South Alcona Flood Reduction

NDMP Project

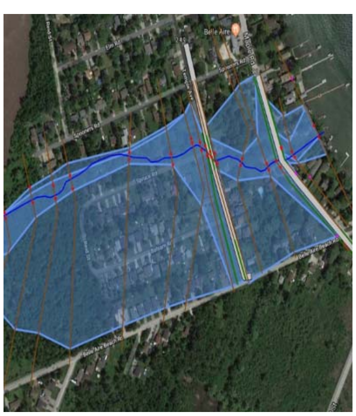
CONSERVATION AUTHORITY CLASS ENVIRONMENTAL ASSESSMENT

Environmental Study Report

Prepared For:

The Lake Simcoe Region Conservation Authority (LSRCA)

March, 2020



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March 31, 2020

Lake Simcoe Region Conservation Authority
120 Bayview Parkway
Newmarket, Ontario
L3Y 3W3

Attention: Mr. Michael Walters, Chief Administrative Officer

RE: SUBMISSION OF CONSERVATION AUTHORITY CLASS ENVIRONMENTAL ASSESSMENT FOR ALCONA (INNISFIL) FLOOD MITIGATION PROJECT

Dear Mr. Walters:

Greenland International - Consulting Engineers (Greenland), is pleased to submit an electronic copy of this Conservation Authority Class Environmental Assessment (EA) for the Alcona (NDMP) Flood Mitigation Project in the Town of Innisfil.

The objective of the Schedule 'C' Class EA Report was to identify and evaluate engineering design options to address chronic flooding issues which have persisted in this area of the Town of Innisfil for many years. The preferred flood remediation solution was selected through the EA process and will help to substantially reduce existing flood damages, while minimizing impacts to both the natural and social environments. The solution is also technically feasible and economically sensible too.

The Notice of Completion for the final report has been filed and dated March 31, 2020.

Greenland would like to acknowledge LSRCA staff, Town of Innisfil, other partners and participants who helped provide guidance and support throughout the comprehensive EA project process (and which was completed over an aggressive 6 month timeframe).

Finally, the Notice of Completion and Environmental Study Report (ESR) document file will be posted on the project's website, www.alconandmp.com.

Please do not hesitate to contact the undersigned if you have any questions.

Yours truly,

GREENLAND INTERNATIONAL CONSULTING LTD.

Josh Maitland, P. Eng.
Project Manager
EA Coordinator

R. Mark Palmer, P. Eng.
President / CEO
Director-in-Charge

South Alcona Flood Reduction Project Class EA

Environmental Study Report

March 2020

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1 INTRODUCTION

Greenland International Consulting Ltd. (Greenland) was retained in 2019 by the Lake Simcoe Conservation Authority (LSRCA) to complete a Conservation Authority (CA) Class Environmental Assessment (EA), the purpose of which is to identify and evaluate design options to address severe chronic flooding issues which have persisted in the Belle Aire & Cedar Creek watersheds of South Alcona for over a decade.

Many residents have expressed concern for public safety as well as rising economic damages to housing and industry. This Environmental Study Report (ESR) summarizes the work completed in support of this project and serves as the milestone for completion of requirements under the EA Act for Class EA process.

The targeted areas for Flood Reduction in Alcona have many important features that need to be considered. Little Cedar Creek (WN6) is mostly a healthy undisturbed stream. There is also little streambank erosion and the watercourse can convey peak flows associated with up to a 100-Year flood event. On the other hand, Belle Aire Creek (WN7) has been compromised due to urban development in the downstream reaches. Therefore, Belle Aire Creek has a lower hydraulic capacity, which results in annual flood damages in excess of $2.0 Million.

Belle Aire Creek also experiences water quality issues due to erosion and nutrient loading (including phosphorous which exceeds Provincial Water Quality Objective (PWQO) levels). Along the shoreline of Lake Simcoe, there are also residential buildings at an elevation within 0.5 meters of yearly high Lake Simcoe level, and therefore, why these properties are prone to seasonal flooding events too. Finally, the Little Cedar Wetland is a highly important natural feature (and a designated Provincially Significant Wetland) with excess local flood storage capacity to mitigate impacts from heavy rainfall and snowmelt (and resultant flooding) with the best science-based design and ecosystem approach.

The LSRCA submitted an application in October 2018 to the National Disaster Mitigation Program (NDMP), funded by the Government of Canada. The purpose of the NDMP is to provide opportunities for high-risk communities who suffer from major flooding events, to reduce or eliminate the effects of flooding to build safer and more resilient communities.

After receiving a sizeable grant from the National Disaster Mitigation Program (NDMP) in January 2019, the LSRCA and Greenland, with cooperation from the Town of Innisfil (Town), initiated a Class EA process to understand the extent of flooding within the context of the surrounding environment for existing conditions (while also having regard for approved future development plans) and to develop and evaluate potential mitigation options.

1.1 The Class Environmental Assessment Process

This project has been completed as a **Conservation Authority Class EA (CA Class EA)**, in accordance with the Conservation Ontario (CO) guiding document, *Class Environmental Assessment for Remedial Flood and Erosion Control Projects (2002, Amended 2013)*, which varies slightly from the Municipal Engineers Association (MEA) Class EA process.

The *remedial* undertakings to which the CA Class EA process applies are:

- Riverine Flooding
- Riverine and Valley Slope Erosion
- Shoreline Flooding
- Shoreline Erosion

For this project, the specific undertaking which applies is 'Riverine Flooding', which is defined as follows in the CO guiding documentation:

> **Riverine Flooding:** Two (2) main causes of flooding in the *riverine* system are an increase in water level from a *storm event* or rapid snow melt, and a result of the formation of ice jams, *frazil ice*, or other debris in watercourses.
>
> *Alternative remedial measures* to protect areas from flooding include preventing the entry of floodwater to a specific site, or altering the flows through the *channel* during *flood* events. Flows can be altered by increasing the *hydraulic* capacity of the watercourse, diverting water from *flood* vulnerable areas and increasing upstream storage.

The CA Class EA process is shown schematically in **Figure 1-1**.

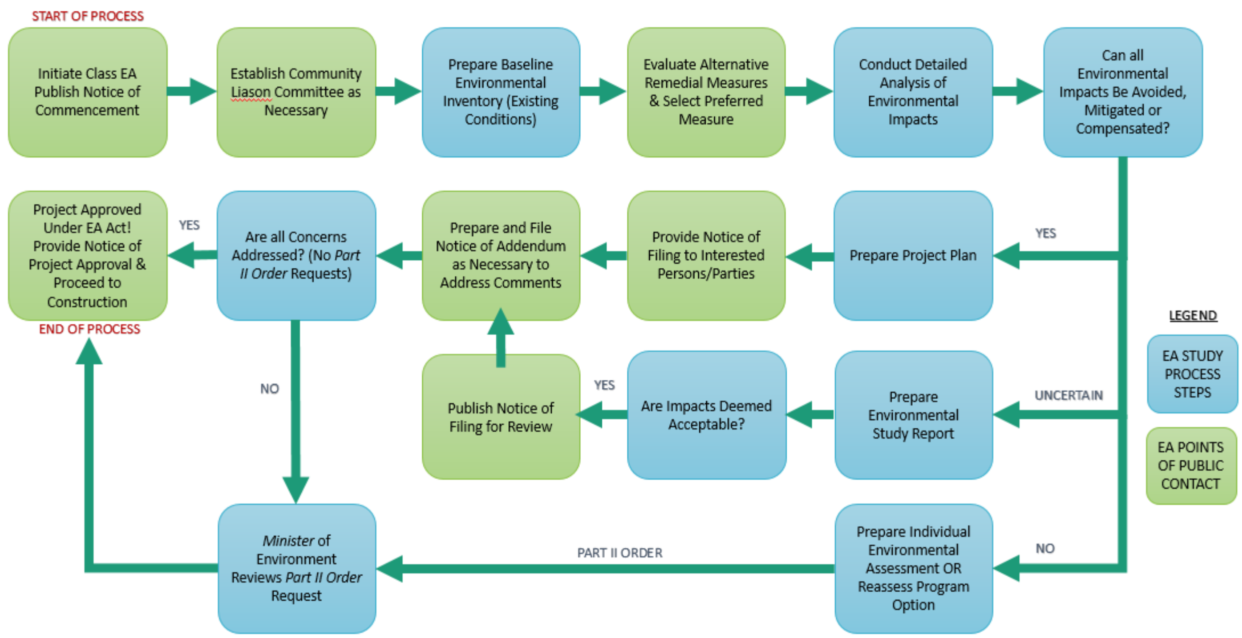

Figure 1-1: Conservation Authority Class EA Process

1.2 Background & Objectives

In September 2011, C.C. Tatham & Associates (CCTA) completed a Master Drainage Plan (MDP) for the Town of Innisfil - Alcona South Secondary Plan Area), as identified in the municipality's Official Plan Amendment #1. This MDP included the headwater (rural) area draining to the subject NDMP Project Study Area. The purpose of the 2011 MDP (and subsequent update completed in 2018 and also by CCTA) was to determine the opportunities and constraints within the Alcona Secondary Plan relating to water resources, drainage and floodplain management. The MDP completion relied on previous technical investigations by Greenland in terms of dual purpose flood reduction and nutrient / sediment removal solutions. The purpose of the MDP strategy was to also reduce the potential for existing (chronic) downstream flood damage near the Lake Simcoe shoreline and outlets of the affected MDP watercourses. Included in this MDP's recommendations was to develop flood mitigation strategies for the subject NDMP Project Study Area. As such, the purpose of this Study was to build upon the MDP recommendations and develop a specific flood mitigation strategy in accordance with the Environmental Assessment Act via the CA Class EA Process.

Implementing flood reduction / mitigative works within the Study Area will help to reduce the risk of flooding to existing residents in the southeast area of the community, and reduce associated financial, environmental and health and safety issues associated with chronic flooding. It will also provide additional value-added benefits. Complimentary objectives identified in achieving the overall goals of the project include:

- Improved flood control and mitigation of flood damages (and also a key Study objective);
- Enhancement or maintenance of the natural characteristics of the tributary area;
- Integrated stormwater management and quantity control;
- Maximized erosion control benefit; and,
- Value-added water quality benefits, including (but not necessarily limited to) reduction of phosphorous loads from the Study Area watersheds to Lake Simcoe.

1.3 Study Area

The lands comprising the Project Study Area include approximately 350 hectares and with a total upstream drain area of (802.23 ha). These headwaters are bounded by Sixth Line to the north; Belle Aire Beach Road to the south; 20th Sideroad to the west; and, the shoreline of Lake Simcoe to the east. The Study Area has very little development. This includes a small subdivision in the south-east corner north of Belle Aire Beach Road, low- density housing along the Lake Simcoe Waterfront and approximately a dozen rural houses along the Study Area limits.

The Sleeping Lion Subdivision (a.k.a. Belle Aire Community) is located to the north of the Study Area and includes two (2) stormwater management (SWM) facilities from this development that outlet into the Study Area. The Canadian National Railroad runs north and south across the centre of the Study Area. The highest risk to human safety from annual (major) flooding events occurs in the south-east corner of the Study Area. Delineation of the Study Area is shown in **Error! Reference source not found.**.

1.4 Study Approach

This Study incorporates an ecosystem and best-science approach in keeping with the following main work plan tasks from the approved NDMP funding grant and overall Mission Statement of the LSRCA:

- Develop an understanding of the existing natural features within the affected watersheds and how they function;
- Predict potential future impacts on the natural environment which may result from land-use changes and development; and,
- Develop a preferred approach for managing stormwater runoff for existing communities and future developments, which will least affect established ecosystem components and provide the most effective technique for flood reduction.
- Implement the preferred method, maintain and monitor site conditions.

The study approach was based on the natural features and how each Study Area watershed functions with the movement of water. A watershed is an area that includes all of the land drained by a single watercourse, such as each of the watercourses that transect and receive drainage from the property.

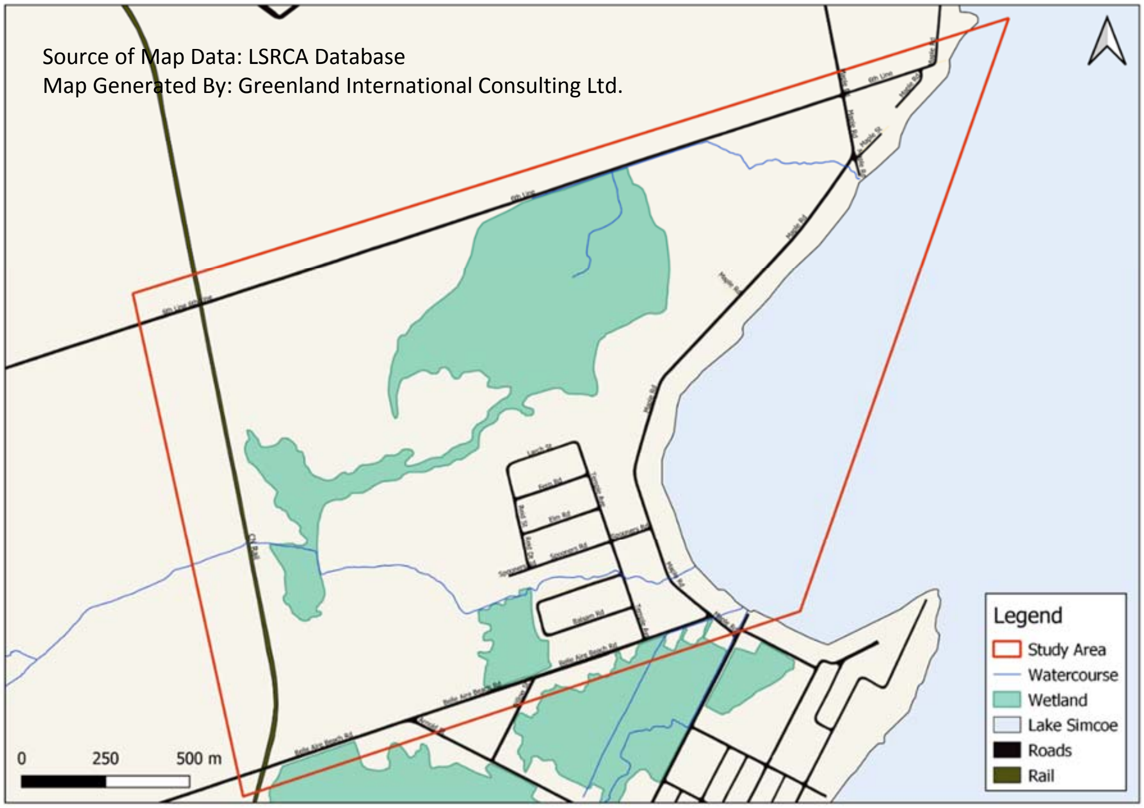

Figure 1-2: NDMP Project Study Area

Changes in the watershed that affect this movement of water may, in turn, affect the natural features and functions. The impact assessment of land-use change in a watershed must consider these fundamental relationships. The hydrologic processes and aquatic and terrestrial resources of a watershed define a unique set of ecosystem functions, attributes, and linkages and provide an overall framework for an assessment of the watershed ecosystem in a holistic manner. Management of a watershed from an ecosystem perspective must address these functional components. Maintenance of the watershed functions, attributes and linkages would typically maintain the existing environmental quality. An ecosystem and best-science based approach attempts to balance environmental protection, conservation, and restoration, with remediation measures for flood reduction to ensure the long-term sustainability of the watershed.

With this in mind, the scope of background work for the Study included the following:

- Collect and review all available existing background information for the Study Area.
- Inventory and map all stormwater management facilities and land use within the Study Area.
- Review previously completed inventories of aquatic and terrestrial features and conduct a cursory water quality assessment to determine opportunities and constraints to the project.
- Review background studies for all relevant watercourse reaches, and identify areas which are highly sensitive to changes in flow regime.

- Confirm the approved LSRCA - Visual OTTHYMO hydrologic model for pre-development conditions and develop a future development (HEC-HMS) model to establish peak flows within the Study Area watercourses.
- Confirm and/or revise available hydraulic models using HEC-RAS to establish flood elevations along relevant reaches within each of the Study Area watercourses.
- Develop a long-list of flood mitigation solutions based on the available background information and updated/best available modeling and in accordance with the EA Process.
- Develop appropriate screening criteria, develop a long list of potential solutions and identify a shortlist of solutions for detailed evaluation.
- Establish detailed evaluation criteria for the short-listed flood mitigation options based on their potential social, economic, technical and environmental impacts and complete an options assessment based on relative impacts to identify a preferred solution.
- Implement a suitable public consultation program, including public meetings, mailing lists and online updates via a project website at various points throughout the project. This program will gather valuable information from those most affected by the project and incorporate their input into the evaluation process.
- Summarize the preferred solution (or solutions as the case may be) and proposed next steps and mitigation measures, as well as the CA Class EA process followed, updated as appropriate based on input from stakeholders and public in an Environmental Summary Report (ESR).

1.5 Report Organization

This ESR (Report) provides a characterization of existing conditions within the Study Area and examines impacts that have occurred from minor and major flooding events. Information within this ESR was collected from other projects in this geographical area too.

By using existing monitoring/study data, and completed reports, the Report was formed as the basis of understanding for the Study Area and to help improve public safety by reducing risk and damages of flooding while considering the protection, enhancement and/or restoration of sensitive resource features and ecological functions. The remaining chapters of the Report will provide details on this process in the following order:

- Section 1: Introduction and Background
- Section 2: Existing Conditions
- Section 3: Future Condition
- Section 4: Methodology for Evaluation
- Section 5: Long List of Flood Reduction Alternatives
- Section 6: Detailed Evaluation of Flood Reduction Options
- Section 7: Summary of Preferred Concept Design
- Section 8: Implementation & Mitigation Strategy
- Section 9: Summary of Public Involvement
- Section 10: Conclusion

1.6 Background Reports

Chapter 2.0 of this Report, Existing Conditions, is largely a review of the following reports, all of which can be found in **Appendix B**:

- Comprehensive Stormwater Management Report dated October 2016, prepared by C.C. Tatham & Associates Ltd.;
- Environmental Impact Study of the Sleeping Lion Subdivision dated 2013, prepared by Azimuth Environmental Consulting, Inc.;
- Alcona South Secondary Plan Master Drainage Plan(s) 2011 & 2018, prepared by C.C. Tatham & Associates Ltd.;
- Alcona South Secondary Plan Master Drainage Plan dated 2010, prepared by Greenland International Consulting Ltd.;
- SWM Implementation Reports and Environmental Impact Studies dated 2013 – 2015, prepared by Greenland International Consulting Ltd. and Azimuth Environmental Consulting Inc.;
- Master Environmental Report Alcona South Secondary Plan dated June 2008, prepared by Azimuth Environmental Consulting Inc.; and
- Hydrogeological Study Alcona South Secondary Plan dated May 2008, prepared by Azimuth Environmental Consulting Inc.

Other smaller studies and reports were used to collect data on geology, archaeology, natural heritage, etc. of the Study Area, can be found in **Appendix C**. Additional analysis of areas where needed will be complete as identified throughout the Report.

1.7 Problem & Opportunity Statement

The problem/opportunity statement which forms the basis for this study was as follows:

"Develop an engineering design solution to reduce flooding within the Study Area by maximizing green infrastructure and to enhance water quality and infiltration before discharging into Lake Simcoe."

2 EXISTING CONDITIONS

2.1 General / Land Use

Existing land use within the Study Area includes a combination of a floodplain, natural area, existing residential development, and vacant or fallow agricultural land. The Study Area is bisected by two (2) primary watercourses in the Lake Simcoe Innisfil Creeks Watershed including Belle Aire Creek (WN7) and Little Cedar Creek (WN6), which receives drainage from the Study Area and exterior lands to the southwest and northwest, respectively.

The lands can be described as generally forested / marsh wetland, with a slight slope to the south from the Alcona Community to the Belle-Ewart settlement. The affected waterbodies include, Little Cedar Creek, Little Cedar Point Wetland, and Belle Aire Creek. The lands to the west of the Study Area are largely agriculture lands of various crops.

To the north of these lands, a medium-density residential subdivision between Emberton Way and Webster Boulevard (to be connected to 6th Line) is being constructed. A proposed Metrolinx Station, including high density residential and commercial infrastructure, is proposed on the west side of the CNR rail line. Single-detached homes are located along St John's Rd, 6th Line, and Houston Ave.

South of the Study Area, additional low-density housing is centred on Belle Aire Beach Rd and 20th Sideroad. There is also undeveloped low-density residential areas between Belle Aire Beach Rd and Ewart St. The Little Cedar Point Wetland complex, and the largest waterbody feature within the Study Area, extends from the central sections of 6th Line to south of Belle Aire Beach Rd and around residential areas of Lefroy.

Appendix A, Figure 2-1, illustrates the locations of significant land uses within and around the Study Area.

2.2 Climate

The climate of the Study Area can be characterized using climate normal records from the Environment Canada station 61110557, located in Barrie approximately 12 km from the Study Area, and for the years 1970 to 2013. The average annual recorded precipitation for this station is 908 mm.

2.3 Geology and Hydrogeology

A Hydrogeological Report was completed by Azimuth Environmental Consulting, Inc. in May 2008 (Hydrogeological Study, Alcona South Secondary Plan, 2008). The Physiography, Geology and Hydrogeology of the Study Area were included. An excerpt from this report is provided below:

> *"Approximately 12,800 years ago, the glacial Lake Algonquin was in the region that we presently know as the Lake Huron basin. This was due to the positioning of the glaciers and the crustal depression, inundating a large area that we now refer to as the Lake Simcoe Basin. Due to the crustal depression and glacial damming, Lake Algonquin wasn't able to drain through the St. Lawrence and thus found a new outlet towards the Mississippi River. However, as the glacier receded, lower outlets were exposed and it started to drain towards the Lake Simcoe basin and then to the glacial Lake Iroquois (Lake Ontario).*
>
> *This report described the area as having several distinct geological units. The area from the Lake Simcoe shoreline extending west approximately to the railway line is described as being an ancient beach/lake bed associated with former Lake Algonquin. Characteristics of this feature are flat topography consisting of a level plain with deep deposits of sand and silt. Areas to the north of this flat land also contain deposits of peat and muck soils between 0.3 and 3 m depth that are*

above finer grain materials such as clays and silts. This results in poorly drained areas with perched water table conditions and surface soil conditions capable of supporting the wet forest, swamp and marsh communities that make up much of the area immediately west of the existing developed areas along the shoreline. The Little Cedar Wetland is one such example and has been designated as a Provincially Significant Wetland (PSW) as of April 2006.

Progressing west of the GO/Metrolinx railway line to the 20th Sideroad and beyond, the lands transition to represent the edge of the old lakebed comprised of sand/till plains, characterized by drumlin hills further to the west. As well, mapping reviewed for the Study Area indicates that the edge of the ancient lakebed area (near the GO/Metrolinx railway line) potentially contains a narrow strip of Gravelly Sandy Loam. **Appendix A*, Figure 2-3*** *shows an overview of soil patterns for the areas surrounding the Study Area.*

The Soil Map of Simcoe County was consulted to understand the soil conditions in the Study Area included as **Appendix A*, Figure 2-3b***. *From this mapping, it was confirmed that much of the west portion of the Study Area (west of the GO/Metrolinx railway line) contains a loam and sandy loam till with moderate drainage and infiltration capacity. In the vicinity of the railway line south of 6th Line, a very well-draining area of gravely sandy loam is present, progressing easterly into the imperfectly drained sandy loam and muck areas consistent with the ancient lake bed designation.*

In general, the water supply for the area is currently from the overburden sand layers at depths between 5 and 45 m deep. From a hydrologic perspective, there is moderate infiltration potential for the till plains that make up the west half of the Study Area while the potential for infiltration is much less on the flatter lands between the Metrolinx Line and Lake Simcoe, due to soil conditions and presence of high groundwater table. The presence of shallow groundwater levels for the lands east of the railway is an important consideration as they provide a potential supply of base flow to the watercourses and help to maintain the water levels in the wetland/swamps prevalent in this area."

2.4 Archaeology

The Archaeological Assessment of the Lefroy Belle Ewart Secondary Plan states that based on a Stage1 background study, there are no documented archaeological resources within the Study Area. However, the Study Area does have moderate potential for as-yet undiscovered prehistoric and historic archaeological resources. The report suggests that a Stage 2 archaeological survey be done of the area. This should be completed at the outset of the detailed design stage of the project.

2.5 Topography

In general, Study Area existing grade slopes from the high points at the north-central areas of the subject site southeast to Lake Simcoe. The existing grade also opens north and south to the valley lands of the subject watercourses that transect or receive drainage from the surrounding externals areas. The site's receiving watercourses are further described in the following **Section 2.6**. Topographic elevation contours of the Study Area are shown in **Appendix A, Figure 2-4**.

2.6 Natural Heritage Features

As highlighted in the Comprehensive Stormwater Management Master Plan; Municipal Class Environmental Assessment Final Report produced by C. C. Tatham & Associates Ltd. on October 21, 2016 (CCTA SWMMP, 2016, **Appendix B**), the Study Area contains areas that have been designated as Natural Heritage System Levels 1-4, and predominately level 1 and level 4. **Appendix A, Figure 2-5** shows the Study

Area's approximate location of each of the Natural Heritage Levels. There are natural environment features across the Study Area that require consideration. The main natural environmental feature that is within the Study Area is the Little Cedar Creek Wetland, which is located in the north and central portions of the Study Area. This wetland is also a Provincially Significant Wetland (PSW). Other natural environmental features consist of the watercourses, Little Cedar Creek, Belle Aire Creek, and Ewart Street Tributary. Specific information regarding these Natural Heritage Features can be found in the Master Environmental Report for the 2008 Alcona South Secondary Plan by Azimuth Environmental Consulting Inc. Part of that report's purpose was to also evaluate and characterize the Natural Heritage Features in this Study Area.

2.7 Hydrology

The hydrology of the Study Area was originally modelled using Visual OTTHYMO 2.0 (VO2) platform for the Sleeping Lion Development project in May 2017. This VO2 model was approved by the Lake Simcoe Region Conservation Authority (LSRCA). Thereafter, the model was adopted by the LSRCA and Town of Innisfil and used to create a HEC-HMS (Hydrologic Engineering Center – Hydrologic Modeling System) model for the Study Area for this project.

The Study Area includes farmland to the west, a low-density residential area to the east along Lake Simcoe and Little Cedar Wetland (Provincially Significant Wetland - PSW) in the mid-north area. Belle Aire Creek runs through the more southern region of the residential area and Little Cedar Creek runs from the PSW complex along the north edge of the Study Area.

For the existing conditions HEC-HMS model, the layout and parameters were obtained from the Sleeping Lion - VO2 hydrologic model. The HEC-HMS hydrologic model required a few other parameters and which were calculated accordingly. The design storms for the 2yr, 5yr, 10yr, 25yr, 50yr, 100yr, Hazel and 25mm Chicago storm events were then extracted from the VO2 model and converted into a format that was readable by the HEC-HMS program.

Peak flows generated by the HEC-HMS model were compared to those of the VO2 model to ensure that the model was working properly. This comparison and the % variance is presented in **Table 2-2-1**.

Table 2-2-1 Comparison of Peak Flows from Existing Conditions of HEC-HMS and VO2 Models

Storm	Belle Aire Creek Outlet Peak Flow (m^3/s)			Cedar Creek Outlet Peak Flow (m^3/s)			
	VO2	HEC-HMS	% Variation		VO2	HEC-HMS	% Variation
2-Yr	1.90	2.0	5.26		1.68	2.0	19.05
5-Yr	3.53	4.0	13.31		3.56	4.0	12.36
10-Yr	5.17	5.6	8.32		5.03	5.5	9.34
25-Yr	7.00	7.5	7.14		6.64	7.2	8.43
50-Yr	8.56	9.2	7.48		8.18	8.8	7.58
100-Yr	10.22	11.0	7.63		9.79	10.5	7.25
Chi-25mm	0.70	0.8	14.29		0.49	0.8	63.27

It was observed that peak flow simulations from each hydrology model compared well. Larger variations were found for the scenarios having lower flow values, such as 2-year, 5-year and Chi-25mm. Even for these scenarios, variation in absolute values is not significant. The median variation between the results from each model and among all scenarios, are 7.6% and 8.9% for Belle Aire Creek and Cedar Creek, respectively. The HEC-HMS hydrology model simulations are conservative when compared to that of the VO2 model.

On the basis of these results for the existing condition land use scenario, the HEC-HMS model was found acceptable. Therefore, this model was then further modified for examining hydrologic conditions for other land use scenarios.

An ultimate (development) conditions model was developed in VO2 for the Sleeping Lion Development project to simulate the hydrology of the post-development area. The layout and parameters, minus the storage nodes, from this scenario were used in the development of the HEC-HMS ultimate conditions hydrology model.

Several residential and some commercial developments are proposed for the area which would change the runoff patterns of the area. It would also result in an increase of impervious surfaces and in turn increased overland runoff, peak flows and risk of downstream flooding too.

The increase in peak flows between the HEC-HMS existing conditions model and the ultimate conditions model are presented in Error! Reference source not found..

Table 2-2: Existing Condition and Ultimate Condition Peak Flow Comparison

Storm Event	Belle Aire Creek Outlet Peak Flow (m^3/s)		Cedar creek Outlet Peak Flow (m^3/s)	
	Existing Condition	*Ultimate Condition*	*Existing Condition*	*Ultimate Condition*
Q_2	2.0	3.8	2.0	4.5
Q_5	4.0	6.3	4.0	7.1
Q_{10}	5.6	8.2	5.5	8.8
Q_{25}	7.5	10.2	7.2	10.6
Q_{50}	9.2	12.1	8.8	12.2
Q_{100}	11.0	14.0	10.5	13.9
Hazel	28.0	30.3	20.1	21.5

A detailed Modeling Report was completed for this project. The inputs for each of the scenarios, the model layout, the model outputs and an in-depth analysis are included in **Appendix F.**

2.8 Hydraulics

A hydraulic (floodplain mapping) model was also previously developed for the Study Area and from the Sleeping Lion Development project. This hydraulic analysis used the HEC-RAS (River Analysis System) model. Two models existed, the first of which was for storms under the 100-yr storm and which consisted of watercourse reaches for the Belle Aire Creek and Little Cedar Creek. The second model was for rainfall events greater than the 100-yr storm. In this second model, a spill from the Belle Aire Creek was directed to and connected Belle Aire Creek with the Little Cedar Creek. This also creates a third spillway area to Lake Simcoe. The 0.5 m Digital Elevation Model (DEM) provided by the LSRCA was used to generate a terrain map for the affected area.

In the existing conditions model, the HEC-RAS model with only the Belle Aire Creek and the Little Cedar Creek systems was used. Peak flows generated by the existing condition HEC-HMS (hydrology) model were then used as inputs for the HEC-RAS (hydraulic) model.

The water surface elevation along each cross section was calculated and which allowed for a flood inundation map to be developed. The existing conditions (HEC-HMS) model showed extensive flooding in residential areas around the Belle Aire Creek. Properties impacted by flooding were tallied for each storm event and a financial analysis was completed to determine annual flood damages. **Figure 2-6** illustrates the current "worst case" existing conditions flood scenario for the Regional Storm Event.

It should be noted that additional flooding in other areas was observed by Greenland during the Project and confirmed with residents from previous flooding events. Therefore, an "Additional Observed Flooding" area map was also prepared and shown in **Figure 2-6**.

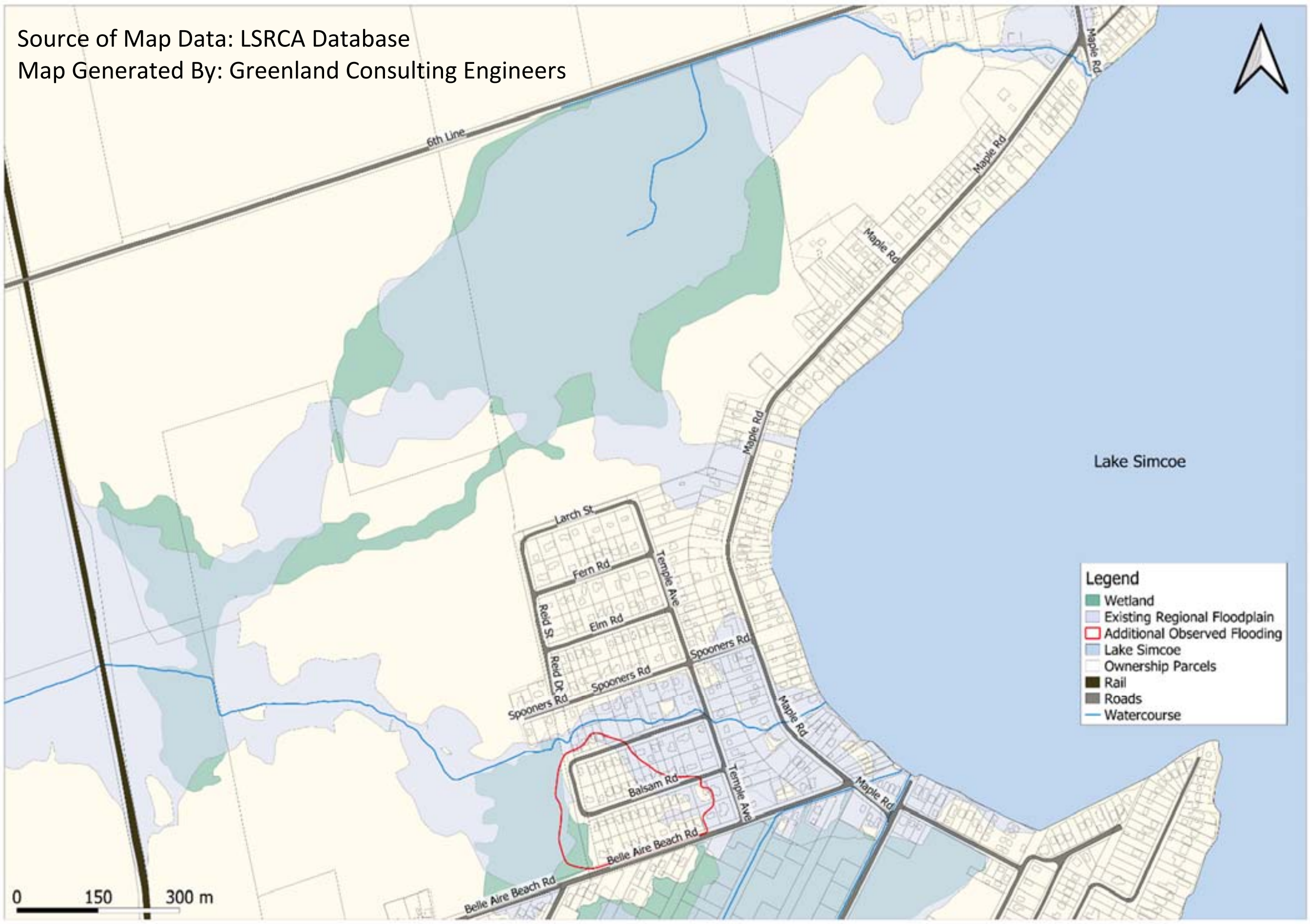

Figure 2-6: Existing Floodplain Mapping

Table 2-3 provides a summary of the anticipated flood damages. Cost calculations were based on a $43,000 average damage claim per unit, per catastrophic flooding event, which was provided by the Intact Centre on Climate Adaptation (ICCA) at the University of Waterloo. The annualized average damages are based on a probability analysis of all events up to and including the Regional Storm. Detailed cost calculations are provided in **Appendix G**.

Table 2-3: Existing Conditions Flood Damage

Storm Event Return Period	# of Homes Impacted	Est. Flood Damages* (2019 $$)
2 Year	37	$ 1,591,000
5 Year	44	$ 1,892,000
25 Year	91	$ 3,913,000
100 Year & Regional	101	$ 4,343,000
**Annualized Average ** **		**$2,079,867**

Costs in the above table only include estimated damages to homes and do not account for costs associated with municipal response, infrastructure repairs, or other intangible impacts (i.e. loss of income for flooded residents).

2.9 Stream Channel Characteristics and Erosion

The basic stream channel and erosion characteristics of the two (2) watercourses traversing the Study Area were identified as follows:

2.9.1 Little Cedar Creek

- Little Cedar Creek is the most natural of the systems in the Study Area exhibiting good natural channel characteristics and relatively stable channel forms throughout its reaches.
- Little Cedar Creek has good channel gradient as it approaches Lake Simcoe and is located in drainage areas with little urban development. Wetland systems in their upper reaches buffer peak flow occurrences and maintain baseflow conditions.
- The focus on the management of Little Cedar Creek should be on maintaining the existing hydrological regime and ensuring existing channel stability and erosion characteristics do not change as a result of development.

2.9.2 Belle Aire Creek

- Belle Aire Creek is considered an altered watercourse with agricultural land use in the upper reaches and urban development in the lower reaches.
- Despite its altered nature, Belle Aire Creek does not show obvious signs of significant erosion or sedimentation.
- Belle Aire Creek has a channel capacity that is exceeded following frequent storm events (2-year). The resultant flooding damage associated with its inadequacies should be considered a high priority when determining a flooding reduction solution.

2.10 Water Quality

Surveys for water quality on Little Cedar Creek and Belle Aire Creek consist of nutrient phosphorus loading and erosion and sediment control were collected as part of the Alcona South Secondary Plan (2018).

The Alcona South Secondary Plan outlined a 62% increase in urbanization which will reduce the amount of surficial soil erosion mostly resulting from agriculture and rural runoff but will increase urban runoff which results in degradation of the surface water quality and increase in-stream erosion.

Water quality control measures are to be implemented as per Alcona South Secondary Plan requirements, which will result in an overall reduction of 33% phosphorus and nutrient levels entering Lake Simcoe.

Water samples were also collected by Azimuth Environmental in 2006, as part of the updates to MER (2004) and MERN (2008) documents, just downstream of the CNR (now Metrolinx) tracks for Belle Aire Creek (June 2006), and at the inflow and outflow of the Little Cedar Wetland (March, April, June, December 2006). Samples were generally not collected during storm events and the water quality for phosphorus, nitrate, and nitrite were below PWQOs for samples from both watercourses.

The results are presented in Error! Reference source not found..

Table 2-4: Water Quality Sample Results for Subject Watercourses

Watercourse and Location	**Water Quality Results**							
	Dry Weather (mg/L)				Wet Weather (mg/L)			
	Nitrate	Nitrite	TSS	Phosphorus	Nitrate	Nitrite	TSS	Phosphorus
Belle Aire Creek at Lake Simcoe	0.40	N.D.	NA	NA	0.8	N.D.	46	0.084
Water Quality Criteria	10 mg/L	1 mg/L	25mg/L-80mg/L	0.03 mg/L	10 mg/L	1 mg/L	25mg/L-80mg/L	0.03 mg/L

NOTES:
1. Nitrate and Nitrite Water Quality Criteria Based on the Ontario Drinking Water Standards.
2. Total Suspended Solids (TSS) Criteria Based on Healthy Fishery Criteria.
3. Phosphorus Based on Provincial Water Quality Objectives (PWQO).

As shown in Error! Reference source not found., the watercourses sampled experience increases of nitrates under storm conditions.

TSS levels are within the healthy fishery range of 25 mg/L to 80 mg/L under storm conditions. However, total phosphorus exceeds the PWQO for all watercourses under storm conditions at the sample locations.

A preliminary nutrient (phosphorus) and sediment loading analysis was completed in 2007 by Greenland for the Cortel Group and its Sleeping Lion Subdivision. The nutrient and sediment analysis (and completed for Modified OPA No. 1 land use conditions) was undertaken as part of analysis for a separate document entitled *Modified Official Plan Amendment, Nutrient and Integrated Drainage Analysis*, June 2007 (Greenland International Consulting Ltd.)

High level nutrient modelling was also completed using SWAT (Soil and Water Assessment Tool) as part of this Class EA to determine the impacts of the preferred solutions. Results of these updates are presented in **Appendix C.**

3 FUTURE CONDITIONS

The Study Area currently consists of farmland with a low-density residential area to the east along Lake Simcoe and Little Cedar Wetland (Provincially Significant Wetland) in the mid-north area. Belle Aire Creek runs from west to east through the more southern region of the residential area where it outlets into Lake Simcoe. Little Cedar Creek runs from the wetland along the north edge of the Study Area to the east where it also drains into Lake Simcoe. There is one small seasonally active outlet running west to east midway between the Belle Aire Creek and the Little Cedar Creek – this is also the 'spill' flow path for storms above the 100-year event as described in **Chapter 2.0**.

The Sleeping Lion Subdivision project is proposing development on both sides of the 6th Line, which is the northern boundary of the Study Area. This development would increase the amount of surface area that is impervious, thus increasing surface runoff and potential risk of flooding.

The modelling tools utilized in the design of the Sleeping Lion Subdivision were also utilized for this Class EA, as mentioned in **Chapter 2.0.** Ultimate conditions used in the Sleeping Lion Development project's HEC-RAS model for storms above 100-yr event, included a reach with cross sections for the emergency spillway area into Lake Simcoe. The ultimate conditions "with storage" model, a variation which also included existing (SWMF's #6 & #7) and proposed (SWMF #8) SWMF's in the area, accounted for a storage feature for Belle Aire Creek flows downstream of the Metrolinx tracks, which diverts flows away from the residential areas, in order to verify the anticipated impacts of the proposed storage solutions evaluated as part of this Class EA. Storm Water Management Facilities (SWMF's) were also modelled to control peak flows from that of the ultimate conditions model and reduce them to below those of the pre-development flows in the existing conditions model.

Several of these SWMF's have been constructed by the Cortel Group (SWM6 and SWM7) and have been included in the post development modelling scenarios of the CA Class EA. The ultimate conditions VO2 (hydrology) model scenario with the storage nodes for the SWMFs was used as the basis for the final HEC-HMS modelling scenario. A storage node was also used to represent changes to the Little Cedar Creek Wetland. Following the evaluation of potential solutions (See **Chapter's 5 & 6**), the final rating curve for the wetland storage node was updated to reflect the proposed solutions.

Peak flows generated by this scenario can be seen in Error! Reference source not found.. As seen below, the constructed SWMF's and existing wetland complex are able to reduce the post-development peak flows to less than those generated by the existing condition (hydrology modelling) scenario.

Table 3-1: Existing, Ultimate and Ultimate w/ Storage Peak Flow Conditions Comparison

Storm Event	Belle Aire Creek Outlet Peak Flow (m^3/s)			Cedar Creek Outlet Peak Flow (m^3/s)		
	Existing Condition	*Ultimate Condition*	*Ultimate Condition with Storage*	*Existing Condition*	*Ultimate Condition*	*Ultimate Condition with Storage*
Q_2	2.0	3.8	1.7	2.0	4.5	0.3
Q_5	4.0	6.3	2.5	4.0	7.1	0.8
Q_{10}	5.6	8.2	3.2	5.5	8.8	1.2
Q_{25}	7.5	10.2	3.9	7.2	10.6	1.9
Q_{50}	9.2	12.1	4.6	8.8	12.2	2.5
Q_{100}	11.0	14.0	5.4	10.5	13.9	3.3
Hazel	28.0	30.3	12.5	20.1	21.5	18.7

It was concluded from the ultimate conditions (with storage) hydrologic modelling scenario that flooding would be greatly reduced in the residential areas of the Belle Aire Creek system. As well, no increase in flooding will occur at the Little Cedar Creek outlet or the emergency spillway in this scenario.

A comparison of the flood inundation maps for the existing and ultimate scenarios is presented in **Figure 3-1 (Appendix A)**.

4 METHODOLOGY FOR EVALUATION

The following chapter provides a description of the evaluation methodology that was used in determining the preferred solution for remedial flood mitigation in the Study Area.

4.1 Flood Mitigation Option Categorization

Table 2 of the CA guiding documentation for a Class EA identifies examples of alternative remedial measures for riverine flooding projects which should be considered, including: 1. Prevent Entry of Flood Water; 2. Increase Hydraulic Capacity of Waterway; 3. Modify River Ice Formation and/or Break-up Processes; 4. Divert Water From Area; and, 5. Increase Upstream Storage.

Review of background conditions, previous reports and modelling completed for the Project indicated that the main causes of flooding are due primarily to conveyance deficiencies within Belle Aire Creek, and a lack of available storage during flooding events. Therefore, it was determined that the best approach to developing appropriate flood mitigation solutions would include developing separate conveyance and storage based alternatives, and completing separate screening and evaluation processes for each of these solution categories.

A two (2) stage process was utilized for the evaluation of design alternatives throughout this Class EA. The initial stage for both conveyance and storage solutions was a screening exercise using a set of 'must pass' screening questions. In other words, a "long-list" of options must meet a set of criteria to be carried forward for further evaluation. This exercise, applied to both the storage and conveyance long-lists resulted in two (2) short lists of alternative solutions. The short-listed options were then put through a detailed comparative evaluation process based on relative environmental impacts of each solution. The conveyance solutions were evaluated first and storage options were then assessed with the added context of the completed conveyance evaluations.

Descriptions of each of these stages, along with associated criteria, are described within the following subsections.

4.2 Screening Criteria

The long list of stormwater management techniques for both the Conveyance and the Storage Options was screened against the criteria described below in **Table 4-1**.

Table 4-1: Screening Criteria for Stormwater Management Alternatives

Screening Question	Screening Decision by Answer	
	Pass	Fail
1. Can the Option satisfy the requirements of the Problem / Opportunity Statement?	Proceed	Eliminate
2. Does the Option have obvious and significant Environmental, Socio-Economic or Technical Impacts which could offset its ability to address the Problem / Opportunity Statement, as compared to other solutions (i.e. exorbitant cost or difficulty)?	Proceed	Eliminate

These criteria represent mandatory or "must-have" criteria which must be met in order to be an acceptable alternative for detailed evaluation. Alternatives were reviewed in conjunction with the noted criteria on a pass or fail basis and carried forward or eliminated accordingly. The final lists of conveyance and storage options which passed all screening questions became the 'short-lists' for detailed evaluation.

4.3 Detailed Evaluation

After arriving at a short list of potential conveyance and storage solutions which would viably address the problem statement without any obvious or significant impacts, the following steps were completed for the detailed evaluation of both short-lists of solutions:

1. Detailed evaluation criteria were first defined for conveyance & storage options (See **Section 4.4**)
2. Impacts of each short-listed alternative were then reviewed against each specific criterion;
3. Rankings were assigned to each solution based on its anticipated relative impacts for each criterion. Options were ranked using a colour coded system for each criterion presented in **Section 4.4**, where "green" represented the most preferred alternative (least impacts), "yellow" criteria represented less preferred alternatives (less impacts) and criteria in "red" represented the least preferred alternative (most impacts).
4. A "most preferred" solution was then selected based on which Option had the best overall ranking, or in other words the option which received the most "green" rankings became the recommended preferred alternative, due to having the lowest relative impact of all evaluated solutions.

It should be noted that this process was followed for both the conveyance and storage solutions, and upon completion of the initial conveyance assessment, 'combined' strategies which incorporated the preferred conveyance option were also added to the storage assessment to ensure a comprehensive review of potential solutions.

4.4 Evaluation Criteria

The criteria used for detailed evaluation are presented below. The criteria are grouped based on technical, natural, social and economic environments.

- Natural Environment Impacts:
  - Impacts of the Option to Vegetation, Wildlife and Natural Environment;
  - Surface / Groundwater Quality Implications; and,
  - Resiliency of Option vs. Climate Change and Future Extreme Weather Impacts.

- Social/Cultural Environment Impacts:
  - Land Use and Archaeological Considerations (Including First Nations);
  - Impacts to Residents; and,
  - Visual Landscape / Aesthetic Impacts.

- Technical/Operational Considerations:
  - Difficulty to Construct or Implement the Option Relative to Other Alternatives; and,
  - Operation and Maintenance Efficiency.

- Economic Impacts:
  - Capital / Construction Costs;
  - Long Term / Operation & Maintenance Cost Burden; and
  - And Payment Structure, Cost Recovery Options, Phasing Flexibility.

5 LONG LIST OF FLOOD REDUCTION ALTERNATIVES

5.1 General

The following chapter provides a detailed description of the long-listed options for conveyance and stormwater storage alternatives considered as part of this Class EA and the results of the screening methodology described in **Chapter 4.0** which was applied to these options to arrive at a short list of viable alternatives. The short-list evaluation is presented in **Chapter 0.0**. For reference, a schematic Summary of Long List Options and their relative geographic locations is provided in **Figure 5-1** below.

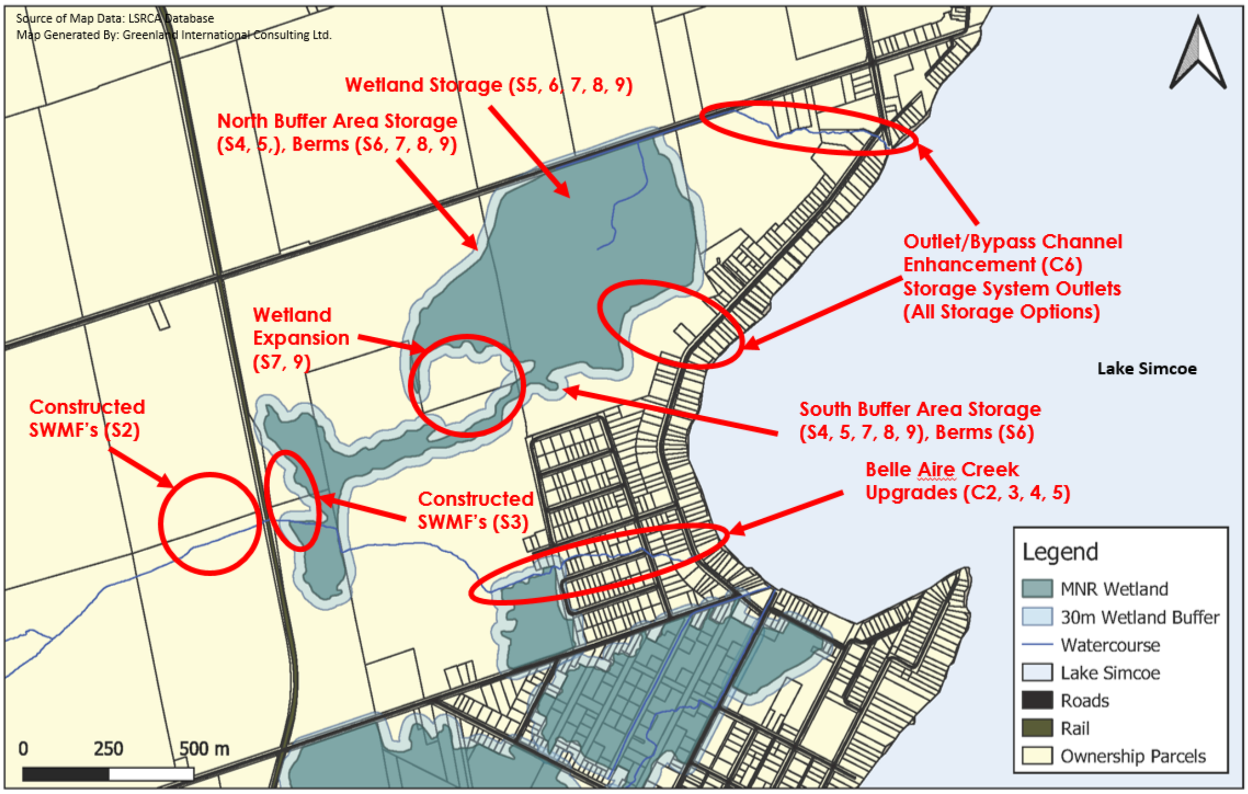

Figure 5-1: Flood Reduction Options - Long List

5.2 Conveyance Options

The following sub-section provides a detailed description of the options which have been identified as potential conveyance solutions, and the screening process applied to these same alternatives to arrive at a short-list of conveyance options to be carried forward for detailed evaluation.

5.2.1 C-1 – Do Nothing – Flood Reduction via Storage Solutions Only

This alternative represents maintaining the status quo from the perspective of conveyance. The modelling report (See **Appendix F**) identifies a capacity of approximately 0.4 m^3/s in the existing conveyance system through developed areas north of Belle Aire Beach road if the status quo is maintained and no improvements or upgrades are pursued. A 'Do Nothing' approach to conveyance would certainly have some negative impacts and would rely entirely on storage solutions to facilitate flood reduction.

The modelling completed as part of this Class EA does indicate that sufficient volume is available upstream to facilitate a storage only solution, albeit with some potential for ongoing impacts. These impacts could potentially be mitigated however, and as such, the "Do Nothing" conveyance option was shorted-listed for further detailed evaluation as it passes both screening Questions identified in **Table 4-1**.

5.2.2 C-2 – Upgrade Belle Aire Creek Channel and Culverts to 100-Year Storm Capacity

This option would essentially represent the opposite of Option C-1 and would include hydraulic upgrades to Belle Aire Creek and associated infrastructure (including culverts) in the 670 m reach between the existing subdivision and Lake Simcoe to accommodate flows for up to and including the 100-year storm event (15.7 m^3/s). Upon review of the channel geometry and topography along the flow path of Belle Aire Creek, it was determined that this option was not technically viable, as substantial raising of land and/or widening of channels would be required within the existing developed areas to facilitate this level of hydraulic upgrades.

Therefore, it was concluded that this alternative cannot satisfy the requirements of the Problem / Opportunity statement due to technical constraints (as per screening Question No. 1 in **Table 4-1**). For this reason, this alternative was not short listed and was not considered further in this study.

5.2.3 C-3 – Upgrade Belle Aire Creek Channel and Culvert Capacity to Convey Existing 2-yr Storm

This Option would increase the capacity of the existing Belle Aire Creek channel from Lake Simcoe to the western edge of existing development (a length of approximately 670 m) from its current hydraulic capacity of approximately 0.4 m^3/s to the 2-year storm capacity of 2 m^3/s. Review of existing topography and modelled channel sections indicates that this could be achieved primarily through grading improvements and without major widening of the channel (as compared to other options such as C-2) or other major detrimental impacts. This option would not only improve localized drainage hydraulics and directly mitigate a substantial number of flood impacts for smaller storm events (up to and including the 2-year event), but would also provide improved baseflow conditions and eliminate standing water observed during preliminary site visits in and around aging culverts (i.e. at the intersection of Spruce Rd. and Temple Ave. which can be seen on Google Maps, see **Figure 5-2** below). It should be noted that in order to maximize mitigation however, this Option would need to be considered in conjunction with storage solutions. For these reasons, Option C-3 was short-listed for additional detailed evaluation.

Figure 5-2: Standing Water at Temple & Spruce (Source Google Maps)

5.2.4 <u>C-4 – Same Upgrade as C-3 but with Alternate Outlet via Undeveloped Properties on Temple Ave & Maple Rd.</u>

This option includes the same proposed hydraulic upgrades as Option C-3 but would redirect the downstream portion of Belle-Aire Creek between Lake Simcoe and Temple Avenue (see **Figure 5-3**) to flow through currently undeveloped properties via a newly constructed outlet channel with a minimum capacity of 2.0 m^3/s to accommodate the 2-year storm event. This option would likely include leaving the current outlet in place as a localized drainage feature for additional capacity (not quantified as part of this study). Although this option would potentially have increased costs complications associated with additional land acquisition as compared to Option C-3, it was determined that this option passes both screening questions outlined in **Table 4-1** and as such it has been carried forward for detailed evaluation.

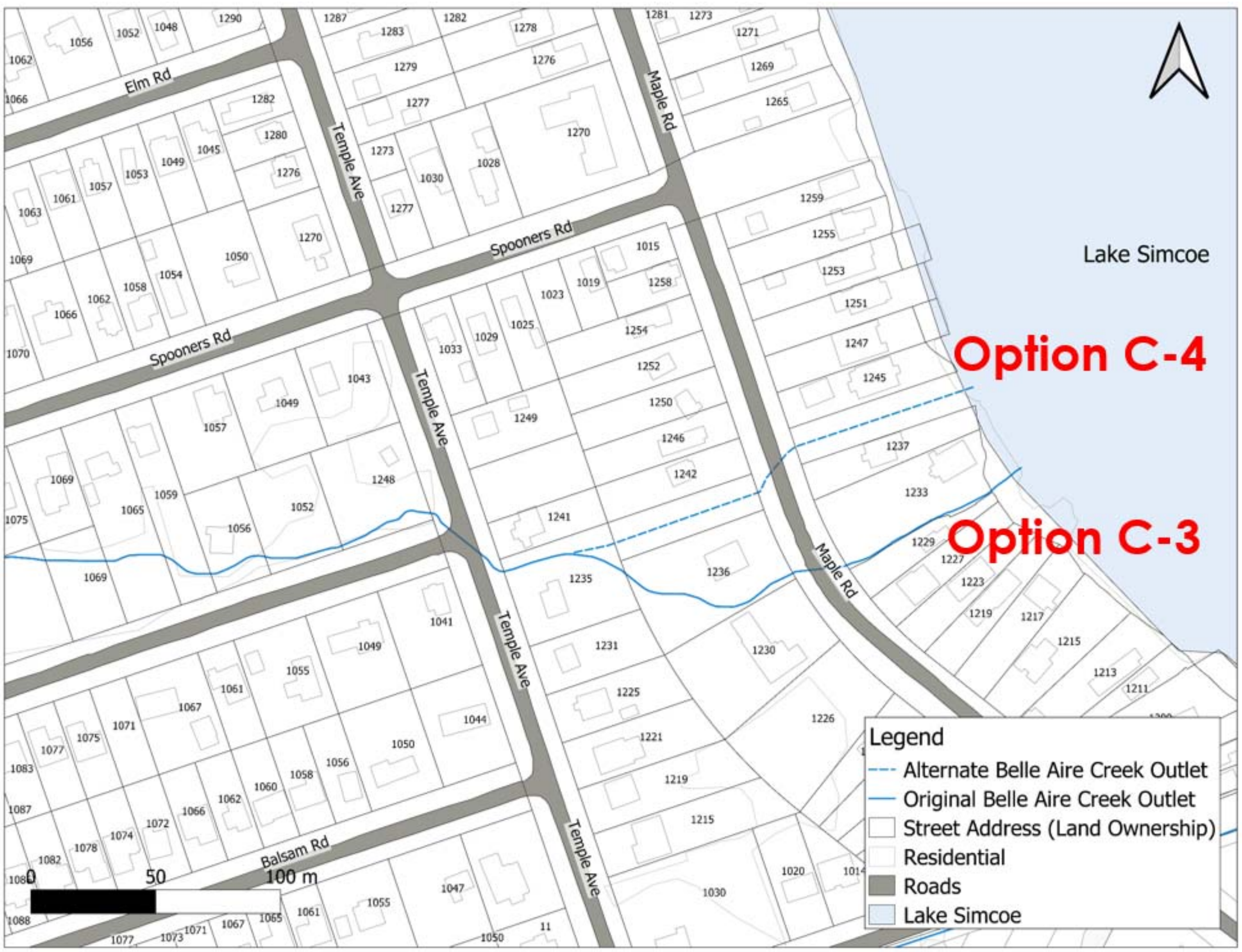

Figure 5-3: Option C-4 Alternate Discharge Route

5.2.5 <u>C-5 – Upgrade Belle Aire Creek Channel and Culverts to 5-Year + Storm Capacity</u>

This option is similar to Options C-3 and C-4 but would include an increase in Belle Aire Creek channel capacity to facilitate flows up to a 5-year event (or beyond). Where Option's C-3 and C-4 appear to be viable without substantial changes to channel geometry or impacts to private property (i.e. for channel widening) it was found during preliminary investigations that any hydraulic capacity expansion beyond the 2-year capacity would begin to have additional detrimental impacts from a technical, land-use and economic perspective, with these impacts growing as the capacity increases went up.

On this basis, and considering the fact that sufficient storage is available to handle events beyond the 2-year capacity, it was determined that this option has potential for significant impacts (as compared on a relative basis to other similar options C-3 and C-4) and as such Option C-5 does not pass screening Question No. 2 in **Table 4-1**. For this reason, this alternative was not short listed and was not considered further in this study.

5.2.6 C-6 – Bypass Wetland & Construct Channel Enhancements in Cedar Creek and/or Municipal Easement to Maple Rd.

This option would completely eliminate upstream flows from entering the existing developed area of Belle Aire Creek downstream of the Metrolinx tracks which bi-sect the Study Area. This option would rely entirely on redirection and storage to capture and control all flows. As this option would eliminate baseflow to the watercourse between the lake and an upstream flow split, there is significant potential for detrimental impacts to stream health in the downstream reaches of Belle Aire Creek.

On this basis, it was determined that this Option does not pass screening Question No. 2 in **Table 4-1**. For this reason, this alternative was not short listed and was not considered further in the Project.

5.3 Flow Bypass & Storage Options

The following sub-section provides a detailed description of the options which have been identified as potential flow bypass and storage-based solutions, and the screening process applied to these same alternatives to arrive at a short-list of storage options to be carried forward for detailed evaluation. It should be noted that the total volume of flow to be bypassed in any of the proposed bypass options will be determined as a result of the detailed evaluation of conveyance options. The storage options being considered herein (unless otherwise specified) are capable of providing adequate storage for all events up to and including the 100-year storm event.

5.3.1 S-1 – Do Nothing

This option would represent the status quo with respect to storage, i.e. relying on existing systems and/or conveyance based solutions to mitigate flooding. As discussed in **Section 5.2**, conveyance solutions alone will not be capable of providing sufficient mitigation to reduce flooding. In addition, none of the SWM facilities located within the study area are hydraulically connected to the main flood-zones in the study area (i.e. residential development north of Belle Aire Beach Road). It was therefore determined that this alternative cannot satisfy the requirements of the Problem / Opportunity statement (as per screening Question No. 1 in **Table 4-1**) and for this reason, the “Do Nothing” storage alternative was not short listed or considered further in this study.

5.3.2 S-2 – Construct New SWMF's On West Side of Rail Line

This Option would include constructing a new SWM Facility to the west of the existing Metrolinx rail line. This Option would require capture and control of a significant portion of upstream drainage and would likely require significant land area and coordination with Metrolinx, as well as potential upgrades to conveyance infrastructure under the rail line. Relatively speaking, this would be a complicated and expensive solution and would likely mean substantial additional studies and design required to minimize any impacts to the Metrolinx line. The option also limits green infrastructure solutions to some extent as proximity to the rail line will likely require a more traditionally ‘engineered’ infrastructure solution. The extended timeline likely required to facilitate all approvals and background evaluations for this option also introduces additional risk associated with inaction and continued flooding damages in the study area for the duration of the design and approvals process.

Based on the above, it was determined that this option has potential for significant impacts and does not pass screening Question No. 2 in **Table 4-1**. For this reason, this alternative was not short listed and was not considered further in this study.

5.3.3 S-3 – Construct New SWMF's on East Side of Rail Line

This Option is similar to Option S-2 but would involve the construction of a SWM facility downstream of the current Metrolinx line. The advantage of this would be that it would theoretically not require any upgrades to the current rail crossing, however sufficient additional background studies and design would be required for any structures within 400m of the Metrolinx line. Relatively speaking, this would also be a complicated and expensive solution (thought likely slightly less so than Option S-2) and would still require additional studies and design required to minimize any impacts to the Metrolinx line. This option also limits green infrastructure solutions to some extent as proximity to the rail line will likely require a more traditionally 'engineered' infrastructure solution. This option also shares the drawback of additional risk associated with timelines for implementation as noted in Option S-2.

Based on this potential for significant impacts, Options S-3 does not pass screening Question No. 2 in **Table 4-1**. For this reason, this alternative was not short listed and was not considered further in this study.

5.3.4 S-4 – Bypass flows to New Green Infrastructure Storage Channel in 30m Wetland Buffer – No Storage in Existing Wetland

This Option would include bypassing flows via a structure located approximately 1 km upstream of Lake Simcoe (approx. 200 m downstream of the Metrolinx crossing) into a new linear green infrastructure feature located in the 30m buffer zone of the existing Cedar Creek Wetland. This option would have no cross connection to the wetland itself and flows would be contained entirely within the buffer zone.

Upon further review of this option it was determined that this alternative cannot provide adequate storage capacity for all storm events without providing additional storage in the wetland area itself, and as such the Option does not satisfy the requirements of the Problem / Opportunity statement (as per screening Question No. 1 in **Table 4-1**).

For this reason, this alternative was not short listed and was not considered further in this study.

5.3.5 S-5 – By-Pass Flows to New Green Infrastructure Storage Channel in 30m Wetland Buffer

This Option is similar to Option S-4 but includes a lower elevation on the side of the buffer channel which is adjacent to the wetland, allowing spillover and storage of stormwater within the wetland itself. This difference results in a viable storage solution with more than sufficient volume to handle flows up to the 100-year storm event, and in fact fully encircling the wetland with a green infrastructure buffer feature provides more than the required level of storage.

This option (as with other solutions utilizing green infrastructure in the buffer zone) would likely have numerous additional environmental benefits beyond providing storage for flood mitigation, including reduction in sediment and nutrient loads.

As such this option was carried forward to the short list for additional detailed evaluation.

5.3.6 S-6 – By-Pass Flows Directly to Existing Wetland and Construct Earth Berms in 30m Buffer

This option would expand the potential storage volume of the existing wetland by constructing an earth berm around the wetland within the buffer. Unlike Option's S-4 and S-5, this option would rely entirely on the wetland for storage, with a forebay downstream of the bypass structure between the structure and the wetland. Although this solution relies less on green infrastructure than other solutions, a properly sized forebay will still facilitate sediment removal and redirection of flows into the wetland for storage. This option also has some economic benefits that should be considered.

This option was carried forward for detailed evaluation as part of the short-list.

5.3.7 S-7 – Option S-6 but with Expansion of main Wetland cell to the West for additional storage.

This option utilizes a similar earth berm encircling the wetland as proposed in Option S-6 but also includes expansion of the wetland area itself by 'cutting the corner' on the western edge of the wetland to reduce the total length of the berm, while also increasing the total available storage within the wetland. This option would mean several acres of land which are technically developable (though which may be challenging to access and/or service) would become environmental lands. Also, despite the shorter berm, this option would have additional construction costs and environmental impacts, requiring approximately 54,000 m^2 of additional tree & vegetation clearing as compared to Option S-6. This same area would also require grading to facilitate additional storage as there is an approximate 2m grade difference between this area and the existing wetland.

As preliminary modelling currently indicates that there is sufficient volume for storage of all storm events up to the 100-year storm within the existing wetland footprint (with sufficient berming), it was determined that potential economic, environmental and land-use impacts for private land-owners are comparatively significant, and as such this Option did not pass screening Question No. 2 in **Table 4-1**.

For this reason, this alternative was not short listed and was not considered further in this study.

5.3.8 S-8 – By-Pass Flows Above 2-yr Storm to Existing Wetland via New Green Infrastructure By-Pass Channel in 30m Buffer and Construct Earth Berms in 30m Buffer

This option effectively acts as a combination of Options S-5 and S-6, in that it will include an earth berm encircling the wetland, but with a green infrastructure channel located along the southern edge of the wetland (within the 30m wetland buffer zone) which serves as both a forebay and as an initial storage and naturalized pre-treatment feature.

Although this option would likely have increased capital costs as compared Option S-6 due to the additional excavation and restoration costs associated with the green infrastructure channel, the channel will provide numerous environmental benefits and will likely decrease maintenance frequency due to the higher dispersion length for incoming sediments.

As such, this option was carried forward for detailed evaluation.

5.3.9 S-9 – Option S8 but with Expansion of main Wetland cell to the West for additional storage.

This option effectively combines the buffer zone works of Option S8 and the wetland expansion proposed as part of Option S-7. As such, this option shares the same economic, environmental and land-use impacts for private land owners as Option S-7, which preliminary modelling deemed unnecessary on the basis of available storage volume.

As such this Option did not pass screening Question No. 2 in **Table 4-1** and for this reason, this alternative was not short listed and was not considered further in this study.

5.4 Summary of Short-Listed Options

Options short-listed during the preliminary screening are summarized in **Table 5-1** below.

These options were carried forward for detailed evaluations (see **Chapter 6** of this ESR) in order to arrive at a final recommended flood remediation design alternative.

Table 5-1: Short Listed Flood Reduction Options by Category

Category	Option Description
Conveyance	C-1: Do Nothing – Flood Reduction via Storage Solutions Only
	C-3: Upgrade Belle Aire Creek Channel and Culvert Capacity to Convey Existing 2-yr Storm
	C-4: Option C-3 upgrades with Alternate Outlet via Temple Ave & Maple Rd Properties
Storage	S-5: By-Pass Flows to New Green Infrastructure Storage Channel in 30m Wetland Buffer
	S-6: By-Pass Flows Directly to Existing Wetland and Construct Earth Berms in 30m Buffer
	S-8: By-Pass Flows to Existing Wetland via New Green Infrastructure By-Pass Channel in 30m Buffer and Construct Earth Berms in 30m Buffer

6 DETAILED EVALUATION OF FLOOD REDUCTION OPTIONS

The following Chapter presents an evaluation of the three (3) Options for both the Conveyance and Storage Stormwater Management Solutions. As described in **Chapter 4**, each set of Options was evaluated based on Natural Environmental Impacts, Social/Cultural/Environment Impacts, Technical/Operation Consideration and Economic Impacts.

The Short-Listed Options are summarized below:

- **C-1** – Do Nothing – Flood Reduction via Storage Solutions Only
- **C-3** – Upgrade Belle Aire Creek Channel and Culvert Capacity to Convey Existing 2-yr Storm
- **C-4** – Option C-3 upgrades with Alternate Outlet via Temple Ave & Maple Rd Properties
- **S-5** – By-Pass Flows to New Green Infrastructure Storage Channel in 30m Wetland Buffer
- **S-6** – By-Pass Flows Directly to Existing Wetland and Construct Earth Berms in 30m Buffer
- **S-8** – By-Pass Flows to Existing Wetland via New Green Infrastructure By-Pass Channel in 30m Buffer and Construct Earth Berms in 30m Buffer

Detailed evaluations and rankings of each Conveyance and Storage Option against the Class EA evaluation criteria are presented in **Table 6-1** and **Table 6-2** respectively. In the evaluation tables, Green is the "Most Preferred Option", Yellow is the "Less Preferred Option" and Red is the "Least Preferred Option".

Please note that more detailed cost information is provided in **Appendix G.**

Table 6-1 Short-List Evaluation for Conveyance Options

Evaluation Criteria	Option C-1 Do Nothing - Flood Reduction Via Storage Solutions Only	Option C-3 Upgrade Belle Aire Creek Channel and Culvert Capacity to Convey Existing 2-Year Storm	Option C-4 Same Upgrades as Option C-3 but with Alternate Outlet via Undeveloped Properties on Temple Ave & Maple Rd.
Natural Environment Impacts			
Impacts of the Option to Vegetation, Wildlife & Natural Environment	No construction impacts.	Construction Impacts limited to 6m Easement and Culvert Upgrades in municipal R.O.W.	Impacts similar to Option C-3 plus additional tree removal and clearing of Maple Rd. Lots.
Surface/Groundwater Quality Implications	Some issues with surface ponding in residential areas will likely remain. No changes to watercourse baseflow.	Reduced flows for all storm events but maintains baseflow. Eliminates ponding in residential areas.	Similar impacts as Option C-3.
Resiliency of Option vs. Climate Change and Future Extreme Weather Impacts	Foregoing upgrades to the channel will have a negative impact on climate change and extreme weather resiliency.	By including the improvements to the Residential Section of Belle Aire Creek, the 1 in 2-year flow will be able to be conveyed, leaving additional volume in the wetland to mitigate extreme weather events.	In addition to improvements offered by Option C-3, the alternate route will provide additional capacity at the downstream end of the system so long as existing culverts on Maple Rd. are left in place.
Natural Environment Overall Rating			
Social / Cultural / Environment Impacts			
Land Use & Archaeological Considerations (Including First Nations)	Least impacts as no work is proposed.	Less land acquisition than Option C-4 but easements still required. No known Archaeological issues with the proposed solution, however this should be verified during detailed design.	Most land acquisition of all options. No known Archaeological issues with the proposed solution, however this should be verified during detailed design.
Impacts to Residents	Continued flooding is anticipated without some upgrades to the existing conveyance system.	Implementation of these changes (in conjunction with storage solutions) will help to reduce flooding conditions for residents. Some impacts to residents during construction, including working easements on private property.	Implementation of these changes (in conjunction with storage solutions) will help to reduce flooding conditions for residents. Some impacts to residents during construction, including working easements on private property.
Visual Landscape/Aesthetic Impacts	The buffer strip around the wetland would increase the aesthetics of the Little Cedar Creek Wetland. The improvements to the residential section of Belle Aire Creek would also make the drainage area more aesthetically pleasing.	Least impact as option will result in improved channel function and aesthetics in residential areas. No tree clearing on Maple Road lots. Some options for trail linkages	Improved aesthetics similar to Option C-3 but with reduced aesthetics on Maple Road lots due to loss of existing tree cover to facilitate alternate outlet. Potential options for trail linkage may offset this.
Social / Cultural Environment Overall Rating			
Technical/Operational Considerations			
Difficulty to Construct or Implement the Option Relative to Other Alternatives	No Works in Existing Residential Areas = Easiest to Construct	Slightly More Difficult than Option C-4 due to more works required on properties with existing structures.	Slightly Less difficult than Option C3 as last 150m of work is on properties without ex. structures. Clearing will still be required however.
Operation & Maintenance Efficiency	Substantial ongoing maintenance of aged infrastructure in Belle Aire residential areas.	Maintenance in the residential areas should be reduced vs. existing aged infrastructure.	Maintenance in the residential areas should be reduced vs. existing aged infrastructure. Some additional new culverts to maintain vs. Option C-3, but slightly less Channel Length.
Technical/Operational Considerations Rating			
Economic Impacts			
Capital/Construction Costs	No capital cost as no additional work is proposed.	Capital and land acquisition costs (easements) anticipated to be approximately $690K	Capital and land acquisition costs (easements & Maple Rd. Properties) anticipated to be approximately $1.38 M
Long Term/Operation & Maintenance Cost Burden	Substantial ongoing maintenance of aged infrastructure in Belle Aire residential areas.	Ongoing Maintenance of Upgraded Channel & Structures Required.	Ongoing Channel Maintenance, Slightly Less Length Than Option C-3 but additional culverts to maintain.
Payment Structure, Cost Recovery Options, and Phasing Flexibility	No Works in Existing Residential Areas	Easement Acquisitions Required	Easement & Property Acquisitions Required
Economic Ranking			
Overall Ranking:			

As seen in the above table, Option C-3 scored the highest in each of the four (4) Evaluation Categories. Therefore, Option **C-3: Upgrade Belle Aire Creek Channel and Culverts Capacity to Coney Existing 2-yr Storm** is the preferred Conveyance Option.

Table 6-2 Short-List Evaluation for Storage Options

Evaluation Criteria	**Option S-5** Bypass flows to New Green Infrastructure Storage Channel in 30m Wetland Buffer	**Option S-6** Bypass flows directly to Ex. Wetland & Construct Earth Berms in 30m Buffer	**Option S-8** Bypass Flows to Ex. Wetland via New Green Infrastructure Bypass/Storage Channel in 30m Buffer & Construct Earth Berms in 30m Buffer
Natural Environment Impacts			
Impacts of the Option to Vegetation, Wildlife & Natural Environment	More Impacts than Option S-6 & S-7 due to clearing of entire 30m buffer strip to replace with bio-filtration/green infrastructure channel. Reduced impacts to wetland due to long buffer/forebay.	Least tree clearing impacts due to 7m width along buffer strip to facilitate berms and access. Shorter inlet channel downstream of bypass will result in reduced settling time - higher impact to wetland.	More clearing than Option S-6 to facilitate 30m biofiltration channel on south side of wetland only but less wetland impacts due to longer inlet channel w/ biofiltration (increased settling time).
Surface/Groundwater Quality Implications	Green infrastructure buffer storage will improve surface and groundwater water quality through bio-infiltration. Enhanced sediment removal prior to entering wetland.	No bio-infiltration proposed for this option. Less benefits to surface and ground water quality. Average sediment removal provided by inlet channel.	Green infrastructure Buffer storage will improve surface and groundwater water quality through bio-infiltration. Enhanced sediment removal prior to entering wetland.
Resiliency of Option vs. Climate Change and Future Extreme Weather Impacts	215,000 m3 more storage than required in 100-year event. High resiliency.	244,000 m3 more storage than required in 100-year event. Very High resiliency.	246,000 m3 more storage than required in 100-year event. Highest resiliency.
Natural Environment Overall Rating			
Social / Cultural / Environment Impacts			
Land Use & Archaeological Considerations (Including First Nations)	Highest use of land area due to utilization of 30m buffer. No known archaeological concerns (to be confirmed during detailed design).	Lowest use of land area for all options due 7m berm width around entire wetland within 30m buffer. No known archaeological concerns (to be confirmed during detailed design).	Slightly more land use than Option S-6 due to bio-infiltration channel inlet. No known archaeological concerns (to be confirmed during detailed design).
Impacts to Residents	Minimal construction impacts to residents. Long term impacts will be similar and generally positive for all options as all options will help to reduce current flooding issues.	Minimal construction impacts to residents. Long term impacts will be similar and generally positive for all options as all options will help to reduce current flooding issues.	Minimal construction impacts to residents. Long term impacts will be similar and generally positive for all options as all options will help to reduce current flooding issues.
Visual Landscape/Aesthetic Impacts	Green infrastructure & bio-infiltration system will be landscaped and can be integrated with trail system linkages for improved aesthetics. Higher impact than Option S-6.	Berms can be integrated with trail system linkages. Highest retention of existing trees and vegetation will lead to minimal aesthetic and visual landscape impacts.	Berms & landscaped green infrastructure inlet can be integrated with trail system linkages. High retention of existing vegetation. Slightly higher impacts than Option S-6.
Social / Cultural Overall Rating			
Technical/Operational Considerations			
Difficulty to Construct or Implement the Option Relative to Other Alternatives	Most difficult option to construct due to substantial earthworks and clearing to facilitate green infrastructure along entire 30m buffer. Some cross connections may also be required.	Lower difficulty due to construction of a berm, new inlet channel, dual outlets, improving two existing channels (Belle Aire Creek and Little Cedar Creek), and completing residential area improvements.	Lower difficulty due to construction of a berm, new inlet channel, dual outlets and improving two existing channels (Belle Aire Creek and Little Cedar Creek). No residential works.
Operation & Maintenance Efficiency	Maintenance of the bypass channel/structure, the entire length of the buffer strip and outlets will be required. Moderate to low maintenance efficiency.	Despite no bio-infiltration/buffer strip channel maintenance requirements, shorter inlet channel will require more regular cleanouts than Option S-8. Maintenance of Bypass and outlet structures will also be required. Moderate maintenance efficiency.	Longer inlet system located on south side of wetland will require less frequent cleanout than Option S-6 and less length to maintain vs. Option S-5. Similar efforts for bypass and outlet structures. Moderate to high maintenance efficiency.
Technical/Operational Rating			
Economic Impacts			
Capital/Construction Costs	Approximately $8.27 Million.	Approximately $5.33 Million.	Approximately $6.11 Million.
Long Term/Operation & Maintenance Cost Burden	Moderate maintenance costs due to size and complexity of buffer strip bio-infiltration systems vs. Options S-6 & S-8.	Moderate maintenance cost due to more regular cleanout requirements without increased settling length.	Less frequent cleanouts than Option S-6 and shorter/less complex bio-infiltration than Option S-5. Lowest Maintenance Cost.
Payment Structure, Cost Recovery Options, Phasing Flexibility	Approximately 3 years required to offset capital costs vs. benefits (reduced flood damage costs)	Approximately 2 years required to offset capital costs vs. benefits (reduced flood damage costs)	Approximately 2 years required to offset capital costs vs. benefits (reduced flood damage costs). Some potential to reduce capital through optimization of South Buffer length during design.
Economic Ranking			
Overall Ranking:			

As seen in the above table, Option S-8 scored the highest in three (3) of the four (4) Evaluation Categories and had the highest overall score. Therefore, Option **S-8: By-Pass Flows Above 2-yr Storm to Existing Wetland via New Green Infrastructure Bypass/Storage Channel in 30m Buffer and Construct Earth Berms in 30m Buffer** is the preferred Storage Option.

7 SUMMARY OF PREFERRED CONCEPT DESIGN

Based on the evaluations presented herein, the recommended overall preferred design concept for remedial flood mitigation in South Alcona (presented in **Figure 7-1** and **Figure 7-2** on the following pages) includes the following preferred options for conveyance and storage, respectively:

7.1 Preferred Conveyance Solution

The preferred conveyance solution is **Option C-3: Upgrade Belle Aire Creek Channel and Culverts Capacity to Coney Existing 2-yr Storm**. This option will include the re-shaping and cleanout of approximately 670 m of Belle Aire Creek through the existing community north of Belle Aire Beach Road to meet a proposed typical cross section as shown in **Figure 7-1** with a maximum channel bottom width of 2m, 2:1 side slopes and a maximum increase in depth of 1.0 m in some areas (i.e. where the channel is currently filled in or has a reversed slope). Culvert replacements and improvements are also recommended at the intersections of Temple Avenue and Maple Road, with triple 900 mm diameter culverts and twin 1.5 m diameter culverts being proposed at each location respectively. These upgrades will provide approximately 2.0 m^3/s of capacity. The flow bypass and storage designs (see **Section 7.2**) will be optimized to ensure that this flow rate is not exceeded in Belle Aire Creek even during the 100-year storm.

7.2 Preferred Storage Solution

The preferred storage/bypass solution is Option **S-8: By-Pass Flows Above 2-yr Storm to Existing Wetland via New Green Infrastructure Bypass/Storage Channel in 30m Buffer and Construct Earth Berms in 30m Buffer** is the preferred storage option.

This option includes a flow split for storms above the 2 year storm event (preliminary design presented in **Appendix F** is even more conservative, using flow split for any events exceeding 0.4 m^3/s) directed into a green infrastructure bio-filtration channel (forebay) located at the south edge of the Little Cedar Creek Wetland, with berming to increase/facilitate wetland storage for storage up to the 100-year storm event.

The solution also includes a dual outlet system with most flows entering Little Cedar Creek (controlled to existing discharge levels) and emergency discharge (above the 100-year storm event) via a second high-flow/emergency outlet channel on municipal property, directed towards Maple Road and ultimately to Lake Simcoe as shown in **Figure 7-2.**

7.3 Anticipated Benefits

Preliminary financial analysis completed during this Class EA estimates that this combined solution could reduce annualized flood damages from $2.7 Million to $197,000, or a 91% reduction as compared to existing conditions (see **Appendix G** for detailed calculations).

Initial water quality modelling was also completed by Greenland as part of this Class EA using the SWAT model. It indicated that the preferred solution will also have tertiary water quality benefits including a net total phosphorous reduction to Lake Simcoe of approximately 10.3 kg per year (assuming zero “treatment”). Details of this analysis are provided in **Appendix C**. These benefits should be more thoroughly quantified as part of the detailed design and implementation process. Suggested implementation and mitigation measures for the preferred flood mitigation strategies are outlined in **Chapter 8** of the ESR.

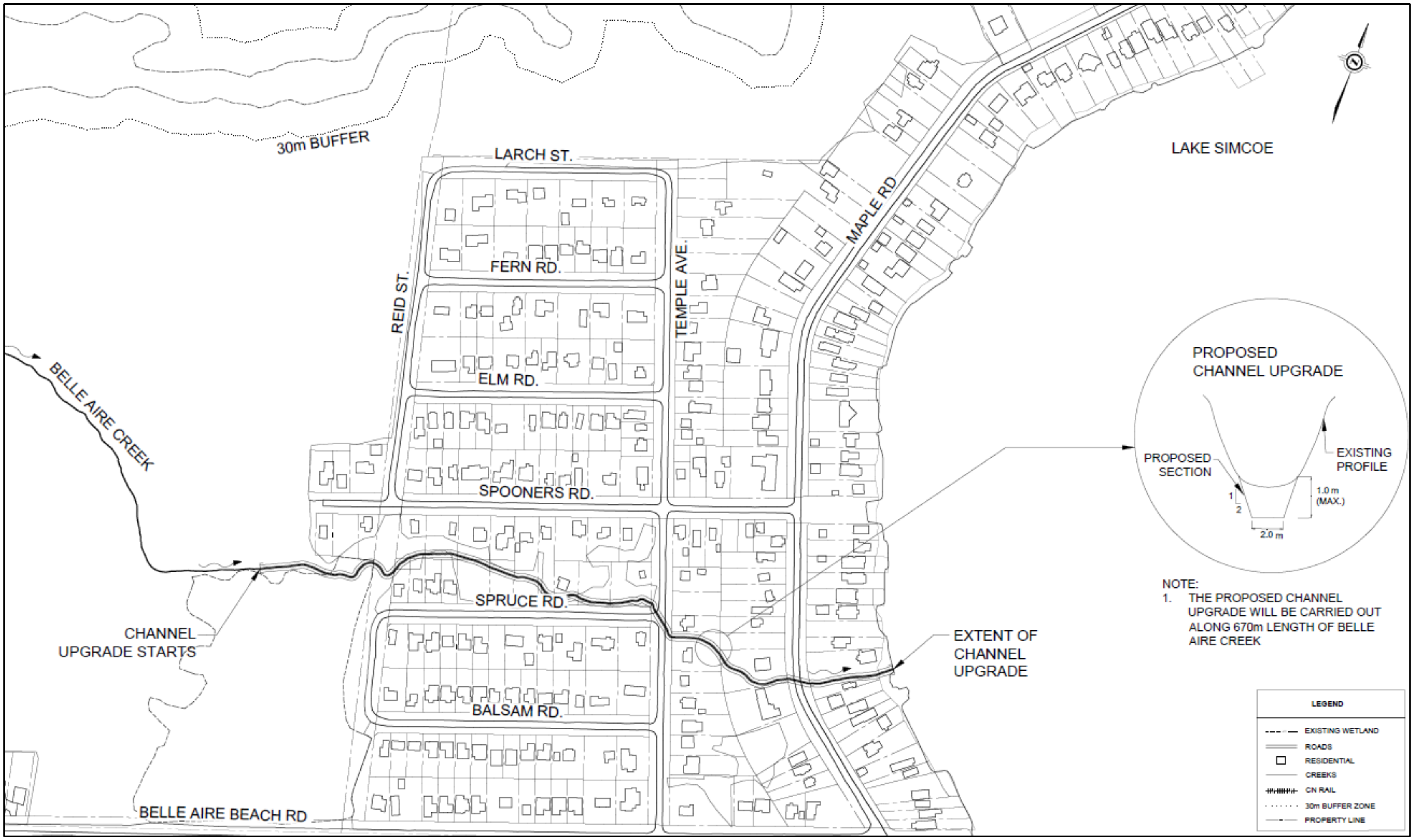

Figure 7-1: Preferred Conveyance Solution Concept Design

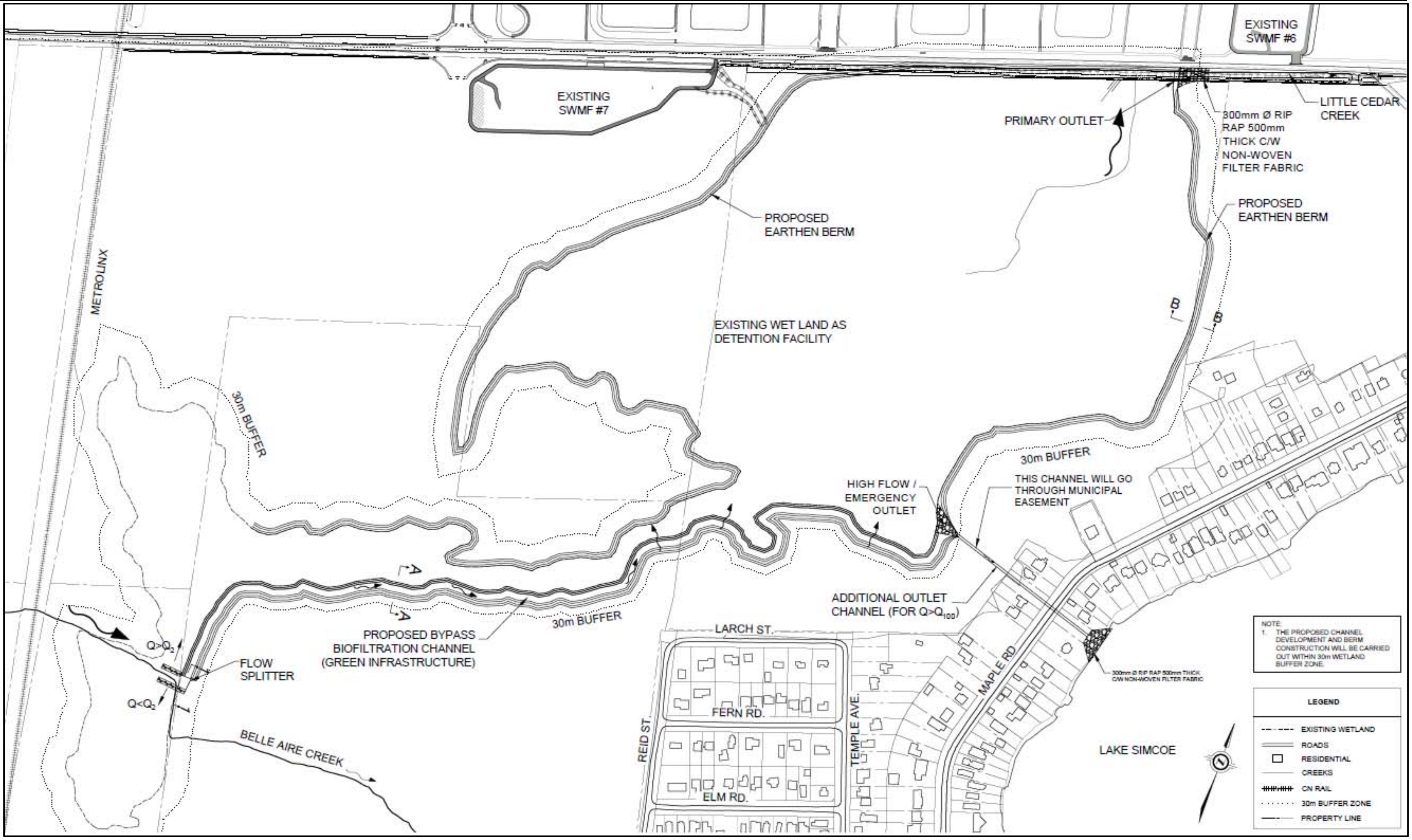

Figure 7-2: Preferred Bypass & Storage Solution Concept Design

8 IMPLEMENTATION & MITIGATION STRATEGY

The following Chapter discusses the key elements of implementing the preferred Concept Designs outlined in the previous chapters. Specifically, approval requirements, data gaps to be addressed, project phasing & timelines, anticipated capital costs and mitigation and monitoring requirements are discussed. With proper mitigation and performance monitoring, flood impacts can be significantly reduced and the natural heritage features and functions within the community can be protected for the long term.

8.1 Projects and Approvals

Projects associated with the preferred concept designs will generally include the construction of a flow bypass structure, green infrastructure/bio-filtration channel, wetland storage system (including earth berms and outlet structures) and channel/culvert capacity improvements along Belle Aire Creek. Although the majority of the EA requirements for these projects have essentially been addressed via this ESR and associated EA process, some additional approvals will be required.

Approval requirements for these projects are summarized in **Table 8-1**.

Table 8-1: Summary of Projects & Approval Requirements

Project Description	Required Approvals
Flow Bypass Structure & Inlet Channel (With Bio-Filtration Feature)	Class EA (This Report), LSRCA & MNR (TBD), Metrolinx, Town, Landowners (through negotiation), Archaeological Assessments (See **Section 8.2**)
Berms and Outlet Structures for Wetland Storage System (All Work within 30m Regulated Buffer by the LSRCA)	Class EA (This Report), Town, Landowners (through negotiation), MECP ECA, LSRCA & MNR Permits, Archaeological Assessments (See **Section 8.2**)
Localized Improvements to Belle Aire Creek Channel and Structures	Class EA (This Report), Town, Landowners (through negotiation), LSRCA & MNR (TBD) Permits, Archaeological Assessments (See **Section 8.2**)

NOTES: 1. Schedule B Project when not approved under the Planning Act
2. The scope of this Class EA has included investigation of design concepts which provide flexibility for the Township to bypass Phase 1A should this prove to be a favourable solution at the time of implementation

8.2 Data Gaps and Additional Studies

It is recommended that the following additional background studies and/or investigations (summarized in **Table 8-2**) be initiated out at the outset of detailed design to verify the effectiveness of the preferred solution and to facilitate the approvals and next steps as outlined in **Section 8.1**.

Table 8-2: Summary of Data Gaps and Additional Studies

Data Gap	Required Additional Studies or Investigations
Confirm topographic data in wetland areas & existing community and associated models.	Detailed topographic survey and/or LIDAR surveys needed to confirm design stage models.
Confirm no Archaeological Impacts in proposed project areas.	Stage 2 Archaeological Investigations as per Town MSP Recommendations (see **Section 2.0**).
Confirm scope of anticipated environmental impacts in project areas.	Site Specific Natural Heritage Investigation including tree removal/protection plans. Update water quality modelling and confirm nutrient reduction estimates.

8.3 Anticipated Project Timelines & Phasing

Following issuance of the notice of completion for this Class EA and closure of the required 30 review and comment period and excepting any Part II orders, the Class EA process for these projects will be complete. At this time, the Project may proceed immediately to design and implementation.

It is recommended that negotiations with landowners and all required background studies listed in **Table 8-2** be initiated as soon as possible following the completion of the EA process. Therefore, these items represent significant time consuming aspects of the implementation process, and as discussed in Chapter 2.0 of this report, existing conditions are costing in excess of $2.0 Million per year in damages to private property, in addition to ongoing costs of municipal emergency response and maintenance/repairs. These costs will continue to burden local residents and the municipality until the preferred solutions are implemented.

8.4 Remedial Flood Mitigation Project Capital Cost

Opinions of probable capital costs (OPC) associated with construction of the preferred Concept Design projects are provided in **Table** 8-3. All costs are provided in 2020 dollars and exclude applicable taxes. Detailed breakdowns of these OPC's and those of other options assessed in **Chapter 6.0** of this ESR are provided in **Appendix G-1** – Site Visit Photos

Appendix H-2 – Flood Mitigation Options
Appendix I-3 – Plan and Cross Section Drawings
Appendix J-4 – Climate Change Resiliency

Appendix K. All OPC's provided as part of this ESR are order of magnitude capital project costs.

Table 8-3: Order of Magnitude Wastewater Treatment and Disposal Costs – Option WWT-9

Project Description	**Opinion of Probable Capital Costs (Millions)***
Flow bypass Structure & Inlet Channel (With Bio-filtration Feature)	$2.61
Berms and Outlet Structures for Wetland Storage System (All Work within Regulated 30m Buffer by LSRCA)	$3.50
Localized Improvements to Belle Aire Creek Channel and Road Drainage Conveyance Structures	$0.69
Sub-total All Projects:	**$6.80**
*Costs include Engineering & Contingency Allowances	

Based on the projected annual damages of approximately $2.079 Million under existing conditions (see **Table 2-3**), and a projected reduction in annual damages to $197,000 under the preferred solution, the payback period for the preferred solution would be approximately **3.6 years**.

A net present value analysis was also completed using the 2019 Bank of Canada discount rate of 4.8% to determine the 50 year lifecycle cost of the proposed projects (including projected annualized damages) versus a "do nothing/status quo" approach. This analysis found that the 50 year net present value of existing damages (excluding costs for things like municipal maintenance) to be approximately **$41.25 Million**, while the lifecycle cost of the preferred solution (including reduced damages, all capital costs in year zero, and an assumed maintenance cost for forebay cleanouts of $500,000 every ten years) was only **$11.47 Million**.

It should also be noted that the above analysis does not factor in any of the financial benefits of the estimated 10.3 kg (minimum) reduction in annual phosphorous loads, which would further reduce the NPV of the proposed solution. Detailed financial calculations are provided in **Appendix G**.

8.5 Project Monitoring and Mitigation Measures

The environmental impacts of the recommended Preferred Design Concepts can be minimized through implementation of a mitigation and monitoring strategy which addresses near-term/construction phase impacts (see **Table 8-4)** as well as long-term impacts (see **Table 8-5**). The purpose of this sub-section is present recommended mitigation strategies which should be referenced and adhered to as the project(s) proceed through design, implementation and ultimately operation.

Diversion and storage works will be constructed outside of environmental protection zones, in an area which is currently undeveloped, which minimizes some of the environmental and social impacts of servicing. Routine inspections during Construction phases of all projects associated with the preferred Design Concept projects will need to be carried out to ensure adherence to design specifications.

Table 8-4: Construction Phase & Near-Term Impacts and Mitigation

Potential Impact	Mitigation Strategy
Sediment & Erosion Control	• Sedimentation and erosion control strategies will be developed for each individual project prior to construction. • Erosion and siltation control measures need to be installed along the construction limits of adjacent wetlands.
Disturbance to Trees & Vegetation	• Construction areas to be restored with native species. • Tree clearing within the regulated 30 m buffer zone should be minimized through use of a tree removal and protection plans. These should be prepared prior to construction as part of the design process and/or Environmental Studies recommended in **Table 8-2** and enforced through inspection activities.
Traffic	• Consultation with Ministry of Transportation, County of Simcoe, local utilities and school boards may be required prior to or during construction. • Affected Property Owners will be notified in advance of construction schedule and duration.
Temporary Impacts (e.g. dust, noise & vibration)	• Construction activities will be limited to day-light hours to minimize impacts to residents. • Dust and storm water controls to be implemented during construction.
Implementation & Commissioning	• Design & tender documents to be developed in consultation with municipal maintenance staff. • Regular site inspections by qualified environmental and civil engineering site inspectors are recommended for all construction work.
Lake Simcoe Protection Plan & Nutrient Analysis	• Design should be completed with direct input from LSRCA technical staff with regards to the impacts of green infrastructure. • Nutrient modelling should be completed as part of the detailed design to quantify treatment impacts of green infrastructure and subsequent phosphorous reductions (& potential offsetting LSRCA program credits).
Other Impacts	• Data gaps identified in **Table 8-2** should be addressed at the outset of the detailed design process in order to streamline design finalize environmental impacts mitigation plans early in the process.

Table 8-5: Long-Term Impacts and Mitigation

Potential Impact	Mitigation Strategy
Surface Water Quality & Monitoring	• Nutrient offsetting and downstream monitoring of nutrient loading should be further investigated at the detailed design stage to verify phosphorous reductions proposed during design and impacts of final green infrastructure implementation.
Stormwater Management & Drainage	• Engineering & Landscape design shall ensure matching of existing drainage patterns in accordance with Town and LSRCA Requirements. • Timing of works should be completed in accordance with Environmental Studies recommended in **Table 8-2**. • Temporary/Interim drainage and SWM measures should be taken into account during construction to minimize potential for construction phase drainage issues.
Removal of Trees & Vegetation	• Restore Construction areas with native species. • Vegetation removal requirements and enhancement opportunities to be investigated at the detailed design stage. • Tree removal and preservation to be conducted in accordance with recommendations of Environmental Studies recommended for completion at the design stage (see **Table 8-2**).
Residential Impacts	• Detailed design should include a Landscaping component which addresses integration of trail systems and other ongoing planning activities (i.e. proposed Innisfil Orbit development) and naturalized plantings to improve aesthetics of the preferred solutions.
Other Environmental Impacts	• In season field inventories in the proposed work limits of the preferred design concept projects are recommended for completion at the detailed design stage. • Fisheries constraints will need to be verified with MNR as part of the design process and incorporated into the design process. • Updated Geotechnical and Hydrogeological investigations should be completed at the detailed design stage. • Final design should include a mitigation strategy to protect and enhance the natural heritage systems within the Community of Alcona in accordance with the mitigation measures recommended above and in the recommended Environmental Studies.

9 SUMMARY OF PUBLIC INVOLVEMENT

Public consultation is an important part of any Class EA Process, and extensive consultation with relevant agencies, stakeholders and the affected public was carried out throughout all stages of the Alcona NDMP Project and throughout this Class EA as documented in **Appendix L**. Notices associated with the CA Class EA process have been provided in the Public Consultation Record (**Appendix M-1**), with copies of all public presentations provided in **Appendix N-2**. A record of all comments received from members of the public and from relevant approvals agencies, as well as responses to those comments can be found in **Appendix O-3**. In addition to the measures listed herein, all notices and related updates, media articles and other helpful information were published on the official Project website maintained by Greenland at www.alconandmp.com.

9.1 Notice of Commencement

The Notice of Study Commencement (NOSC) was sent to the agency and stakeholder mailing list, posted on the Town's website (www.innisfil.ca) and published in the local newspaper the Innisfil Journal on **September, 20 2019**. Copies of the NOSC and associated circulation lists can be found in **Appendix O-1**.

9.2 Public Information Center (PIC) No. 1 and No. 2

Notices of the Public Open House (PIC) No. 1 & 2 were sent to the agency and stakeholder mailing list as revised with individuals requesting to be kept informed throughout the Project process following issuance of the Notice of Commencement. It was also published on the Town's website and in the Innisfil Journal on December 5th, 2019 and February 20th, 202 respectively. The Notice for PIC No. 1 and No. 2 are provided in **Appendix M-1**.

PIC No. 1 was held on **Thursday 10 December 2019** from 4:00 PM to 7:00 PM in the Community Rooms B & C at 2101 Innisfil Beach Rd, Innisfil, ON L9S 1A1. The purpose of the meeting was to present:

- The Class EA process;
- Background information on the Study Area and work done to date;
- Provide background information on modelling and existing flood damages
- Discuss the long-list of solutions & Screening Process;
- Present the short list of design concepts;
- Present & Discuss the decision-making framework & evaluation criteria; and,
- Solicit input on the foregoing from the public, agencies and stakeholders.

The PIC No. 1 presentation, display panels and hand-out material are provided in **Appendix N-2.** The public and review agencies had the opportunity to review the Class EA material and provide input on the information provided to date. A handout summarizing the information was available together with a comment sheet to be completed and returned as desired.

Two (2) comment sheets were returned and two (2) letters were received via the online website and email. Copies of received comments, meeting agendas/minutes and the PIC attendance sheet are provided in **Appendix O-3**.

PIC No. 2 was held on **Tuesday 10 March 2020** from 4:30 PM to 7:30 PM in the Community Rooms B & C at 2101 Innisfil Beach Rd, Innisfil, ON L9S 1A1. The purpose of the meeting was to present:

- The Class EA process;

- Background information on the Study Area and work done to date;
- Discuss the long-list of solutions & Screening Process;
- Present the short list of design concepts;
- Present & Discuss the decision-making framework & evaluation criteria;
- Present the Evaluation Process and Results for Storage & Conveyance Options;
- Present the Recommended Preferred Design Concept for the Study Area; and
- Solicit input on the foregoing from the public, agencies and stakeholders.

The PIC No. 2 presentation, display panels and hand-out material are provided in **Appendix N-2.** The public and review agencies had the opportunity to review the Class EA material and provide input on the information provided to date. A handout summarizing the information was available together with a comment sheet to be completed and returned as desired.

No comment sheets were returned and no letters were received via the online website or email. Copies of received comments, meeting agendas/minutes and PIC attendance sheet are provided in **Appendix O**.

9.3 Issuance of Notice of Completion

The notice of Completion for the Alcona NDMP Class EA Environmental Study Report was published on **March 31, 2020**.

The notice was sent to the agency and stakeholder mailing list as revised with individuals requesting to be kept informed throughout the process following issuance of the Notice of Commencement and subsequent PIC. The notice was also published on the LSRCA website and in the Innisfil Journal.

A copy of the Notice of Completion is provided in **Appendix M-1.**

9.4 Implementation of Received Comments

Meetings and discussions with residents impacted by flooding have been an important part of this EA process. For example, flooding areas not shown in the modelling have been identified for Greenland by impacted residents and shown as ‘additional observed’ flooding areas in this ESR. These areas will need additional survey during design.

Other than providing additional insight to the scope of the problem, comments from residents have generally been positive and supportive of the approach which has been taken to this EA. Any further comments received during the 30 day review period beginning on the date of the Notice of Completion will be incorporated in the EA project file and considered and/or implemented as appropriate. Documentation of received comments and responses is provided in **Appendix H-3**.

10 CONCLUSION

This Conservation Authority Class EA has been completed to determine a preferred design concept for remedial flood mitigation measures to address chronic flooding in the Community of Alcona.

Through a comprehensive EA process, a preferred storage and conveyance Design Concept has been determined which proposes the bypassing of flows above 0.4 m^3/s via a green infrastructure inlet channel to a new storage system in the Little Cedar Wetland and limiting flow to the downstream reaches of Little Cedar Creek to a maximum capacity of 2.0 m^3/s (**Storage Option S-8**), in conjunction with implementing channel and culvert upgrades to this same reach (**Conveyance Option C-3**) will help to mitigate the current annualized damages by up to 91%, while also ensuring that all natural features are maintained, restored, or improved, including a minimum anticipated reduction in annual total phosphorous loading to Lake Simcoe of 10.3 kg.

Based on a 50 year lifecycle, it is anticipated that preferred solution will cost approximately $11.47 Million (NPV), while maintaining the status quo will result in a cost to residents of $41.25 Million (NPV) over the same time period.

We trust that the foregoing Environmental Study Report meets with the LSRCA's requirements and the goals for addressing this important issue.

GREENLAND INTERNATIONAL CONSULTING LTD.

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Reviewed By:

R. Mark Palmer, P. Eng.
President / CEO & Director-in-Charge

Appendix A – Figures
Appendix B – Innisfil MDP Report (Excerpts)
Appendix C – Preliminary Water Quality Analysis
Appendix D – Environmental Studies (Azimuth 2008)
Appendix E – Archaeological Studies (Poulton & Associates Inc.)
Appendix F – Hydrologic and Hydraulic Modeling Report
- **Appendix G-1 – Site Visit Photos**
- **Appendix H-2 – Flood Mitigation Options**
- **Appendix I-3 – Plan and Cross Section Drawings**
- **Appendix J-4 – Climate Change Resiliency**

Appendix K – Cost Analysis
Appendix L – Public Involvement
- **Appendix M-1 – Public Notices**
- **Appendix N-2 – Public Information Centers 1 and 2 Materials**
- **Appendix O-3 – Public Feedback, Comments & Responses**