additional Considerations			Watershed Priority
										Identified Replacement Date (Condition Assessment)	Capital Plan / MTO Schedule	Projects to be Completed in Combination / Order	
Bear Creek Watershed (Refer to Figure 25)	150	SWMF Retrofit No. 61 (BR08b)	Between Red Oak Dr. and County Rd. 27	SExpand existing SWMF to increase the permanent pool volume provided for water quality treatment.	14	24	3	38	2	Not Identified		N/A	2
	154	Culvert Improvement No. 78	Ardagh Rd.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Arterial Road - 100 Year design flood frequency).	8	26	2	34	3	Not Identified		N/A	3
	155	Watercourse Improvement No. 33	Downstream of Ardagh Rd. (Reach Be-14)	Watercourse improvements along Bear Creek to stabilize existing bed erosion.	16	34	1	50	1	Not Identified		N/A	1
Johnson Drainage Area (Refer to Figure 22)	159	Trunk Storm Sewer No. 8	Johnson St. from Steel St. to Kempenfelt Bay	Construct a trunk storm sewer (upsized local sewer) to eliminate overland flow deficiency.	15	65	1	80	1	Not Identified		N/A	1
Nelson Drainage Area (Refer to Figure 22)	180	Trunk Storm Sewer No. 12	Blake St. from Johnson St. to Puget St.	Construct trunk storm sewer to service Blake St. and eliminate overland flow deficiencies.	9	41	1	50	1	Not Identified		N/A	1

18 Detailed Design and Construction

Following ratification by City Council and successful completion of the Class EA process, the individual projects will proceed to detailed design and construction subject to available capital funding. Prior to construction, approval for the proposed works will be required from the Lake Simcoe Region Conservation Authority (LSRCA) and Nottawasaga Valley Conservation Authority (NVCA) under Ontario Regulation 179/06, from the Ministry of the Environment, Conservation and Parks (MECP) under the Ontario Water Resources Act and Fisheries and Oceans Canada under the Fisheries Act. All subsequent permits and approvals that may be required for the implementation of the Preferred Solution are as follows:

- Development, Interference with Wetlands & Alteration to Shorelines & Watercourses Permit – LSRCA;
- Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Permit – NVCA;
- Environmental compliance approval for Municipal and Private Sewage Works – MECP; and
- Permit to Take Water – MECP (If required)

Additional requirements that may need to be considered as part of detailed design and construction are the archaeological, cultural and natural heritage constraints of each project including migratory birds nesting periods, fishery timing windows, and species at risk. The archaeological, cultural and natural heritage requirements for each project are outlined in Section 15 of this report.

During the detailed design of the Preferred Solution, the owners of the existing utilities in the City should be notified of the proposed works, of any impacts the proposed works will have on the existing utilities, and of any conflicts or relocations required to complete the infrastructure improvements. Coordination with existing utilities will be required throughout detailed design and construction.

The age and condition of the existing culverts vary throughout the City. Depending on the age and condition of the culverts, there may be opportunities to use the existing culverts and add an additional culvert(s) to the crossing to achieve the design criteria, particularly for newer culverts in good condition. Utilizing the existing culvert will reduce costs. It is recommended that the age of the existing culverts be reviewed, and the condition of the culvert be assessed as part of detailed design to determine if using the existing culvert is feasible and appropriate.

For low impact development measures, specifically infiltration measures, the impacts the systems have on local groundwater levels needs to be confirmed as part of detailed design.



Infiltration systems have the potential to cause local groundwater mounding. Groundwater mounding next to or near homes and foundations may cause adverse impacts on the structure, such as increased sump pump usage, flooding of basements or increase hydrostatic pressures and foundation damage. It is recommended that the groundwater impacts be assessed at detailed design to confirmed that no adverse impacts will be caused by the construction of the infiltration system.



19 Climate Change

Water quality and quantity, the aquatic ecosystems, the natural environment including creeks and shorelines in the Lake Simcoe and Nottawasaga Valley watersheds are expected to be influenced directly and indirectly by climate change. How Lake Simcoe and the Nottawasaga River will be affected and how they will respond to climate change remains uncertain, however, effective stormwater management planning and design will improve each watershed's ability to adapt to climate change.

Climate change is predicted to shift weather patterns, amplify the variability of extreme weather events and increase the intensity of extreme storm events. As climate changes, the risk of flooding, erosion and infrastructure failure will likely increase as higher intensity storms will generate greater surface runoff in urban areas. Increased flooding and erosion pose risks to public health and safety, to property damage, natural heritage features, the natural environment and Lake Simcoe and the Nottawasaga River. To mitigate these risks and adapt to variable extreme weather conditions, climate change must be considered as part of effective stormwater management planning and design.

Proactively, the City of Barrie currently applies a simple approach to adapting to climate change by applying a 15% increase (adjustment factor) to the City's rainfall intensity-duration-frequency (IDF) relationships developed from historic rainfall data. The updated IDF relationships adjusted for climate change are presented in the City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines (November 2009).

A review of approaches currently used by municipalities to adjust their rainfall design standards to account for climate change has been completed. Similar to the City of Barrie, the City of Ottawa applies a 15% increase (adjustment factor) to its historic rainfall intensity-duration-frequency (IDF) relationships. The City of Welland developed projected IDF relationships through statistical analysis using historic and current climate data and precipitation extremes, and future climate data based on global climate model predictions. The result being projected IDF data for the 2020 and 2050 planning horizons. Additional approaches have been used, however, a consistent approach has not.

Recently, the Ministry of Transportation (MTO) developed and released the IDF Curve Lookup tool for the purpose of retrieving current and future intensity-duration-frequency (IDF) curves across Ontario. The IDF Curve Lookup tool uses Environment Canada climate station data and time-trend analysis to predict future IDF curves. Time-trend analysis was completed using the available data from 1960 to 2010 (base year) and a linear trend was observed and extrapolated



from this period to 2060 for each Environment Canada climate station in Ontario. Predicted IDF curves can be obtained from the IDF Curve Lookup tool for the City of Barrie.

The predicted IDF curves generated by the tool for the City of Barrie in 2050 produce rainfall depths and intensities on average 7% less than the current City of Barrie intensity-duration-frequency (IDF) relationships adjusted by 15% to account for climate change. Similarly, the predicted IDF curves generated by the tool for 2100 produce rainfall depths and intensities on average 3% less than the current City of Barrie intensity-duration-frequency (IDF) relationships adjusted by 15% to account for climate change.

The University of Waterloo has also developed and released the IDF Climate Change Tool 3.0. This tool generates future IDF curves based on statistical analysis of historical climate data through mathematical models. Predicted IDF curves can be obtained from the IDF Climate Change Tool 3.0 using the historic climate data from the Barrie WPCP (Station ID 6110557). The predicted IDF curves generated by the tool for the City of Barrie in 2056 produce rainfall depths and intensities on average 7 to 19% less than the current City of Barrie intensity-duration-frequency (IDF) relationships adjusted by 15% to account for climate change depending on the mathematical model used.

Based on the comparisons of the predicted future IDF curves from the various tools, the current City of Barrie intensity-duration-frequency (IDF) relationships adjusted by 15% to account for climate change are valid for infrastructure sizing through the planning horizon 2050 and potentially beyond. It is recommended that the City reassess the adjustment factor (15% increase) used to account for climate change when Environment Canada release their IDF curve updates to ensure the City's design standards remain valid and properly account for climate change through the City's planning horizon.



20 SWM Funding

As stormwater management has evolved so has the need for alternative funding mechanisms to support municipal infrastructure. As a result of this evolution, municipalities are seeking alternative funding mechanisms to the traditional tax based approach to cover the growing costs of operating, maintaining and replacing their existing SWM assets. Alternative funding mechanisms include development charges, stormwater utilities, grants, and water quality trading as discussed in the following sections.

20.1 FUNDING MECHANISMS

20.1.1 Development Charges

Development charges are fees imposed by municipalities on new developments to fund the increased capital costs related to service improvements in support of new development and growth. Development charges help fund capital works projects to provide critical infrastructure to support growth. Development charges are collected from developers at the time of development, however, the fees may only be used to fund growth related capital costs. Development charges are already applied to new developments in the City of Barrie in accordance with By-Law 2013-032 (City of Barrie Municipal – Wide Development Charges) at rates included in Schedule “A” based on the type of development or redevelopment.

In 2014, Watson & Associates Economists Ltd. (Watson) prepared the Development Charge Background Study for the City of Barrie. The DC recoverable costs calculation included the stormwater and drainage improvements within the former municipal boundary. A total of \$54,955,793 of the total gross capital cost of \$121,473,593 was attributable to the increase service needs of anticipated development. It is understood that Watson is currently undertaking an update to the Development Charge Background Study which will be finalized in 2019.

The preferred solution selected as part of this Drainage Master Plan will be included in the Development Charge Background Study. It was determined that the general recommendations of this study benefit existing and will not be included in development charge calculations. However, the individual projects recommended through this study will be reviewed, and where appropriate will be included. The percentage of the project cost assigned to development charges is based on the combined population and employment growth percentages for the former City of Barrie boundary and Secondary Planning Areas and the 2041 planning horizon.



20.1.2 Stormwater Utilities

Stormwater utilities or stormwater rates are user based fees charged to property owners discharging stormwater from their property to municipal stormwater infrastructure based on their contribution. The rates charged to property owners are typically based on contributing drainage area, land use classification, or impervious area and account for their specific contribution to the municipal stormwater management system. Stormwater utilities are becoming increasingly popular as a form of funding to offset the costs of SWM operation and maintenance and programs have been initiated in Kitchener, Waterloo, Hamilton, Edmonton, Saskatoon and Halifax to name a few.

Stormwater utility fees are incorporated into Municipal By-Laws enforceable under the Planning Act and are generally based on a properties contribution to the municipal storm infrastructure. The stormwater utility is not mandated by government legislation and is highly flexible and can be tailored to individual municipalities and coordinated with other funding mechanisms. The key being the basis for determining the rates charged must be fair and reasonable, and the rates must be related to the cost of the services provided by the municipality. Various methodologies for calculating the stormwater rate have been implemented including the following:

- Tiered flat fee based on zoning classification, total property area or building area;
- Stormwater fee using an equivalent residential unit based on impervious area;
- Stormwater fee using an equivalent hydraulic area based on impervious and pervious area; and
- Stormwater fee based on intensity of development (impervious area).

Stormwater utilities can be implemented in many different ways. A very basic option is to establish a flat fee structure. Flat fees can be based on property size, zoning, and building area. Flat fees for stormwater can be attached to a customer's sanitary sewer utility bill and they can be introduced through a stormwater levy attached to the residential tax bill. Though flat fees are generally easy to apply, more complicated methods are much more equitable. Three basic methods for establishing equitable service fees have been established.

The first is the Equivalent Residential Unit (ERU) method. This is the most common billing method and is based on the amount of impervious area on a parcel. A representative sample of a typical single family residential (SFR) home's impervious footprint and its impact is first assessed and considered the ERU. Generally all SFRs up to a defined maximum area are billed for one ERU. For non-SFR parcels, the impervious area is divided by the typical SFR impervious area to determine the number of ERUs to be billed to the parcel. This method allows for some



variation. A tiered-SFR flat-rate approach can be implemented based on analysis of SFR parcels within defined total area groups. This increases the equitability of the fee system.

The second basic method is the Intensity of Development (ID) method. Once again, impervious area is the main factor that governs billing. Stormwater utilities for the ID method are based on the percentage of impervious area for a specific parcel. All parcels are charged a fee based on the percentage of impervious area (intensity of development). Categories are defined by the impervious percentage range and the cost per area varies between these categories.

The final basic method is the Equivalent Hydraulic Area (EHA) method. For this method, parcels are billed on the combined runoff impact of their pervious and impervious areas where the impervious area is charged at a much higher rate than the pervious area. Consideration of the impact of pervious area makes this method the most equitable, though it is more work to analyze and determine a unique EHA.

A comparison of the different options to establish the Stormwater Utility service fee is included in the following table. Each of these basic options can be modified to increase equitability, though this will generally increase the effort to administer. For example, setting up a tiered approach based on general variability and having credits based on BMPs or location can be implemented for any of these options.

Table 66: Stormwater Utility Service Fees

FEE BASIS	EQUITABLE ALLOCATION	CONTRIBUTION FROM TAX EXEMPT PROPERTIES	INCENTIVES FOR ON-SITE SWM	EASE OF PUBLIC UNDERSTANDING	EFFORT TO ADMINISTER
Flat Fees	Low	Variable	Low	Low	Low
Equivalent Residential Unit	Medium	Yes	Medium	High	Medium
Intensity of Development	High	Yes	Medium	Medium	High
Equivalent Hydraulic Area	Very High	Yes	High	Medium	Very High

Stormwater utilities generally provide a stable revenue stream compared to other funding alternatives and provide an opportunity to tailor an equitable service fee to cover the cost of the services provided based on a defensible methodology. A Stormwater Utility Rate Study is required to determine a fair and equitable, legally defensible rate that will generate sufficient revenue to cover the SWM operation and maintenance costs. Undertaking a Stormwater Utility Rate Study is the first step in initiating a stormwater utility.



20.1.3 Water Quality Trading (WQT)

Water quality trading is an innovative approach to achieve water quality objectives established in a watershed by allowing developers facing significantly higher stormwater management costs to satisfy their regulatory obligations by contributing to equivalent water quality reductions elsewhere in the watershed at a lower cost. For example, a developer in Barrie may contribute to the retrofit of a downstream SWMF that will produce a net reduction in post development phosphorus in Lake Simcoe at a cost lower than constructing a treatment facility servicing their individual development. Alternatively, WQT allows dischargers that exceed their water quality objectives to sell surplus reductions or credits to other discharges in the watershed who face much higher costs to comply with the water quality objectives. The essence of water quality trading is collectively engaging key stakeholders to reduce nutrients loads in a cost effective and strategic manner.

In accordance with Policy 4.25 of the LSPP, the Ministry of the Environment conducted a Water Quality Trading Feasibility Study in the Lake Simcoe Watershed (XCG Consultants Ltd., Kieser & Associates LLC, D.W Draper Associates, and Commexus Inc., February 2010). The study reviewed existing WQT programs, identified options for the structure and delivery of WQT programs, and examined the environmental, social, and economic implications of implementing a WQT program in the Lake Simcoe watershed. The study concluded that a WQT program using the clearinghouse or exchange markets frameworks would be best suited for the Lake Simcoe Watershed, where trading is conducted through a facilitator or exchange. The study determined that WQT programs in the Lake Simcoe watershed are feasible, however, the willingness of potential participants to engage in the WQT program is unknown.

The Lake Simcoe Region Conservation Authority has established a Phosphorus Offsetting Policy. The policy mandates that the increase in phosphorus load from a development must be zero. In situations where this mandate cannot be satisfied, the developer or proponent must provide a phosphorus offset to the LSRCA. The offset value is \$35,000/kg at a ratio of 2.5:1. The revenue generated through the offsetting program will be used to reduce phosphorus loads elsewhere in the watershed. The LSRCA phosphorus offsetting program is in its infancy. However, it is understood that the LSRCA will administer the program.

Through the implementation of the preferred solution recommended in this Drainage Master Plan, the City of Barrie will be retrofitting and creating stormwater management facilities that will reduce phosphorus. As such, the City will be accumulating credits which they may use to offset City projects elsewhere in the watershed. However, there may be an opportunity for the City to sell credits to generate funds for capital projects through a phosphorus offsetting program of their own.



As part of this Drainage Master Plan, a phosphorus credits trading registry template has been developed for the City (see Appendix P). The City may use the phosphorus credits trading registry to maintain a record of the credits accumulated and traded between capital projects and, if desirable, to developers.

20.2 FUNDING MECHANISM COMPARISON

The total contribution each funding source can provide to maintain the City's SWMF assets differs along with the availability and equitable allocation of funds. Incentives for providing lot level controls, such as rain barrels, cisterns, permeable pavers, soakaway pits, and green roofs differ between the funding sources like the cost and effort to administer the funding mechanisms. Also, contributions from tax exempt properties are available through stormwater utilities and development charges unlike traditional funding sources and grants.

A stormwater utility is the only dedicated funding mechanism capable of covering the cost to maintain the City's existing and future SWMF assets with an equitable allocation of fees. Unfortunately, the cost and effort to administer a stormwater utility is high compared to the other funding mechanisms discussed. The general tax levy is the only other dedicated funding mechanism, however the cost to maintain the City's existing SWM assets exceeds the operating budget generated from the general tax levy. The backlog of maintenance work will continue to grow if the funds generated through the general tax levy are not supplemented by another source. The other funding mechanisms identified are not dedicated sources. The funding from these mechanisms is dependent on development and grants from government agencies. As such, the availability of funding is intermittent and unpredictable.

20.3 RECOMMENDED FUNDING MECHANISM

A City wide stormwater utility implementing fair and reasonable rates related to the cost of the services provided by the City is considered the most equitable and stable source of funding for existing SWM infrastructure improvements and maintenance, and is recommended for implementation. The structure of the utility, the methodology for calculating the utility rate, and the implementation plan for the utility will be developed through the completion of a Stormwater Utility Rate Study. To expedite the implementation of the stormwater utility, it is recommended that the City initiate the Stormwater Utility Rate Study in a timely manner.

In the short term, until the stormwater utility is established, funding through the City's general tax base will form the only stable revenue stream for existing SWM infrastructure improvements and maintenance. As such, the continued use of the general tax base to fund existing SWM infrastructure improvements and maintenance is recommended. It is also recommended that the City explore all options for government grants and funding to



supplement the general tax base. The funding should be directed towards maintaining the existing SWMF's in the City of Barrie and the level of service they provide.

Currently, the City applies development charges to new development to fund the increased capital costs related to service improvements in support of new development and growth. As new development will not result in a net reduction in phosphorus in accordance with the LSPP, developers can fairly be assigned the responsibility for addressing the impact. As such, it is deemed appropriate to collect funding for SWM infrastructure improvements related to development and growth through Development Charges.

As the City will be generating phosphorus credits through the implementation of the preferred solution set out in this Drainage Master Plan, the city should approach the LSRCA to discuss phosphorus offsetting. The City should approach the LSRCA to determine if the revenue generated through the LSRCA offsetting program will be made available to the City for capital projects resulting in phosphorus reductions in the Lake Simcoe watershed such as SWMF retrofits. The City should also approach the LSRCA and discuss the City selling credits obtained through capital projects to developers to fund additional capital projects within the City.



21 Conclusions

The recommendations contained herein will be presented to the General Committee for ratification. Those individuals and parties that requested to be kept informed of the Municipal Class EA process will be notified of the selection of a Preferred Solution and the steps of the process moving forward after ratification.

If concerns are raised during this process which cannot be resolved in discussion with the City of Barrie, the Minister of the Environment, Conservation and Parks may be requested to make an Order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order), which addresses individual Environmental Assessments. Requests must be received by the Minister at the address below within thirty (30) days of the publication of the Notice of Completion for the project. A copy of the request must also be sent to the City of Barrie Infrastructure Planning Group.

The Honourable Rod Philips
Minister of the Environment, Conservation and
Parks
College Park 5th Floor
777 Bay Street
Toronto, ON M7A 2T5

Tom Reeve, P.Eng.
Senior Infrastructure Planning Program
Coordinator
The Corporation of the City of Barrie
70 Collier Street
Barrie, ON L4M 4T5

Following the successful completion of the Municipal Class EA process (no Part II Orders received) it would be the City's intention to implement the Preferred Solution, subject to available capital funding and Council approval.

