TATHAM ENGINEERING

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Whiskey Creek Drainage Improvements at Minet's Point

City of Barrie

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	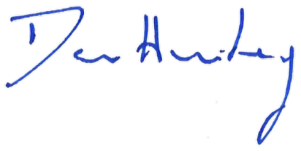
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Issue	Date	Description
1	December 11, 2020	First Submission (Draft)
2	April 27, 2021	Second Submission (Final Draft)
3	June 15, 2021	Third Submission (Final)

Document Contents

Tables

Figures

Appendices

1 Introduction

In 2020, the City of Barrie retained Tatham Engineering Limited (Tatham) to undertake the Whiskey Creek Drainage Improvements at Minet's Point Environmental Assessment. The assessment is being undertaken in accordance with the Schedule 'B' Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment Document (October 2000, as amended in 2007, 2011, and 2015). This Municipal Class Environmental Assessment details the drainage deficiencies and issues identified in the study area, alternative solutions considered to address these deficiencies/issues, and the evaluation of these alternatives towards developing a preferred alternative solution to be implemented moving forward.

1.1 STUDY AREA

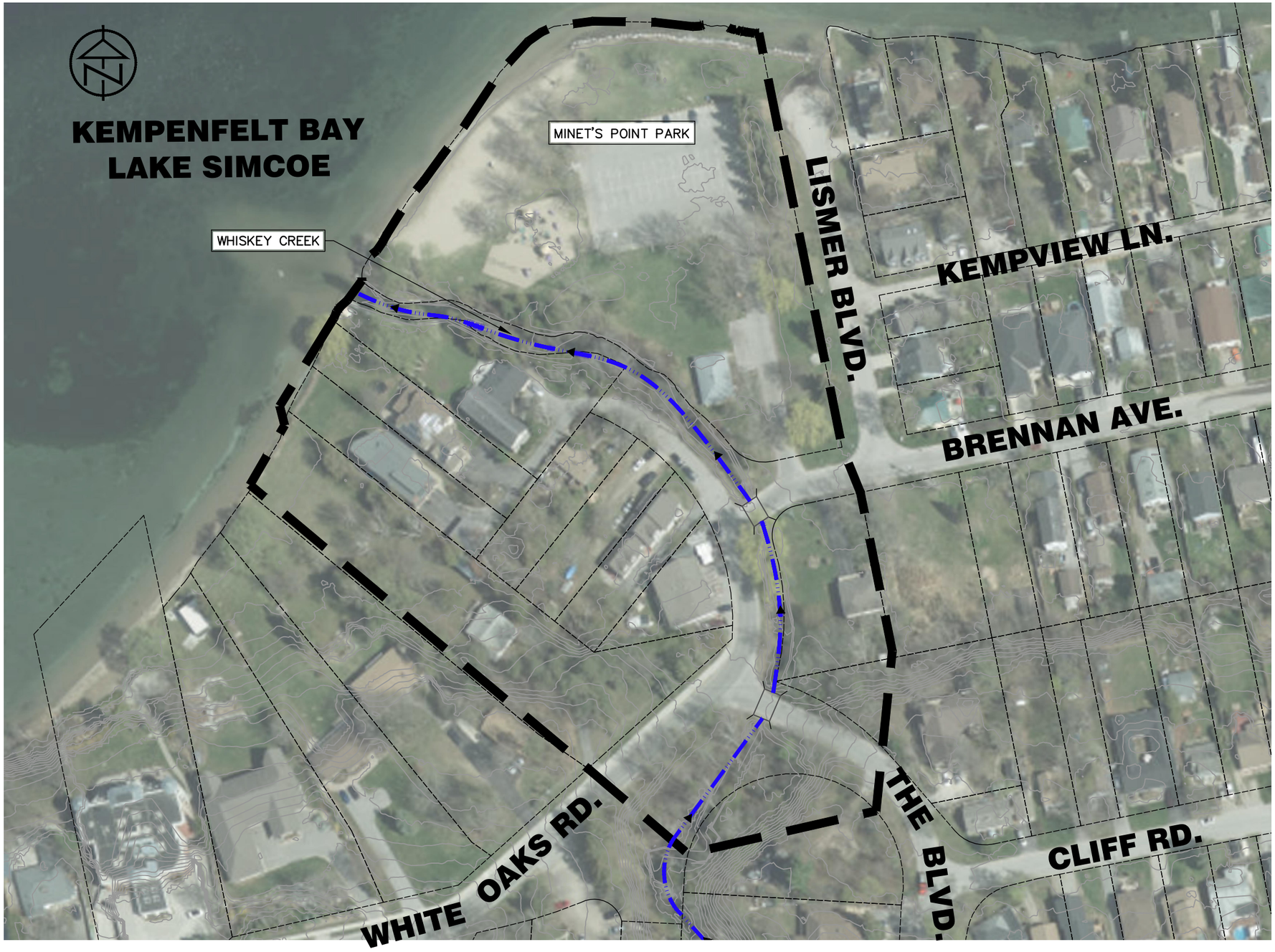
The study area is the lower reach of Whiskey Creek, including its floodplain, from The Boulevard to Kempenfelt Bay as illustrated on Figure 1 – Study Area Location Plan provided overleaf. Drainage improvements are being considered within the study area to reduce the frequency of flooding along this reach of Whiskey Creek. Alternative solutions being considered also include transportation system modifications which potentially impact traffic movement and pedestrian access north of Hurst Drive from White Oaks Road to Brennan Avenue. Although drainage improvements are only being considered in the study area illustrated on Figure 1, the transportation impacts are being evaluated in the overall area north of Hurst Drive between White Oaks Road and Brennan Avenue.

1.2 BACKGROUND

The subject reach of Whiskey Creek from the outlet at Kempenfelt Bay to just upstream of The Boulevard has had historic flooding issues and has been the subject of several technical studies to identify deficiencies along the drainage system and recommend preferred solutions for implementation. The past technical studies providing recommendations for the subject reach of Whiskey Creek which were reviewed for this Class EA are summarized in the following sections.

1.2.1 Whiskey Creek Master Drainage Plan Update (2011)

The *Whiskey Creek Master Drainage Plan Update Environmental Assessment Document* prepared by AECOM (October 2009, Brief Technical Addendum August 2011) was adopted by the City of Barrie in 2011. The preferred alternative solution established through the Class EA process was Alternative 5 – Increase hydraulic capacity to 1:100-year storm conveyance for creek channel and culvert crossings with specific locations for Regional storm conveyance. The



KEY PLAN

LEGEND

- EX. PROPERTY LINE
- STUDY AREA
- 250.00 EX CONTOUR

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WHISKEY CREEK DRAINAGE IMPROVEMENTS

FIGURE 1 – STUDY AREA LOCATION PLAN

DWG. No. **FIG.1**

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Drawing Name: 120114–Whiskey Creek Design Alt.dwg, Plotted: Oct 09, 2020

individual projects recommended for implementation under the preferred alternative solution included culvert improvements at The Boulevard and Brennan Avenue to convey the 1:100-year return frequency design storm peak flow (greater than the City design guidelines for local road crossings; 1:50-year) and watercourse improvements from The Boulevard to Kempenfelt Bay.

1.2.2 Detailed Design

Following the adoption of the *Whiskey Creek Master Drainage Plan Update Environmental Assessment Document* prepared by AECOM (October 2009, Brief Technical Addendum August 2011), the preferred alternative solution proceeded to final design. During final design, several constructability issues were identified with the preferred alternative solution, including poor soil conditions in the area, conflicts with existing services, utilities and the existing washroom/generator building, grading constraints, construction timelines relative to fishery timing windows, resident access during construction, and cover constraints. As such, the detailed design was put on hold and the preferred alternative solution was re-evaluated as part of the *Drainage Master Plan (2019)* discussed next.

1.2.3 Drainage Master Plan (2019)

The *Drainage Master Plan* (DMP) prepared by Tatham Engineering Limited (Tatham) in March 2019 evaluated alternative solutions to address the drainage issues along the subject reach of Whiskey Creek. Individual projects recommended for implementation through the DMP included culvert improvements at The Boulevard and Brennan Avenue and watercourse improvements from The Boulevard to Kempenfelt Bay, which are consistent with the recommendations of the *Whiskey Creek Master Drainage Plan Update Environmental Assessment Document*. Specifically, the DMP recommended:

- The existing culvert crossing The Boulevard be replaced with a 10.67 m open bottom span structure with capacity to convey the 1:100-year return frequency design storm peak flow;
- The Whiskey Creek watercourse between Brennan Avenue and The Boulevard be widened and deepened to convey the 1:100-year return frequency design storm peak flow;
- The existing culvert crossing Brennan Avenue be replaced with twin 9.14 m open bottom span structures with capacity to convey the 1:100-year return frequency design storm peak flow and Brennan Avenue be raised to accommodate minimum cover requirements; and
- The Whiskey Creek watercourse between Kempenfelt Bay and Brennan Avenue be widened and deepened to convey the 1:100-year return frequency design storm peak flow. To provide this capacity, the watercourse would need to be graded at a 0% slope from Kempenfelt Bay to Brennan Avenue and the existing sewage pumping station, a building in Minet's Point Park and the park entrance relocated.

The DMP also noted that Whiskey Creek is a coldwater fishery and a low flow channel must be incorporated into the design of the watercourse improvements.

During the DMP, changes to the road network were identified as alternative solutions to address flooding along Whiskey Creek. However, the DMP focused on drainage improvements and the changes to the local road network fell outside the scope of the study. As such, it was recommended through the DMP that the preferred solution through the subject reach of Whiskey Creek be re-evaluated in a subsequent Class EA.

1.2.4 Whiskey Creek Drainage Improvements at Minet's Point (2021)

As part of this environmental assessment, the changes to the road network identified through the *Drainage Master Plan (2019)* were evaluated against the hydraulic improvements. Also, the constructability issues identified through the previous detailed design were reconsidered as part of the evaluation of the alternative solutions considered. To do so, the following was completed:

- A detailed topographic survey was completed to identify and address any grading and cover constraints;
- A base plan was prepared from the topographic survey, available record drawings for White Oaks Road, The Boulevard and Brennan Avenue, and utility designs supplied by the various utility providers to identify all potential service and utility conflicts;
- The existing soils reports available in the study area were reviewed and alternative culvert foundation designs were considered for the various alternative solutions; and
- The construction timelines were re-evaluated in consideration of the scope of work under each alternative solution and the fishery timing windows applied to Whiskey Creek through the subject reach.

The constructability issues were also considered in the preparation of the project cost estimates for each alternative solution considered. Detailed design and construction recommendations for the preferred alternative solution are included in Section 10 of this report.

1.2.5 Additional Background

Additional background related to this project, including legal surveys, reports on historic flooding, etc. are included in Appendix A for reference.

1.3 PROJECT TEAM

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

- City of Barrie (City);
- Tatham Engineering Limited (Tatham) – Engineering;
- Lake Simcoe Region Conservation Authority (LSRCA);
- RiverStone Environmental Solutions Inc. (RiverStone) – Natural Heritage;
- Archeoworks Inc. (Archeoworks) – Archeological; and
- Water's Edge Environmental Solutions Team (Water's Edge) – Geomorphology.

1.4 MUNICIPAL CLASS EA PROCESS

This Municipal Class Environmental Assessment has been developed in accordance with the Schedule 'B' Municipal Class Environmental Assessment process (provided overleaf) outlined in the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment Document (October 2000, as amended in 2007, 2011 and 2015). It considers all aspects of the environment: physical, natural, social, cultural and economic, and involves consultation with the public, affected parties and review agencies throughout the process.

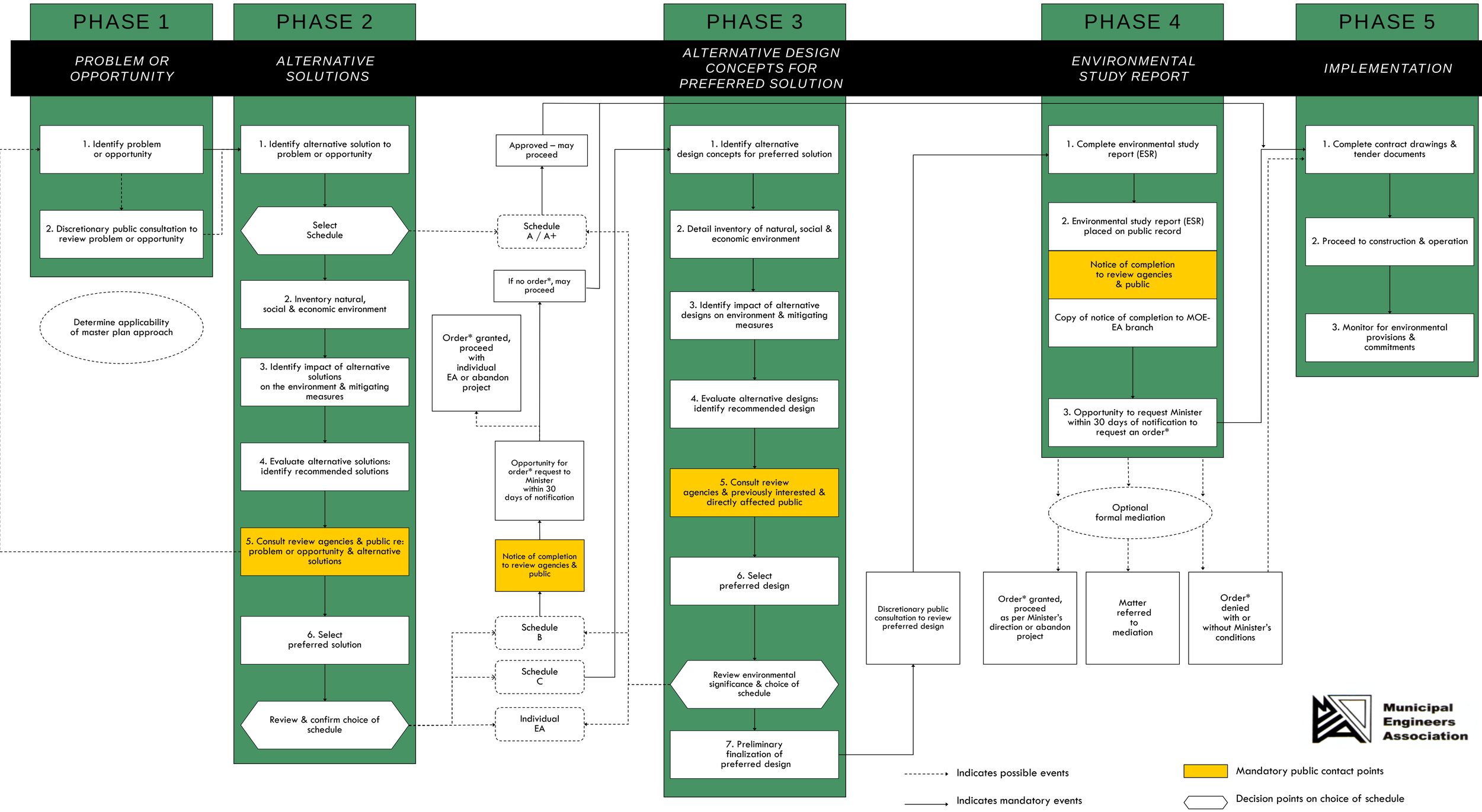
This Municipal Class Environmental Assessment is proceeding through Phases 1 and 2 of the Class EA process as follows:

Phase 1: Identify the Problem.

Phase 2: Identify and assess, at a strategic level, alternative solutions to the identified problem, then recommend the preferred solution that can be implemented as a separate subsequent project(s).

This document has been prepared upon the conclusion of Phases 1 and 2 of the Class EA process and made available for public comment prior to being approved and adopted by the City.

Municipal Class EA Process



Municipal Engineers Association

1.5 EXISTING POLICIES

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

1.5.1 Storm Drainage and Stormwater Policies and Design Guidelines (2020)

The City of Barrie *Storm Drainage and Stormwater Management Policies and Design Guidelines* provide direction for the effective management of stormwater in the City. The Policies and Guidelines provide uniform minimum standards and policies for the planning process and stormwater infrastructure design. The document includes the City's policies and guidelines regarding environmental protection (water quality, water quantity, water balance, etc.), natural hazards (flood and erosion hazards), stormwater management facility design, and urban design concepts including traditional concepts and low impact development (LID) techniques. Generally, these guidelines include the mandates of the other policies, regulations and guidelines discussed in this section. As such, these guidelines act as the basis for the development of the stormwater solutions.

As per the City's guidelines, the minor drainage system (storm sewer) shall be designed to convey the 1:5-year (minimum) design storm peak flow. Watercourses and channels shall be capable of conveying the Regulatory storm peak flow without flooding adjacent private property, where feasible. Flooding of existing buildings and/or property shall be eliminated where feasible. Brennan Avenue and The Boulevard are urban local roads and culvert crossings and road elevations must satisfy the 1:50-year design flood frequency criteria.

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

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

1.5.3 LSRCA Watershed Development Guidelines (2020)

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

subject to LSRCA review and approvals allowing the LSRCA to ensure development proposals have regard for the existing natural hazards.

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

1.5.4 LSRCA Technical Guidelines for Stormwater Management Submissions (2016)

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

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

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

As part of road reconstruction projects, attempts are to be made to fully comply with the linear development volume control criteria. If compliance is not achievable due to soil/groundwater conditions or site constraints, flexible treatment alternatives shall be applied. The flexible treatment alternatives are described as follows:

- Alternative 1 – Retain the runoff from the 12.5 mm event from the total reconstructed impervious surface;
- Alternative 2 – Achieve runoff volume reduction to the maximum extent possible (minimum 5 mm from all impervious surfaces); or
- Alternative 3 – Off-site control of the runoff from a 25 mm event from the net increase in impervious surface.

1.5.5 Lake Simcoe Protection Plan (2009)

The Lake Simcoe Protection Plan's priority is to protect and restore the long-term ecological health of the Lake Simcoe watershed. Short term focus includes restoring the health of aquatic life, improving water quality, maintaining water quantity, protecting and rehabilitating shorelines and natural heritage features, and addressing impacts of invasive species, climate change, and

recreational activities. The strategies outlined in the LSPP will evolve over time based on scientific research and experience to ensure the objectives are satisfied. The objectives of the Plan as set out in the *Lake Simcoe Protection Plan* (2009) are to:

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

The study area is located in the Lake Simcoe watershed and falls under the general authority of the *Lake Simcoe Protection Plan* (LSPP).

1.5.6 Stormwater Management Planning and Design Manual (2003)

The *Stormwater Management Planning and Design Manual* evolved from the MECP *Stormwater Quality Best Management Practices* manual (June 1991) in response to evolving stormwater management practices to provide an integrated approach to effective stormwater management planning and design focused on water quality, water quantity and erosion control. The Planning

and Design Manual is a tool, not a rulebook, providing practical guidance for the effective design of lot level, conveyance, and end-of-pipe stormwater practices. The objectives of the Planning and Design Manual are to apply an integrated treatment train approach to manage stormwater, maintain the hydrologic cycle, protect water quality and prevent increased erosion and flooding.

1.5.7 The City of Barrie Official Plan (2018)

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

The stormwater management goals of the OP are:

- To protect and enhance the water quality and environmental, aesthetic and recreational potential of the City's watercourses, Little Lake, Kempenfelt Bay and Lake Simcoe.
- To encourage effective stormwater management to control flooding, erosion, sedimentation and maintain and enhance water quality in the receiving watercourses and water bodies.
- To promote the incorporation of natural waterways, valleys, and ponds into continuous green corridors for wildlife habitat, open space, and parkland.
- To ensure stormwater management policies minimize stormwater peak flows, contaminant loads including phosphorus, and maintain or increase the extent of vegetative and pervious surfaces.

The alternatives for this project, especially as they relate to the effective management of flooding, erosion and sediment, will consider these goals, objectives and policies.

1.5.8 Provincial Policy Statement (2020)

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

- Development and site alteration are restricted on lands adjacent to natural heritage features unless it is demonstrated that the natural features and their ecological functions are not negatively impacted.

- Development and site alteration are restricted on lands adjacent to sensitive surface water and groundwater features unless mitigative measures or alternate development approaches protect these natural features.
- Significant built heritage features are to be conserved.

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

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

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

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

1.5.10 Natural Heritage Strategy (2013)

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

1.5.11 Natural Hazards Policies

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

1.5.12 Growth Plan

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

1.5.13 Phosphorus Reduction Strategy (2010)

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

1.5.14 Phosphorus Offsetting Policy (2017, Updated 2019)

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

As the City implements projects, they will be required to pay the phosphorus offset or implement measures to achieve the Zero Export Target. If measures are implemented which reduce phosphorus loads below existing conditions, the City will receive a credit to offset increases in phosphorus loads resulting from City projects elsewhere in the watershed, eliminating the need to pay the phosphorus offset. It is recommended that the City maintain a record of phosphorus offsets and credits applied/accumulated throughout the City and evaluate the most cost-

effective solution (implementing treatment options or paying the required phosphorus offset) for each capital project moving forward.

1.5.15 Lakes and Rivers Improvements Act (LRIA)

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

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

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

- Dams;
- Watercourse crossings (bridges, culverts and causeways) where the drainage area for the watershed upstream of the crossing is greater than 5 km^2 unless construction is being undertaken by a Provincial Ministry or municipality, or contractors employed by a Provincial Ministry or municipality on lands owned by the Crown or the municipality undertaking the construction;
- River channels (channelization of rivers, including dredging, diverting or enclosing a channel except for the installation or maintenance of a drain subject to the Drainage Act) where channelization of a river or stream may harmfully alter fish habitat, or impede the movement of fish in a river, stream or lake. Where the potential impact of channelization work on fish habitat and/or fish movement is unknown, such impacts must be confirmed with Department of Fisheries and Oceans (DFO) or their delegate in consultation with the MNRF. Where it is determined that proposed work will adversely affect fish habitat and/or impede the movement of fish an LRIA approval is required;

- Enclosures (river or stream enclosures) that enclose a length of watercourse greater than 20 m and may harmfully alter fish habitat or impede fish movement;
- Buried pipelines and cables where they hold back, forward or divert water; and
- Municipal and other drains.

1.5.16 Habitat Protection Provisions of the Fisheries Act

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

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

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

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

For this study, a DFO review is required for the culvert and watercourse improvements that do not satisfy the DFO exemption criteria and measures to avoid and mitigate harm.

1.6 LAKE SIMCOE WATER LEVELS

The focus of this environmental assessment is to reduce the frequency of flooding associated with Whiskey Creek through the study area. However, we understand the public has concerns

regarding Lake Simcoe water levels and flooding along the shoreline. Although shoreline flooding will not be addressed through this EA, we want to provide an overview of how and why Lake Simcoe water levels are managed.

Lake Simcoe is part of a much larger system known as the Trent-Severn Waterway. The Trent-Severn Waterway is 386 km long with 18,600 square kilometers of interconnected lakes, rivers and channels which connect Lake Ontario at Trenton to Georgian Bay at Port Severn. Hundreds of thousands of people rely on the waterway for drinking water, flood control, tourism and recreation and the waterway provides water for power generation, municipal water supply, agriculture and supports a variety of fish and wildlife. The City of Barrie is one of nearly 50 communities located on its shores which is impacted by the management of this waterway.

Lake Simcoe water levels are managed by Parks Canada via the Trent-Severn Waterway. Typically Lake Simcoe water levels vary by 0.4 to 0.5 m during any given year. The highest levels occur in the spring and as summer progresses the water level begins to drop. The lowest levels are reached in late fall and winter. As Lake Simcoe is part of the larger Trent-Severn Waterway, actions taken to alter water levels in Lake Simcoe cannot occur without repercussions elsewhere in the waterway. As such, the management of the Trent-Severn Waterway is extremely complex and considers all the varying needs and impacts that each decision or action will have on the rest of the waterway. Parks Canada described the management of Lake Simcoe Water Levels as follows:

"Lake Simcoe is controlled by several dams constructed in the multiple outlet channels at Washago. Parks Canada monitors and manages water levels throughout the year to ensure sufficient water for navigation, preserve ecological integrity and to provide flood mitigation to the extent possible for the lake and the Trent-Severn Waterway. Water level management on Lake Simcoe adheres to a complex protocol that incorporates many contributing factors, and considers the entire watershed network. In general, the water levels of Lake Simcoe and Lake Couchiching are operated based on target levels that resemble natural lake level patterns, such as the rapid rise in the spring, the gradual lowering through late fall, followed by constant levels in winter. These target levels are based on operational and navigation requirements, topography and hydrology, the protection of public safety, ecological considerations for wildlife and fisheries, as well as socio-economic considerations. In addition, water levels in Lake Simcoe respond slowly to water management operations and the lake levels are not easily adjusted by the dams, unless there is significant time in which to discharge water. It may take several days of water management operations using the dams in Washago to impact water levels or to reach the targeted level, while taking into account downstream conditions."

2 Problem / Opportunity Statement

The *Whiskey Creek Master Drainage Plan Update (2009)*, *Drainage Master Plan (2019)* and minor and major drainage system models of Whiskey Creek were reviewed in detail to clearly identify the drainage issues/deficiencies in the study area which need to be addressed. The Problem and Opportunity Statements for this Class EA are provided in the following sections.

2.1 PROBLEM STATEMENT

Currently, the downstream reach of Whiskey Creek between The Boulevard and Kempenfelt Bay experiences flooding during both minor and major storm events. Frequent flooding of private and municipal property during minor and major storms has been documented downstream of The Boulevard due to insufficient culvert and channel capacities. West of Whiskey Creek, water leaving the watercourse flows northwest along White Oaks Road and across private property to Kempenfelt Bay. East of Whiskey Creek, water leaving the watercourse spills northeast across Brennan Avenue and Lismer Boulevard flooding Minet's Point Park and private property as it flows to Kempenfelt Bay. The flooding has caused historic damage to both private and municipal property and causes concern for public safety.

2.2 OPPORTUNITY STATEMENT

An opportunity exists to improve the hydraulic capacity of Whiskey Creek, including the Brennan Avenue and The Boulevard culvert crossings, to reduce the frequency of flooding downstream of The Boulevard to Kempenfelt Bay. There is also an opportunity to reduce erosion, improve habitat (both fish and terrestrial), reduce maintenance requirements, and reduce public safety hazards through improvements to Whiskey Creek through the study area. As such, the City has initiated this Class EA to identify and evaluate alternative solutions to the identified problems based on their impacts on the physical, natural, social, cultural and economic environments. A preferred solution(s) having the greatest positive impact will be the end product of this study.

3 Project Environment

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

3.1 PHYSICAL ENVIRONMENT

3.1.1 Whiskey Creek

Downstream of Hurst Drive to The Boulevard, Whiskey Creek meanders through a well defined, well vegetated valley corridor. The creek banks are typically steep having been shaped by bank and basal scour indicating the creek is migrating laterally. The creek contacts the valley walls at several locations and the large meanders typically have large point bars formed by sand deposition. Through this reach, Whiskey Creek has an average bankfull channel width and depth of 5.3 m and 0.43 m, respectively.

Between The Boulevard and Brennan Avenue, Whiskey Creek runs parallel to White Oaks Road. This reach lacks riparian vegetation resulting in increased erosion due to the lack of root stabilization along the creek banks. Through this reach, Whiskey Creek has an average bankfull channel width and depth of 4.2 m and 0.55 m, respectively.

Downstream of Brennan Avenue to Kempenfelt Bay, the lake water levels create a backwater condition through most of this reach of Whiskey Creek. Essentially, the main channel of Whiskey Creek is below the lake water level. There is increased riparian vegetation along the banks of the creek through this reach and the bankfull channel is at it largest in the study area downstream of Brennan Avenue. Through this reach, Whiskey Creek has an average bankfull channel width and depth of 6.0 m and 0.61 m, respectively.

The Whiskey Creek floodplain was originally developed as part of *Whiskey Creek Master Drainage Plan Update.* Downstream of Hurst Drive, flooding has been documented on both private and municipal property due to undersized culverts and insufficient channel capacities. The Whiskey Creek floodplain is contained within the valley corridor between Hurst Drive and The Boulevard. However, The Boulevard culvert crossing has been determined to have the limiting capacity of the drainage system downstream of Hurst Drive and flow spills east and west from the creek during both minor and major storms. West of Whiskey Creek, flow runs northeast along White Oaks Road, through private properties to Kempenfelt Bay. East of Whiskey Creek, flow spills over Brennan Avenue, through Minet's Point Park, over Lismer Boulevard and through private

properties to Kempenfelt Bay. The flooding has caused historic damage to both private and municipal property and causes concern for public safety.

The private properties identified within the existing floodplain of Whiskey Creek downstream of The Boulevard are summarized in the following table:

Table 1: Private Property Subject to Flooding

199 The Boulevard	202 Cliff Road	204 Cliff Road	206 Cliff Road
208 Cliff Road	210 Cliff Road	212 Cliff Road	214 Cliff Road
216 Cliff Road	218 Cliff Road	7 Brennan Ave	10 Brennan Ave
11 Brennan Ave	13 Brennan Ave	14 Brennan Ave	15 Brennan Ave
16 Brennan Ave	17 Brennan Ave	18 Brennan Ave	19 Brennan Ave
20 Brennan Ave	21 Brennan Ave	22 Brennan Ave	23 Brennan Ave
24 Brennan Ave	27 Brennan Ave	28 Brennan Ave	29 Brennan Ave
30 Brennan Ave	36 Brennan Ave	40 Brennan Ave	42 Brennan Ave
51 Brennan Ave	3 Lismer Blvd	5 Lismer Blvd	9 Lismer Blvd
11 Lismer Blvd	13 Lismer Blvd	15 Lismer Blvd	204 Kempenview Ln
206 Kempenview Ln	208 Kempenview Ln	210 Kempenview Ln	212 Kempenview Ln
214 Kempenview Ln	216 Kempenview Ln	218 Kempenview Ln	220 Kempenview Ln
221 Kempenview Ln	222 Kempenview Ln	223 Kempenview Ln	224 Kempenview Ln
226 Kempenview Ln	228 Kempenview Ln	229 Kempenview Ln	230 Kempenview Ln
36 White Oaks Road	46 White Oaks Road	50 White Oaks Road	52 White Oaks Road
54 White Oaks Road	58 White Oaks Road	64 White Oaks Road	65 White Oaks Road
Number of Properties	64	Assessed Value	$28,111,000

Note: MPAC Assessed value presented (may not reflect current market value)

As part of this EA, the HEC-RAS hydraulic model of Whiskey Creek updated as part of the *Drainage Master Plan* was updated further to include site specific topographic survey information

collected in 2020 to verify the function of Whiskey Creek under various peak flows. The results of the assessment are summarized in Section 4 and detailed in the *Hydrologic & Hydraulic Modeling Technical Memorandum* enclosed in Appendix B.

The City's OP lists one of its goals as "to protect people and property and to minimize social disruption within the City from natural hazards including flooding and erosion." Erosion is an important consideration for this study. In support of this EA, Water's Edge Environmental Solutions Team has prepared a *Fluvial Geomorphological Assessment and Design Alternative Review* to establish the erosion potential of Whiskey Creek through the study area. Erosion has been witnessed through the subject reach of Whiskey Creek and the results of the fluvial geomorphological assessment indicate that Whiskey Creek is sensitive to increases in flow and sediment load. The results of the assessment are detailed in the *Fluvial Geomorphological Assessment and Design Alternative Review* enclosed in Appendix C.

3.1.2 Drainage Infrastructure

The major drainage system infrastructure in the study area consists of Whiskey Creek itself and the Brennan Avenue and The Boulevard culvert crossings. The Brennan Avenue culvert crossing is a 3650 mm × 1500 mm concrete box culvert having a conveyance capacity of 10.4 m^3/s (approximately equal to the 1:2-year return frequency design storm peak flow). The Boulevard culvert crossing is an 1800 mm × 1070 mm CSP arch culvert with a capacity of 3.4 m^3/s (less than the 1:2-year return frequency design storm peak flow). The capacity of both culverts does not satisfy the City's design flood frequency criteria (1:50-year return frequency design storm peak flow).

A condition assessment of the Brennan Avenue and The Boulevard culvert crossings prepared by Chrisholm, Fleming & Associates in 2019 identified the following:

- Brennan Avenue culvert crossing – the concrete soffit of the culvert, the culvert foundation, and the gabion basket retaining walls lining the channel banks at the crossing need replacement in 1 to 5 years; and
- The Boulevard culvert crossing – the asphalt road surface above the culvert requires replacement in 1-5 years, however the culvert is not in need of replacement for +10 years.

The minor drainage system infrastructure in the study area consists of storm sewer networks draining to Whiskey Creek. Storm sewers on White Oaks Road and The Boulevard drain to Whiskey Creek at The Boulevard. Similarly, a storm sewer on Brennan Avenue drains to Whiskey Creek at Brennan Avenue. As per the City's guidelines, the minor drainage system (storm sewer) is designed to convey the 1:5-year (minimum) design storm peak flow.

3.1.3 Existing Infrastructure (Sanitary, Water and Utilities)

In addition to the storm drainage infrastructure, sanitary, water and utility infrastructure is present in the study area. The Minet's Point sewage pump station is located in the southeast corner of Minet's Point Park. The pump station services the Minet's Point area. Sanitary sewers on the local roads in the area drain to a 900 mm diameter sanitary sewer on Lismer Boulevard feeding the pump station. The pump station discharges sewage via a 250 mm diameter sanitary force main which runs southwest from the pump station under Whiskey Creek north of Brennan Avenue to White Oaks Road and south/southwest along White Oaks Road to Hurst Drive.

A generator in the washroom/generator building located in Minet's Point Park next to Whiskey Creek provides auxiliary power to the pump station when required. The washroom/generator building also provide washrooms and change rooms for the public using Minet's Point Park. It is noted that a condition assessment of the washroom/generator building has been completed by the City to determine a replacement timeframe for the building/generator. The *Minet's Point Sewage Pumping Station Condition Assessment* (WSP, March 2021) noted the pumping station is in good to fair condition with a total replacement cost, including the washroom/generator building, of $1,619,900. The Condition Assessment identified works required immediately, and in the short (1-5 years), intermediate (6-10years), and long-term (11-25 years). The washroom/generator building structural components were identified for replacement in the long-term. As the washroom/generator building is located next to Whiskey Creek, within an erosion hazard area, and subject to flooding, the relocation of the building is recommended.

The Minet's Point area is serviced with potable water by water mains on the local roads in the area. Of note, a 200 mm diameter water main runs along White Oaks Road and 150 mm diameter water mains run on The Boulevard, Brennan Avenue and Lismer Boulevard in the study area. A 38 mm diameter water service has also been installed to the washroom/generator building to service this facility.

There are several utilities within the study area including hydro, gas, and telecommunications. Overhead hydro services the study area and a hydro transformer and underground hydro service feed the washroom/generator building and pump station. A 50 mm diameter gas main is located on White Oaks Road, Brennan Avenue and Lismer Boulevard and the area is serviced by telecommunication cables.

3.1.4 Transportation System

In support of this study, Tatham Engineering Limited prepared a traffic review to establish the traffic volumes and operations of the existing road network and the impacts the alternative solutions will have on the road system. The study area for the assessment of the road network consists of Lakeshore Drive, Hurst Drive, Minet's Point Road, Brennan Avenue, White Oaks Road,

The Boulevard, Minet's Point Park and their respective intersections. A brief description of the existing road sections is provided in the following table:

Table 2: Road Sections

ROAD	ROAD CLASS[1]	CROSS SECTION	SPEED (km/h)	CAPACITY[2] (vphpl)	DIRECTION OF TRAVEL
Lakeshore Drive	Parkway	2-lane	50	900	E-W
Hurst Drive	Arterial	2-lane	50	900	E-W
Minet's Point Road (S of Lakeshore Dr)	Arterial	4-lanes	50	900	N-S
Minet's Point Road (N of Lakeshore Dr)	Local	2-lane	50	400	N-S
Brennan Avenue	Local	2-lane	40	400	N-S
White Oaks Road	Local	2-lane	40	400	N-S
The Boulevard	Local	2-lane	40	400	N-S
Minet's Point Park	Local	2-lane	40	400	N-S

[1] functional classification as per the City of Barrie Official Plan
[2] capacity is denoted as vehicles per hour per lane

The assessment concluded that there is ample capacity available on the roads to accommodate existing traffic volumes and to facilitate future growth and no intersection improvements are required at this time. The results of the assessment are detailed in the *Traffic Impact Study Technical Memorandum* enclosed in Appendix D.

The alternative solutions include construction on Brennan Avenue and The Boulevard at Whiskey Creek, the removal of Brennan Avenue and The Boulevard at Whiskey Creek, constructing new transportation linkages and relocating the entrance to Minet's Point Park. The improvements will result in isolated temporary disturbances to long-term changes to the road network and traffic movement. As such, the impact each alternative solution has on the transportation system is an important consideration for this study.

3.2 NATURAL ENVIRONMENT

In support of this study, RiverStone Environmental Solutions Inc. completed an assessment of the existing the natural heritage features throughout the study area. The assessment was

completed to characterize the terrestrial and aquatic habitat in Whiskey Creek and the lands adjacent to it. The natural heritage features were assessed through a review of the available background information and site investigations. The results of the assessment are summarized in the following sections and detailed in the *Natural Heritage Resources Technical Memorandum* enclosed in Appendix E.

3.2.1 Fisheries

As part of the previous *Drainage Master Plan*, fish species in Whiskey Creek were mapped. The mapped fish species specific to Whiskey Creek are summarized in the following table. The mapped fish species are not site specific.

Table 3: Mapped Fish Species Summary

CREEK	FISH SPECIES
Whiskey Creek	Brook Trout, Rainbow Smelt, Golden Shiner, Emerald Shiner, Spottail Shiner, Bluntnose Minnow, Blacknose Dace, Longnose Dace, Creek Chub, Rock Bass, Pumpkinseed, Smallmouth Bass, Black Crappie, Iowa Darter, Logperch, Mottled Sculpin, Slimy Sculpin

Source: Natural Heritage Assessment Technical Memorandum (Azimuth Environmental Consulting, Inc., October 2017); mapped fish species in watercourse

As part of this study, it was confirmed that Whiskey Creek maintains coldwater habitat and the fish communities in Whiskey Creek include both coldwater and warmwater species. Mitigation measures to reduce the risk of the works on fish and fish habitat include implementation of in-water work timing windows, performing works "in the dry," minimizing the grading/disturbance below the high water elevation (1:2-year return frequency design storm peak flow water level), maintaining and/or improving groundwater connectivity through installation of open bottom passages, naturalizing disturbed banks and implementing appropriate staging and sedimentation and erosion controls during construction. It is expected that projects within lands regulated under Ontario Regulation 179/06 will require an LSRCA permit. Furthermore, a Request for Review will be required for submission to Fisheries and Oceans Canada (DFO) for works that may result in Harmful Alteration, Disruption or Destruction to fish habitat.

3.2.2 Terrestrial Habitat

Significant woodlands and wildlife habitat are absent from the study area. However, two threatened or endangered species (Little Brown Bat and Northern Long-eared Bat) were identified as having potential to make use of the mature trees (larger than 25 cm in diameter measured at breast height) within the study area. To minimize the potential for negative impacts to the Little Brown Bat and Northern Long-eared Bat and their roosting habitat:

- The number of larger trees removed for drainage improvements should be minimized and additional trees should be planted to off-set the lost trees;
- Where trees are to be removed, tree felling should occur between October 15th and April 15 to be sensitive to roosting bats (this window is also sensitive to the breeding and nesting of migratory birds); and
- Should construction timing require tree felling during this window, a qualified biologist should undertake a survey using acoustic monitoring to determine if roosting bats are making use of the trees. Similarly, nest surveys should be completed to identify and locate any active nests of bird species covered under the Migratory Bird Convention Act and Fish and Wildlife Conservation Act.

If a nest is located or evidence of breeding is noted, a mitigation plan should be developed to avoid any potential impacts on birds or their active nests.

3.3 SOCIAL ENVIRONMENT

3.3.1 Property Value

Existing flooding and the presence of municipal infrastructure on private property can negatively impact property values and the City's ability to improve existing drainage infrastructure. As such, any improvement alternative that will prevent/reduce flooding on private property and relocate municipal infrastructure into municipally owned lands would be a positive improvement.

3.3.2 Public Safety

The existing drainage infrastructure, specifically the Brennan Avenue and The Boulevard culvert crossings, in the study area operate at levels below current City design standards resulting in flooding on municipal and private property. The flooding presents a public safety concern as pedestrian and vehicular access, including emergency vehicle access, will be obstructed or eliminated along White Oaks Road, Brennan Avenue and The Boulevard. The conveyance of both minor and major storm flows and compliance with the *Provincial Policy Statement* in this regard is an important consideration in the review of alternative solutions.

In addition to flooding, the lack of pedestrian barricades at fall hazards, and structure barriers and approach guide rails at each culvert crossing pose a threat to public safety. As such, the installation of signage, pedestrian barricades, structure barriers and approach guide rails are recommended as part of the alternative solutions.

3.3.3 Additional Social impacts

In addition to potential impacts on property values and public safety, removing roads, new transportation linkages, relocating the washroom/generator building, and construction will create impacts related to noise, pedestrian access, traffic movement and local businesses. These potential impacts have been considered as part of the evaluation of the alternative solutions.

3.4 ECONOMIC ENVIRONMENT

3.4.1 Construction Costs

Each alternative solution has an upfront capital cost to construct. Project cost estimates have been prepared for each alternative solution to aid in the evaluation of the economic impacts to implement each solution. The project cost estimates have been developed using recent tender pricing received on similar projects completed by Tatham Engineering Limited. The unit rates used represent 2020 costs.

The relocation of the existing washroom/generator building to accommodate the construction of various alternative solutions is a significant cost. The replacement cost of the Minet's Point Sewage Pumping Station, including the washroom/generator building, established as part of the Condition Assessment is $1,619,900 and the washroom/generator building structural components were identified for replacement in the long-term (11-25 years). It is recommended that the washroom/generator building be relocated outside the erosion hazard setback associated with Whiskey Creek under each alternative solution considered. As such, the replacement cost has been excluded from the project cost estimates developed for the alternative solutions as the sewage pumping station replacement is considered a separate project.

Until the washroom/generator building is relocated it should be floodproofed to an elevation of 220.75 m or 0.3 m above the Regional Storm water level. The cost of floodproofing the washroom/generator building has been excluded from the project cost estimates as the cost will be consistent across the alternative solutions considered.

3.4.2 Life Cycle Costs

Each alternative solution also has a life cycle cost associated with maintenance (culvert crossing cleanouts, erosion repairs, sediment cleanout in Whiskey Creek, etc.) and future infrastructure replacement costs. Life cycle costs for each alternative solution have been estimated from the project cost estimates prepared for each alternative solution to aid in the evaluation of the economic impacts to implement each solution.

3.4.3 Property Acquisition Costs

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

3.5 CULTURAL HERITAGE ENVIRONMENT

Cultural heritage resources include archaeological resources, built heritage resources and cultural heritage resources.

3.5.1 Archaeological Resources

A Stage 1 Archaeological Assessment (Project Information Form #439-0106-2020) was undertaken in 2020 by Archeoworks Inc. in support of this environmental assessment. A Stage 1 AA consists of a review of geographic, land use and historical information for the property and the relevant surrounding area, a property visit to inspect its current conditions and contacting the Ministry of Heritage, Sport, Tourism and Culture Industries to find out whether, or not, there are any known archaeological sites on or near the property. Its purpose is to identify areas of archaeological potential and further archaeological assessment (e.g. Stage 2 – 4) as necessary. The Stage AA is included in Appendix F.

Stage 1 AA background research established elevated potential for the recovery of archaeologically significant materials within the study area due to the presence of primary and secondary water sources. Review of aerial photographs, orthophotographs, supplemented by on-site property inspection determined that much of the study area retains its archaeological potential. Considering these findings, the following recommendations are presented:

1. Parts of the study area that were identified as having archaeological potential removed, as per Section 1.3.2 and Section 1.4.1, Standard 1.f. of the 2011 S&G, are exempt from requiring Stage 2 AA. No further work is recommended in this area.
2. Parts of the study area that were identified as having no or low archaeological potential are exempt from requiring Stage 2 AA. No further work is recommended in this area.
3. All areas identified as retaining archaeological potential must be subjected to a Stage 2 AA. These areas must be subjected to test pit survey at five-metre intervals in accordance with the standards set within Section 2.1.2 of the 2011 S&G.

4. Should construction activities extend beyond the assessed limits of the study area, further archaeological investigation will be required to assess the archaeological potential of these lands.

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

A Stage 2 AA will be undertaken for parts of the study area that were identified as having archaeological potential and that will be impacted by the property as early as possible during detailed design.

3.5.2 Built Heritage Resources and Cultural Heritage Landscapes

The screening checklist (Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes), developed by the Ministry of Heritage, Sport, Tourism and Culture Industries, was completed as part of the project file (see Appendix G). The study area was determined to have low potential for built heritage resources and cultural heritage landscapes. Therefore, no technical cultural heritage studies have been undertaken.

4 Existing System Analysis

The reach of Whiskey Creek from The Boulevard to Kempenfelt Bay is within a residential area in the City of Barrie. The low flow channel follows White Oaks Road to Kempenfelt Bay and there is evidence of erosion along its length. Above the low flow channel, the banks are heavily vegetated including mature trees. The watercourse has limited capacity and is further constrained by an existing 1800 mm x 1070 mm CSP arch culvert crossing The Boulevard and an existing 3650 mm x 1500 mm concrete box culvert crossing Brennan Avenue.

Significant flooding has been documented between The Boulevard and Kempenfelt Bay including roadway overtopping and flow along White Oaks Road. On the west side of the watercourse, significant flows are conveyed along White Oaks Road and through private properties to Kempenfelt Bay. On the east side of the watercourse, flow can spill through private properties starting just downstream of The Boulevard continuing to Kempenfelt Bay.

As part of this EA, the HEC-RAS hydraulic model of Whiskey Creek updated as part of the *Drainage Master Plan* was updated further to include site specific topographic survey information collect in 2020 to verify the function of Whiskey Creek under various peak flows. The results of the assessment are summarized in Section 4 and detailed in the *Hydrologic & Hydraulic Modeling Technical Memorandum* enclosed in Appendix B.

4.1 HYDROLOGY

The LSRCA approved the hydrologic model prepared in support of the *Whiskey Creek Master Drainage Plan Update (2009)*. The hydrologic model was later updated in accordance with the changes described in the *Whiskey Creek Master Drainage Plan Revisions Brief Technical Addendum (2011)*. The LSRCA approved flows represent future land use conditions. However, they do not account for climate change. The LSRCA approved flows are summarized in the following table.

Table 4: Approved LSRCA Flow Summary

STORM	PEAK FLOW (m^3/s)		
	THE BOULEVARD	BRENNAN AVENUE	KEMPENFELT BAY
1:2-Year	10.03	10.06	10.08
1:5-Year	19.49	19.56	19.59
1:10-Year	27.27	27.38	27.43
1:25-Year	35.03	35.17	35.24
1:50-Year	42.04	42.20	42.29
1:100-Year	52.25	52.50	52.62
Hurricane Hazel	73.32	73.66	73.82

As part of the *Drainage Master Plan* (DMP), city-wide minor and major drainage system hydrologic models were created using the best information available. The DMP peak flows have not been approved by the LSRCA and it was agreed the LSRCA approved flows would be used in this study. However, the DMP hydrologic model was generated using the best information available and calibrated to historic streamflow data. As such, the City hopes to use the DMP hydrologic models in the future, once approved by the LSRCA. To determine which hydrologic model (LSRCA approved versus DMP) produces the most conservative results, a comparison of the peak flows was completed. The peak flow comparison is presented in Table 5 provided overleaf.

As part of the DMP, the LSRCA identified hydrologic model updates necessary to secure LSRCA approval of the major system hydrologic model. The model updates fell outside the scope of the DMP. However, the City approved the model updates for the Whiskey Creek watershed as part of this EA. The necessary model updates have been completed and the resultant peak flows at various points of interest in the study area are presented in Table 5. As of the date of this report, the revised hydrologic model has not been approved by the LSRCA. A memo summarizing the model updates and the new results is enclosed in Appendix B for reference.

The 1:50-year return frequency design storm peak flow was excluded from the *Whiskey Creek Master Drainage Plan Update* hydrologic model results. For this study, the 1:50-year return frequency design storm peak flows were estimated by applying the relative difference (120%)

between the DMP 1:25-year and 1:50-year return frequency design storm peak flows to determine the LSRCA 1:50-year return frequency design storm peak flow.

Table 5: Peak Flow Comparison (LSRCA Approved versus DMP)

LOCATION	PEAK FLOW (m^3/s)																				
	1:2-YEAR			1:5-YEAR			1:10-YEAR			1:25-YEAR			1:50-YEAR			1:100-YEAR			HURRICANE HAZEL		
	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)	LSRCA (2011)	DMP (2019)	EA (2021)
Hurst Drive	10.00	8.66	9.78	19.42	13.70	15.74	27.16	19.39	22.61	34.88	27.42	30.84	41.86	33.64	36.51	52.03	38.33	40.90	72.99	69.27	69.24
The Boulevard	10.03	8.68	9.79	19.49	13.69	15.71	27.27	19.26	22.33	35.03	27.07	30.25	42.04	32.90	35.59	52.25	37.38	39.76	73.32	69.62	69.56
Brennan Avenue	10.06	8.72	9.80	19.56	13.73	15.76	27.38	19.33	22.42	35.17	27.14	30.37	42.20	32.95	35.66	52.50	37.46	39.84	73.66	70.07	69.96
Lake Simcoe	10.08	8.68	9.75	19.59	13.70	15.64	27.43	19.19	22.20	35.24	26.88	30.06	42.29	32.80	35.66	52.62	37.34	39.75	73.82	70.04	69.98

Note: 1:50-year return frequency design storm peak flows were excluded from Whiskey Creek Master Drainage Plan Update. 1:50-year LSRCA flows were estimated using relative difference between 1:25-year and 1:50-year DMP flows.

4.2 HYDRAULICS

Like the hydrologic models, there are currently two existing hydraulic models of Whiskey Creek. A HEC-RAS model was prepared and approved by the LSRCA as part of the *Whiskey Creek Master Drainage Plan Update* and an updated model was prepared in 2015 as part of the City's minor/major stormwater model development project. The 2015 model was further updated as part of the *Drainage Master Plan*.

As a first step for this project, the appropriate hydraulic model for use in this study was discussed. A comparison of the LSRCA approved model cross-sections against the updated DMP model cross-sections was presented. Though the locations of the cross-sections are not consistent between the two models, the results clearly show that the cross-sections in the updated HEC-RAS model includes a higher level of detail/accuracy along Whiskey Creek.

As the assessment of alternatives does not involve updating floodplain mapping for Whiskey Creek, the LSRCA advised that the HEC-RAS model updated as part of the DMP may be used as long as any changes/deviations from the LSRCA approved HEC-RAS model are fully documented in a supporting report. Therefore, the DMP HEC-RAS model has been used for this study. The development of the HEC-RAS hydraulic models through the minor/major stormwater model development project and *Drainage Master Plan* were fully documented in reports prepared in support of these projects. Also, a training session was held at the City of Barrie, which LSRCA staff attended, to review the model development, calibration and verification process. The previous reports should be reviewed for additional information regarding the development of the Whiskey Creek HEC-RAS model developed through the DMP. A summary of the model updates completed as part of this study and a comparison of the updated model to the LSRCA approved model is provided in the *Hydrologic & Hydraulic Modeling Technical Memorandum* enclosed in Appendix B.

4.3 HYDRAULIC MODEL RESULTS

The existing conditions hydraulic model results of Whiskey Creek through the study area are detailed in the *Hydrologic & Hydraulic Modeling Technical Memorandum* enclosed in Appendix B and summarized as follows:

- The existing 1800 mm x 1070 mm CSP arch culvert crossing The Boulevard has a conveyance capacity of 3.4 m^3/s which is less than the 1:2-year return frequency design storm peak flow. The depth of road overtopping during the Regulatory Storm is greater than 1.3 m;
- The existing 3650 mm x 1500 mm concrete box culvert crossing Brennan Avenue has a conveyance capacity of 10.4 m^3/s which is less than the 1:5-year return frequency design

storm peak flow. The depth of road overtopping during the Regulatory Storm is approximately 0.8 m;

- Downstream of The Boulevard the channel capacity is less than the 1:2-year return frequency design storm peak flow. On the west side of the watercourse flow is conveyed along White Oaks Road and through private properties to Kempenfelt Bay. On the east side of the watercourse flow will spill east across Brennan Avenue, through Minet's Point Park and across Lismer Boulevard and drain through private properties to Kempenfelt Bay;
- The cumulative spill east between The Boulevard and Kempenfelt Bay during the 1:2-year return frequency design storm and during the Regulatory Storm are 0.7 m^3/s (approximately 7% of flow) and 15.9 m^3/s (approximately 22% of flow), respectively.

The Boulevard culvert crossing has a conveyance capacity less that the 1:2-year return frequency design storm peak flow and flow will overtop the crossing at depths greater than 0.3 m during minor and major storms. The Brennan Avenue culvert crossing has a conveyance capacity less than the 1:5-year return frequency design storm peak flow and flow will overtop the crossing at depths greater than 0.3 m during minor and major storms. As such, neither crossing provides safe access egress to the area east of Whiskey Creek. Currently the area north of Hurst Drive, east of Whiskey Creek has three points of access (Brennan Avenue at Hurst Drive, Brennan Avenue at Whiskey Creek and The Boulevard at Whiskey Creek). However, safe access egress is only provided via Brennan Avenue at Hurst Drive during minor and major storms.

There are 125 residential lots north of Hurst Drive, east of Whiskey Creek which are provided with three points of access most of the time. However, during minor and major storms, the number of accesses is reduced to one, Brennan Avenue at Hurst Drive. This poses a public safety hazard and does not satisfy the Ontario Build Code (a minimum of two access points are required for 100 or more dwelling units) during minor and major storms.

Based on the floodplain mapping prepared in support of the *Whiskey Creek Master Drainage Plan Update (2009)*, 64 private properties with an assessed value of $28,111,000 are within the Whiskey Creek floodplain downstream of The Boulevard. In addition to private property, Minet's Point Park is subject to flooding during minor and major storms and water will flood The Boulevard, White Oaks Road, Brennan Avenue, Lismer Boulevard, Kempview Lane and Whitty Lane. The existing washroom/generator building, and Minet's Point Pump Station are located in the floodplain and subject to flooding during minor and major storms.

5 Alternative Solutions

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

5.1 EXISTING (BASELINE) CONDITIONS

5.1.1 Alternative 1 – Do Nothing

The "Do Nothing" alternative allows for the consideration of not making any changes to Whiskey Creek from The Boulevard to Kempenfelt Bay. This alternative is being considered to provide a benchmark to gauge the physical, natural, social, cultural and economic implications of the other alternatives. To comply with the City of Barrie Drainage Policies, if this alternative were selected, consideration should be given to the fact that the City may acquire private property or interests therein (easements) impacted by flooding.

Under Alternative 1, the existing culverts and watercourse will remain unchanged from existing conditions. The existing watercourse is described as follows:

- The watercourse downstream of Brennan Avenue to Kempenfelt Bay is approximately 1 - 2 m deep and 8 - 15 m wide between the main channel banks. The low flow channel geometry is variable;
- The culvert crossing Brennan Avenue is a 3650 mm x 1500 mm concrete box culvert;
- The watercourse between The Boulevard and Brennan Avenue is approximately 1 - 1.5 m deep and 8 - 10 m wide between the main channel banks. The low flow channel geometry is variable; and
- The culvert crossing The Boulevard is an 1800 mm x 1070 mm CSP arch culvert.

5.2 HYDRAULIC IMPROVEMENTS

5.2.1 Alternative 2 – Improve Culverts/Watercourse to Convey 1:100-Year Design Storm

An opportunity exists to replace the culvert crossings of Brennan Avenue and The Boulevard with culverts sized to convey the 1:100-year return frequency design storm peak flow. There is also an opportunity to improve Whiskey Creek from The Boulevard to Kempenfelt Bay to increase its conveyance capacity to the 1:100-year return frequency design storm peak flow. Alternative 2 is consistent with the recommendations of the previous *Whiskey Creek Master Drainage Plan Update (2011)* and *Drainage Master Plan (2019)*.

5.2.2 Alternative 3 – Improve Culvert/Watercourse to Convey Less Than 1:100-Year Design Storm

The same opportunity exists to improve the culvert crossings and watercourse described under Alternative 2 to a reduced level of service (designed to convey less than the 1:100-year return frequency design storm peak flow). An opportunity exists to improve the culvert crossings and watercourse from The Boulevard to Kempenfelt Bay to reduce the frequency of flooding while reducing/eliminating the conflicts, relocations and constructability issues identified under Alternative 2.

5.3 FLOW DIVERSIONS

5.3.1 Alternative 7 – Additional Conveyance Route (Flow Diversion) Through 36 White Oaks Road

A diversion structure can be constructed under White Oaks Road upstream of The Boulevard to redirect a portion of the Whiskey Creek flow to a new channel constructed through 36 White Oaks Road to Kempenfelt Bay. During storm and freshet events, a portion of the flow within Whiskey Creek would be redirected through the diversion structure and proposed channel, reducing flows and the frequency of flooding along Whiskey Creek.

5.4 HYDRAULIC IMPROVEMENTS PLUS TRANSPORTATION SYSTEM MODIFICATIONS

5.4.1 Alternative 4 – Remove Brennan Avenue at Whiskey Creek

Under Alternative 4, two options are being considered as described in the following sections:

Alternative 4A – Remove Brennan Avenue at Whiskey Creek

An opportunity exists to remove Brennan Avenue, including the culvert crossing, at Whiskey Creek daylighting the watercourse and removing a restriction to flow. An opportunity also exists to improve Whiskey Creek from Kempenfelt Bay to The Boulevard along with The Boulevard culvert crossing to increase the conveyance capacity of the drainage system and reduce the frequency of flooding in the area. To maintain pedestrian access, a pedestrian span bridge would replace the Brennan Avenue culvert crossing.

Alternative 4B – Remove Brennan Avenue at Whiskey Creek and Connect Brennan Avenue and The Boulevard

An opportunity exists to complete the works described under Alternative 4A and construct a new transportation linkage between Brennan Avenue and The Boulevard. A new section of road can be constructed through 7 Brennan Avenue connecting Brennan Avenue to The Boulevard improving the transportation network in the area under Alternative 4.

5.4.2 Alternative 5 – Remove The Boulevard at Whiskey Creek

Under Alternative 5, two options are being considered similar to Alternative 4 as described in the following sections:

Alternative 5A – Remove The Boulevard at Whiskey Creek

An opportunity exists to remove The Boulevard, including the culvert crossing, at Whiskey Creek daylighting the watercourse and removing a restriction to flow. Under Alternative 5A, Whiskey Creek would be improved from Kempenfelt Bay to The Boulevard and the Brennan Avenue culvert crossing would be improved to increase the conveyance capacity of the drainage system and reduce the frequency of flooding in the area. To maintain pedestrian access, a pedestrian span bridge would replace The Boulevard culvert crossing.

Alternative 5B – Remove The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard

An opportunity exists to complete the works described under Alternative 5A and construct the new transportation linkage between Brennan Avenue and The Boulevard described under Alternative 4B.

5.4.3 Alternative 6 – Remove Brennan Avenue and The Boulevard at Whiskey Creek

Under Alternative 6, three options are being considered as described in the following sections:

Alternative 6A – Remove Brennan Avenue and The Boulevard at Whiskey Creek

An opportunity exists to remove Brennan Avenue and The Boulevard, including the culvert crossings, at Whiskey Creek daylighting the watercourse and removing the two flow restrictions. Under alternative 6A, Whiskey Creek would be improved from Kempenfelt Bay to The Boulevard to increase the conveyance capacity of the watercourse and reduce the frequency of flooding in the area. To maintain pedestrian access, pedestrian span bridges would replace the Brennan Avenue and The Boulevard culvert crossings.

Alternative 6B – Remove Brennan Avenue and The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard

An opportunity exists to complete the works described under Alternative 6A and construct the new transportation linkage between Brennan Avenue and The Boulevard described under Alternative 4B.

Alternative 6C – Remove Brennan Avenue and The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard and New Connection to Hurst Drive

An opportunity exists to complete the works described under Alternative 6A and construct a second new transportation linkage between Southview Road and Hurst Drive. A new section of road can be constructed through 205 and 207 Southview Road connecting Southview Road and Hurst Drive further improving the transportation network in the area under Alternative 6.

6 Alternative Solutions Assessment

To assess the effectiveness of the alternative solutions considered, the existing condition HEC-RAS hydraulic model of Whiskey Creek was revised to include the proposed improvements. The results of the analysis, specifically the reduction in the frequency of flooding, culvert sizes, private property and infrastructure impacts and costs are discussed in the subsequent sections.

6.1 EXISTING (BASELINE) CONDITIONS

6.1.1 Alternative 1 – Do Nothing

Alternative 1 represents the "do nothing" alternative and generally does not meet the City of Barrie design standards. The Brennan Avenue and The Boulevard culvert crossings do not satisfy the City's design flood frequency criteria (1:50-year return frequency design storm conveyance capacity). The culvert crossings do not have sufficient capacity to convey the peak flow generated by the 1:5-year return frequency design storm. The conveyance capacity of the main channel of Whiskey Creek is also limited; generally having a conveyance capacity equal to the culvert crossings.

Significant flooding has been documented between The Boulevard and Kempenfelt Bay including roadway overtopping and flooding of private property. As discussed, 64 private properties with an assessed value of $28,111,000 are within the Whiskey Creek floodplain downstream of The Boulevard. In addition to private property, Minet's Point Park is subject to flooding during minor and major storms and water will flood The Boulevard, White Oaks Road, Brennan Avenue, Lismer Boulevard and Kempenview Lane. The existing washroom/generator building, and Minet's Point Pump Station are located in the floodplain and subject to flooding during minor and major storms.

Under this alternative, the frequency of flooding in the study area will not change, erosion along Whiskey Creek will persist, there will continue to be public safety concerns regarding flooding and safe access egress, and City maintenance requirements will likely increase.

6.2 HYDRAULIC IMPROVEMENTS

6.2.1 Alternative 2 – Improve Culverts/Watercourse to Convey 1:100-Year Design Storm

Under Alternative 2, the main channel of Whiskey Creek must be re-graded and widened from its outlet to Kempenfelt Bay (elevation of approximately 218.00 m) at 0% grade to Brennan Avenue to convey the 1:100-year return frequency design storm peak flow. The existing Brennan Avenue culvert crossing would be replaced with an 11 m wide concrete span structure complete with an open bottom to satisfy the 1:100-year design flood frequency criteria. Similarly, the main channel of Whiskey Creek must be re-graded and widened from Brennan Avenue to The

Boulevard and the existing culvert crossing of The Boulevard replaced with an 11 m wide concrete span structure complete with an open bottom to provide the same capacity as the downstream channel/structure.

To accommodate the watercourse and channel improvements, the washroom/generator building in Minet's Point Park, a hydro transformer and the entrance to the park west of Lismer Boulevard must be relocated along with various utilities (gas and hydro). Also, the road profile above the Brennan Avenue culvert crossing must be revised to provide sufficient cover over the proposed concrete span structure. Furthermore, a sanitary force main crossing Whiskey Creek at Brennan Avenue would need to be lowered or relocated and the existing sanitary sewer and water main at both crossings would need to be protected. The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City to accommodate the proposed improvements.

The re-grading of Whiskey Creek from Kempenfelt Bay to Brennan Avenue at 0% grade would make this reach of Whiskey Creek an extension of the lake, negating the requirement for a low flow channel for fish passage through this area. However, a low flow channel would need to be incorporated into Whiskey Creek between Brennan Avenue and The Boulevard. Also, it is anticipated that the main channel banks will need to be armoured with erosion protection measures to prevent further erosion of the watercourse.

The capacity of Whiskey Creek from The Boulevard to Kempenfelt Bay can only be increased to equal the 1:100-year return frequency design storm peak flow if Whiskey Creek is re-graded at 0% grade. Maintaining a grade of 0.4%, which is similar to existing conditions, can only convey the 1:50-year return frequency design storm peak flow.

Increasing the conveyance capacity of Whiskey Creek downstream of The Boulevard to equal the 1:100-year return frequency design storm peak flow results in a significant reduction in the frequency of flooding within the study area. The depth water overtops Brennan Avenue (0.29 m) and The Boulevard (0.50 m) during the Regional (Hurricane Hazel) Storm exceeds the safe access egress criteria for roadways at The Boulevard. However, under this scenario flooding of the roadways would be a rare occurrence.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 2 are $10.0M and $3.9M, respectively.

6.2.2 Alternative 3 – Improve Culvert/Watercourse to Convey Less Than 1:100-Year Design Storm

The capacity of Whiskey Creek from The Boulevard to Kempenfelt Bay can be increased to convey peak flows less than the 1:100-year return frequency design storm peak flow as described in the following sections.

1:50-Year Return Frequency Conveyance Capacity

The main channel of Whiskey Creek can be re-graded and widened from its outlet to Kempenfelt Bay (elevation of approximately 218.00 m) at 0.4% grade to Brennan Avenue to convey the 1:50-year return frequency design storm peak flow. Under this option, both culvert crossings must be widened along with the channel from Kempenfelt Bay to The Boulevard to convey the 1:50-year return frequency design storm peak flow. The existing Brennan Avenue culvert crossing would be replaced with a 13.4 m wide concrete span structure complete with an open bottom to satisfy the 1:50-year design flood frequency criteria. The existing culvert crossing of The Boulevard replaced with a 11 m wide concrete span structure complete with an open bottom will provide the same capacity as the downstream channel/structure.

To accommodate the watercourse and channel improvements, the washroom/generator building in Minet's Point Park and a hydro transformer must be relocated. Also, the entrance to Minet's Point Park must be realigned. The road profile above the Brennan Avenue culvert crossing must be revised to provide sufficient cover over the proposed concrete span structures. The sanitary force main crossing Whiskey Creek at Brennan Avenue and the existing sanitary sewer and water main at both crossings would need to be lowered/protected. The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City to accommodate the proposed improvements.

Increasing the conveyance capacity of Whiskey Creek downstream of The Boulevard to equal the 1:50-year return frequency design storm peak flow results in a significant reduction in the frequency of flooding within the study area. The depth water overtops Brennan Avenue (0.42 m) and The Boulevard (0.68 m) during the Regional (Hurricane Hazel) Storm exceeds exceeds the safe access egress criteria for roadways. However, under this scenario flooding of the roadways would be a rare occurrence.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 3 for the 1:50-year return frequency conveyance capacity are $10.0M and $4.2M, respectively.

1:25-Year Return Frequency Conveyance Capacity

Alternatively, the main channel of Whiskey Creek can also be re-graded and widened from its outlet to Kempenfelt Bay (elevation of approximately 218.00 m) at 0.4% grade to Brennan Avenue to convey the 1:25-year return frequency design storm peak flow. Under this option, both culvert crossings must be widened along with the channel from Kempenfelt Bay to The Boulevard to convey the 1:25-year return frequency design storm peak flow. The existing Brennan Avenue culvert crossing would be replaced with a 11 m wide concrete span structure complete with an open bottom to satisfy the 1:25-year design flood frequency criteria. The existing culvert crossing of The Boulevard replaced with a 7.9 m wide concrete span structure complete with an open bottom will provide the same capacity as the downstream channel/structure.

To accommodate the watercourse and channel improvements, the washroom/generator building in Minet's Point Park and a hydro transformer must be relocated. Also, the entrance to Minet's Point Park must be realigned. The road profile above the Brennan Avenue culvert crossing must be revised to provide sufficient cover over the proposed concrete span structure. The sanitary force main crossing Whiskey Creek at Brennan Avenue and the existing sanitary sewer and water main at both crossings would need to be lowered/protected. The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City to accommodate the proposed improvements.

Increasing the conveyance capacity of Whiskey Creek downstream of The Boulevard to equal the 1:25-year return frequency design storm peak flow results in a significant reduction in the frequency of flooding within the study area. The depth water overtops Brennan Avenue (0.54 m) and The Boulevard (0.89 m) during the Regional (Hurricane Hazel) Storm exceeds the safe access egress criteria for roadways. However, under this scenario flooding of the roadways would be a rare occurrence.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 3 for the 1:25-year return frequency conveyance capacity are $9.4M and $3.5M, respectively.

1:10-Year Return Frequency Conveyance Capacity

Alternatively, the main channel of Whiskey Creek can also be re-graded and widened from its outlet to Kempenfelt Bay (elevation of approximately 218.00 m) at 0.4% grade to Brennan Avenue to convey the 1:10-year return frequency design storm peak flow. Under this option, both culvert crossings must be widened along with the channel from Kempenfelt Bay to The Boulevard to convey the 1:10-year return frequency design storm peak flow. The existing Brennan Avenue

culvert crossing would be replaced with a 9.8 m wide concrete span structure complete with an open bottom to satisfy the 1:10-year design flood frequency criteria. The existing culvert crossing of The Boulevard replaced with a 7.3 m wide concrete span structure complete with an open bottom will provide the same capacity as the downstream channel/structure.

To accommodate the watercourse and channel improvements, only the hydro transformer must be relocated. The existing washroom/generator building and entrance to the park may remain in their current locations. Also, the road profile above both the Brennan Avenue and The Boulevard culvert crossings may remain as is. The sanitary force main crossing Whiskey Creek at Brennan Avenue and the existing sanitary sewer and water main at both crossings would need to be lowered/protected. The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City to accommodate the proposed improvements.

Increasing the conveyance capacity of Whiskey Creek downstream of The Boulevard to equal the 1:10-year return frequency design storm peak flow results in a moderate reduction in the frequency of flooding within the study area. The depth water overtops Brennan Avenue (0.66 m) and The Boulevard (0.92 m) during the Regional (Hurricane Hazel) Storm exceeds the safe access egress criteria for roadways. However, under this scenario flooding of the roadways would be a rare occurrence.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 3 for the 1:10-year return frequency conveyance capacity are $8.4M and $3.3M, respectively.

6.3 FLOW DIVERSIONS

6.3.1 Alternative 7 – Additional Conveyance Route (Flow Diversion) Through 36 White Oaks Road

A diversion structure can be constructed under White Oaks Road upstream of The Boulevard to redirect a portion of the Whiskey Creek flow to a new channel constructed through 36 White Oaks Road to Kempenfelt Bay. A 6401 mm x 1829 mm concrete box culvert installed under White Oaks Road upstream of The Boulevard can divert approximately 28.4 m^3/s of the 1:100-year return frequency design storm peak flow in Whiskey Creek to a new channel constructed through 36 White Oaks Road. The Alternative 7 hydraulic model results are summarized as follows:

- Baseflows will continue to drain through Whiskey Creek as they currently do with no diversion of baseflow out of the watercourse;

- Only a portion of the peak flow will be diverted from Whiskey Creek during storm and freshet events and a portion of the peak flow will continue to be conveyed by Whiskey Creek to Kempenfelt Bay;
- The diversion of flow will reduce peak flows through the subject reach of Whiskey Creek such that the design flood frequency of the Brennan Avenue and The Boulevard culvert crossings will increase to 1:25-year and 1:5-year, respectively; and
- With the flow diversion, the main channel of Whiskey Creek will be able to convey the 1:10-year return frequency design storm peak flow and flooding will be reduced in the study area.

The flow split between Whiskey Creek and the proposed drainage channel through 36 White Oaks Road under Alternative 7 is summarized in the following table.

Table 6: Alternative 7 Flow Split Summary

STORM	FLOW (m^3/s)		DEPTH OF OVERTOPPING (m)	
	WHISKEY CREEK	DIVERSION	BRENNAN AVE	THE BOULEVARD
1:2-Year	2.5	7.6	0.0	0.0
1:5-Year	4.2	15.3	0.0	0.2
1:10-Year	7.6	19.7	0.0	0.4
1:25-Year	12.1	23.0	0.2	0.6
1:50-Year	16.8	25.3	0.3	0.7
1:100-Year	23.4	28.4	0.3	0.8
Hurricane Hazel	40.2	33.2	0.5	1.1

Under Alternative 7, 36 White Oaks Road would need to be acquired by the City in full to accommodate the proposed new drainage channel. The City should also consider acquiring a portion of 7 Brennan Avenue and 199 The Boulevard as Whiskey Creek currently occupies a portion of these properties. Also, an existing sanitary sewer, sanitary force main and water main on White Oaks Road would have to be lowered to accommodate the construction of the diversion structure (concrete box culvert). However, the road profile of White Oaks Road may remain as is. The property acquisition costs associated with Alternative 7 are estimated at $1.7M and the estimated total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 7 are $7.0M and $3.0M, respectively.

6.4 HYDRAULIC IMPROVEMENTS PLUS TRANSPORTATION SYSTEM MODIFICATIONS

Alternatives 4 through 6 involve implementing hydraulic improvements to increase the conveyance capacity of the drainage system downstream of The Boulevard consistent with Alternatives 2 and 3 while also completing transportation system modifications. The transportation system modifications include removing sections of Brennan Avenue and The Boulevard at Whiskey Creek and adding transportation linkages to address potential impacts to traffic movement and pedestrian access. For Alternatives 4 through 6, the hydraulic improvements described under Alternative 3 for the 1:50-year return frequency design storm conveyance capacity were considered to complete a comparative evaluation of the hydraulic improvements plus transportation system modifications against the hydraulic improvements only. As such, the discussion provided in the following sections is for the hydraulic improvements required to convey the 1:50-year return frequency design storm peak flow and the associated transportation system modifications for the corresponding alternative solutions. The hydraulic results and infrastructure impacts for Alternatives 4 through 6 remain consistent with those described under Alternative 3 – 1:50-Year Return Frequency Conveyance Capacity.

6.4.1 Alternative 4A – Remove Brennan Avenue at Whiskey Creek

An opportunity exists to remove Brennan Avenue, including the culvert crossing, at Whiskey Creek daylighting the watercourse and removing a restriction to flow. The capacity of Whiskey Creek can be increased from Kempenfelt Bay to The Boulevard to convey the 1:10-year, 1:25-year, 1:50-year or 1:100-year return frequency design storm peak flows, depending on the improvements implemented. The watercourse improvements required to increase the conveyance capacity of Whiskey Creek to equal the respective return frequency design storm peak flows are described under Alternatives 2 and 3.

Likewise, the existing culvert crossing under The Boulevard can be replaced with a structure sized to convey the 1:10-year, 1:25-year, 1:50-year or 1:100-year return frequency design storm peak flows, depending on the improvements implemented. The culvert crossing improvements required to increase the conveyance capacity of The Boulevard culvert crossing to equal the respective return frequency design storm peak flows are described under Alternatives 2 and 3.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 4A to provide a 1:50-year return frequency design storm peak flow capacity are $9.1M and $2.6M, respectively. These estimates include the cost of a pedestrian bridge at Brennan Avenue.

6.4.2 Alternative 4B – Remove Brennan Avenue at Whiskey Creek and Connect Brennan Avenue and The Boulevard

The only difference between Alternative 4A and 4B is the inclusion of the new transportation linkage (new local road) between Brennan Avenue and The Boulevard under Alternative 4B. As such, the watercourse and culvert crossing improvements described under Alternative 4A are consistent with those required for Alternative 4B. As the spill east starts within 20 m of the Brennan Avenue culvert crossing where the grade of the new road will have to tie into the existing grade of Brennan Avenue, the new section of road has only a minor impact on the spill east and frequency of flooding in the area.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.2M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 4B to provide a 1:50-year return frequency design storm peak flow capacity are $9.4M and $2.8M, respectively. These estimates include the cost of the new transportation linkage and a pedestrian bridge at Brennan Avenue.

6.4.3 Alternative 5A – Remove The Boulevard at Whiskey Creek

An opportunity exists to remove The Boulevard, including the culvert crossing, at Whiskey Creek daylighting the watercourse and removing a restriction to flow. The capacity of Whiskey Creek can be increased from Kempenfelt Bay to The Boulevard to convey the 1:10-year, 1:25-year, 1:50-year or 1:100-year return frequency design storm peak flows, depending on the improvements implemented. The watercourse improvements required to increase the conveyance capacity of Whiskey Creek to equal the respective return frequency design storm peak flows are described under Alternatives 2 and 3.

Likewise, the existing culvert crossing under Brennan Avenue can be replaced with a structure sized to convey the 1:10-year, 1:25-year, 1:50-year or 1:100-year return frequency design storm peak flows, depending on the improvements implemented. The culvert crossing improvements required to increase the conveyance capacity of the Brennan Avenue culvert crossing to equal the respective return frequency design storm peak flows are described under Alternatives 2 and 3.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 5A to provide a 1:50-year return frequency design storm peak flow capacity are $9.1M and $2.5M, respectively. These estimates include the cost of a pedestrian bridge at The Boulevard.

6.4.4 Alternative 5B – Remove The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard

The only difference between Alternative 5A and 5B is the inclusion of the new transportation linkage (new local road) between Brennan Avenue and The Boulevard under Alternative 5B. As such, the watercourse and culvert crossing improvements described under Alternative 5A are consistent with those required for Alternative 5B. As the spill east starts within 20 m of the Brennan Avenue culvert crossing where the grade of the new road will have to tie into the existing grade of Brennan Avenue, the new section of road has only a minor impact on the spill east and frequency of flooding in the area.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.2M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 5B to provide a 1:50-year return frequency design storm peak flow capacity are $9.4M and $2.7M, respectively. These estimates include the cost of the new transportation linkage and a pedestrian bridge at The Boulevard.

6.4.5 Alternative 6A – Remove Brennan Avenue and The Boulevard at Whiskey Creek

An opportunity exists to remove both Brennan Avenue and The Boulevard, including both culvert crossings, at Whiskey Creek daylighting the watercourse and removing two restrictions to flow. The capacity of Whiskey Creek can be increased from Kempenfelt Bay to The Boulevard to convey the 1:10-year, 1:25-year, 1:50-year or 1:100-year return frequency design storm peak flows, depending on the improvements implemented. The watercourse improvements required to increase the conveyance capacity of Whiskey Creek to equal the respective return frequency design storm peak flows are described under Alternatives 2 and 3.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.1M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 6A to provide a 1:50-year return frequency design storm peak flow capacity are $8.2M and $1.0M, respectively. These estimates include the cost of a pedestrian bridge at Brennan Avenue and The Boulevard.

6.4.6 Alternative 6B – Remove Brennan Avenue and The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard

The only difference between Alternative 6A and 6B is the inclusion of the new transportation linkage (new local road) between Brennan Avenue and The Boulevard under Alternative 6B. As such, the watercourse and culvert crossing improvements described under Alternative 6A are consistent with those required for Alternative 6B. As the spill east starts within 20 m of the

Brennan Avenue culvert crossing where the grade of the new road will have to tie into the existing grade of Brennan Avenue, the new section of road has only a minor impact on the spill east and frequency of flooding in the area.

The entire 7 Brennan Avenue property and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $1.2M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 6B to provide a 1:50-year return frequency design storm peak flow capacity are $8.5M and $1.2M, respectively. These estimates include the cost of the new transportation linkage and a pedestrian bridge at Brennan Avenue and The Boulevard.

6.4.7 Alternative 6C – Remove Brennan Avenue and The Boulevard at Whiskey Creek, Connect Brennan Avenue and The Boulevard and New Connection to Hurst Drive

Under Alternative 6C, the works described under Alternative 6B are proposed along with a second new transportation linkage (new local road) between Southview Road and Hurst Drive. This second transportation linkage is located outside the Whiskey Creek Regulatory floodplain and will have no impact on flooding along Whiskey Creek. As such, the hydraulic model results for Alternative 6C are consistent with those of Alternative 6B.

The entire 7 Brennan Avenue, 205 Shoreview Road and 207 Shoreview Road properties and a portion of 199 The Boulevard would need to be acquired by the City at an estimated cost of $2.5M to accommodate the proposed improvements. The estimate total upfront capital cost (including property acquisition) and 100-year life cycle cost of Alternative 6C to provide a 1:50-year return frequency design storm peak flow capacity are $10.2M and $1.4M, respectively. These estimates include the cost of the new transportation linkages and a pedestrian bridge at Brennan Avenue and The Boulevard.

6.5 HYDRAULIC RESULTS SUMMARY

A summary of the hydraulic model results for the various alternative solutions during the Regulatory Storm is presented in Table 6.

6.6 PROPERTY/INFRASTRUCTURE IMPACT SUMMARY

A summary of the property and infrastructure impacts identified for each alternative solution is provided in Table 7.

6.7 PROJECT COSTS SUMMARY

A summary of the property acquisition, upfront capital and life cycle costs associated with each alternative solution is presented in Table 8. The project cost estimates are included in Appendix I for reference.

Table 7: Hydraulic Model Results Summary

ALTERNATIVE	DESIGN FLOOD FREQUENCY		BRENNAN AVENUE CULVERT CROSSING				THE BOULEVARD CULVERT CROSSING				SPILL	
	LSRCA (2011)	DMP (2019)	Structure Size	Culvert Flow (m^3/s)	Weir Flow (m^3/s)	Depth of Overtopping (m)	Structure Size	Culvert Flow (m^3/s)	Weir Flow (m^3/s)	Depth of Overtopping (m)	Peak Flow (m^3/s)	% of Flow
1	<1:2	<1:2	3650 x 1500 mm Conc. Box	17.3	46.4	0.80	1800 x 1070 mm CSPA Culvert	4.1	69.3	1.31	15.9	21.5
2	1:100	>1:100	11.0 m x 2.0 m Span Structure	65.8	6.6	0.29	11.0 m x 2.3 m Span Structure	62.9	10.4	0.50	1.8	2.4
3	1:50	>1:100	13.4 m x 1.5 m Span Structure	53.6	16.8	0.46	11.0 m x 1.9 m Span Structure	51.2	22.1	0.78	5.2	7.1
	1:25	>1:50	11.0 m x 1.5 m Span Structure	49.4	19.4	0.54	7.9 m x 1.9 m Span Structure	45.6	27.8	0.89	5.6	7.5
	1:10	>1:25	9.8 m x 1.7 m Span Structure	39.0	28.9	0.66	7.3 m x 1.9 m Span Structure	43.3	30.1	0.92	10.1	13.6
Alternatives 4 through 6 can be designed to satisfy the 1:10-year, 1:25-year, 1:50-year and 1:100-year Design Flood Frequency (LSRCA approved flows) consistent with Alternatives 2 and 3 (see results presented above)												
7	<1:5	>1:5	3650 x 1500 mm Conc. Box	15.9	21.0	0.47	1800 x 1070 mm CSPA Culvert	3.7	36.5	1.07	6.3	15.4

Notes: 1) Results are presented for the Regulatory Storm. Capacities for the culverts/structures are under head during the Regulatory Storm.
2) Alternative 3 hydraulic model results presented for scenario where Whiskey Creek is regraded from Kempenfelt Bay to Brennan Avenue at 0.4%.

Table 8: Property/Infrastructure Impact Summary

ALTERNATIVE	DESIGN FLOOD FREQUENCY	PROPERTY ACQUISITION	INFRASTRUCTURE IMPACTS
1	<1:2	None	None
2	1:100	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Washroom/generator building, hydro transformer, park entrance, various utilities. **Adjust:** Brennan Avenue road profile. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
3	1:50	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Washroom/generator building, hydro transformer, various utilities. **Adjust:** Brennan Avenue road profile. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
	1:25	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Washroom/generator building, hydro transformer, various utilities. **Adjust:** Brennan Avenue road profile. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
	1:5	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
4A	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
4B	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
5A	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard. **Create:** Dead end requiring vehicle turn around at The Boulevard.
5B	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
6A	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard. **Create:** Dead end requiring vehicle turn around at The Boulevard.
6B	1:10	Brennan Avenue 199 The Boulevard (portion of)	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
6C	1:10	Brennan Avenue 199 The Boulevard (portion of) 207 Shoreview Road 205 Shoreview Road	**Relocate:** Hydro transformer, various utilities. **Lower/Relocate:** Sanitary force main. **Protect/Relocate:** Sanitary sewer and watermain at Brennan Avenue and The Boulevard.
7	< 1:5	36 White Oaks Road	**Lower:** Sanitary force main, sanitary sewer, watermain.

Table 9: Project Cost Summary

ALTERNATIVE	DESIGN FLOOD FREQUENCY	PROPERTY ACQUISITION COSTS	UPFRONT CAPTIAL COSTS	TOTAL UPFRONT PROJECT COST	LIFE CYCLE COST
1	<1:2-Year	$0	$0	$0.0M	$1.5M
2	1:100	$1.1M	$8.9M	$10.0M	$3.9M
3	1:50	$1.1M	$8.9M	$10.0M	$4.2M
	1:25	$1.1M	$8.3M	$9.4M	$3.5M
	1:10	$1.1M	$7.3M	$8.4M	$3.3M
4A	1:50	$1.1M	$8.0M	$9.1M	$2.6M
4B	1:50	$1.2M	$8.2M	$9.4M	$2.8M
5A	1:50	$1.1M	$8.0M	$9.1M	$2.5M
5B	1:50	$1.2M	$8.2M	$9.4M	$2.7M
6A	1:50	$1.1M	$7.1M	$8.2M	$1.0M
6B	1:50	$1.2M	$7.3M	$8.5M	$1.2M
6C	1:50	$2.6M	$7.6M	$10.2M	$1.4M
7	<1:5	$1.7M	$5.3M	$7.0M	$3.0M

Note: Property Acquisition Costs Estimated by City of Barrie; property acquisition costs to be fair market value determined at the time of sale.

7 Alternative Solutions Evaluation

The improvement alternatives developed in Section 5 have been evaluated with respect to their impact on the physical, natural, social, cultural and economic environments presented in Section 3.

The evaluation of the alternative solutions as previously described is descriptive or qualitative in nature allowing for a comparative evaluation of the pros and cons associated with each alternative. The evaluation is focussed on the ability of the alternatives to adequately address the problem statement, and in doing so, provide a solution that is consistent with the requirements of the governing policies. The evaluation of each improvement alternative is provided in Table 10.

Alternatives 4 through 6 involve implementing hydraulic improvements to increase the conveyance capacity of the drainage system downstream of The Boulevard consistent with Alternatives 2 and 3 while also completing transportation system modifications. The transportation system modifications include removing sections of road at Whiskey Creek and adding transportation linkages to address potential traffic and pedestrian movement. For Alternatives 4 through 6, the hydraulic improvements described under Alternative 3 for the 1:50-year return frequency design storm conveyance capacity were considered to complete a comparative evaluation of the hydraulic improvements plus transportation system modifications against the hydraulic improvements only. As such, the alternative solutions evaluation provided in Table 10 for Alternatives 4 through 6 is for the hydraulic improvements required to convey the 1:50-year return frequency design storm peak flow and the associated transportation system modifications for the corresponding alternative solutions.

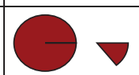
TABLE 10: ALTERNATIVE SOLUTIONS EVALUATION

Preferred Solution

Alternative	Description		PHYSICAL ENVIRONMENT		ECONOMIC ENVIRONMENT		SOCIAL/CULTURAL ENVIRONMENT		NATURAL ENVIRONMENT		Accumulated Score
			Description	Total Score	Description	Total Score	Description	Total Score	Description	Total Score	
EXISTING (BASELINE) CONDITIONS											
1	Do Nothing		<1:2-Year design storm peak flow conveyance capacity resulting in continued flooding; continued erosion; no impacts to transportation system.		Upfront capital cost (initial investment) = $0; 100-year life cycle costs (replacement costs) = $1.5M; no change to local businesses.		No Archaeological impacts; safe access/egress provided via only one access with frequent flooding of additional access points; no property impacts; and no impacts on noise, pedestrian access or traffic movement.		Improper bankfull channel width with continued erosion resulting in fish habitat degradation; no terrestrial impacts		
HYDRAULIC IMPROVEMENTS / FLOW DIVERSIONS											
2	Improve Culverts/Watercourse to Convey 1:100-Year Design Storm		1:100-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms; improved bankfull channel width with reduce erosion; relocation of park entrance required.		Upfront capital cost (initial investment) = $10.0M; 100-year life cycle costs (replacement costs) = $3.9M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with infrequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Flat channel from Kempenfelt Bay to Brennan Ave. resulting in fish habitat degradation; opportunity for minor terrestrial habitat enhancements.		
3	Improve Culverts/Watercourse to Convey Less Than 1:100-Year Design Storm	1:50-Year Design Storm Capacity	1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms; improved bankfull channel width with reduce erosion; relocation of park entrance required.		Upfront capital cost (initial investment) = $10.0M; 100-year life cycle costs (replacement costs) = $4.1M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with infrequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
		1:25-Year Design Storm Capacity	1:25-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms; improved bankfull channel width with reduce erosion; relocation of park entrance required.		Upfront capital cost (initial investment) = $9.4M; 100-year life cycle costs (replacement costs) = $3.5M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with infrequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
		1:10-Year Design Storm Capacity	1:10-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms; improved bankfull channel width with reduce erosion; no change to transportation system.		Upfront capital cost (initial investment) = $8.4M; 100-year life cycle costs (replacement costs) = $3.3M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with infrequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
		1:5-Year Design Storm Capacity	1:5-Year design storm peak flow conveyance capacity reducing flooding during minor storms; improved bankfull channel width with reduce erosion; no change to transportation system.		Upfront capital cost (initial investment) = $7.7M; 100-year life cycle costs (replacement costs) = $2.6M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
7	Additional Conveyance Route (Flow Diversion) Through 36 White Oaks Road		1:5-Year design storm peak flow conveyance capacity reducing flooding during minor storms; improved bankfull channel width with reduce erosion; no change to transportation system.		Upfront capital cost (initial investment) = $7.0M; 100-year life cycle costs (replacement costs) = $3.0M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of additional two access points; requires the acquisition of 36 White Oaks Road; and two years of construction with no noise impacts.		Improper bankfull channel width with continued erosion resulting in fish habitat degradation; no terrestrial impacts.		

TABLE 10: ALTERNATIVE SOLUTIONS EVALUATION

Preferred Solution

Alternative	Description		PHYSICAL ENVIRONMENT		ECONOMIC ENVIRONMENT		SOCIAL/CULTURAL ENVIRONMENT		NATURAL ENVIRONMENT		Accumulated Score
			Description	Total Score	Description	Total Score	Description	Total Score	Description	Total Score	
PREFERRED HYDRAULIC IMPROVEMENTS / FLOW DIVERSION PLUS TRANSPORTATION SYSTEM MODIFICATIONS											
3	Improve Culverts/Watercourse to Convey Less Than 1:100-Year Design Storm	1:50-Year Design Storm Capacity	1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms; improved bankfull channel width with reduce erosion; relocation of park entrance required.		Upfront capital cost (initial investment) = $10.0M; 100-year life cycle costs (replacement costs) = $4.1M; short term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with infrequent flooding of additional two access points; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
4A	Remove Brennan Avenue at Whiskey Creek		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight section of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave..		Upfront capital cost (initial investment) = $9.1M; 100-year life cycle costs (replacement costs) = $2.6M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of single additional access point; only one access to Brennan Ave.; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
4B	Remove Brennan Avenue at Whiskey Creek and Connect Brennan Avenue and The Boulevard		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight section of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave. and new transportation linkage (between Brennan Ave. and The Boulevard).		Upfront capital cost (initial investment) = $9.4M; 100-year life cycle costs (replacement costs) = $2.8M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of single additional access point; two accesses to Brennan Ave.; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
5A	Remove The Boulevard at Whiskey Creek		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight section of watercourse and improved bankfull channel width with reduced erosion; removal of The Boulevard.		Upfront capital cost (initial investment) = $9.1M; 100-year life cycle costs (replacement costs) = $2.5M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of single additional access point; two accesses to Brennan Ave.; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
5B	Remove The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight section of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave. and new transportation linkage (between Brennan Ave. and The Boulevard).		Upfront capital cost (initial investment) = $9.4M; 100-year life cycle costs (replacement costs) = $2.7M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; safe access egress provided via only one access with frequent flooding of single additional access point; two accesses to Brennan Ave.; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
6A	Remove Brennan Avenue and The Boulevard at Whiskey Creek		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight sections of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave. and The Boulevard.		Upfront capital cost (initial investment) = $8.2M; 100-year life cycle costs (replacement costs) = $1.0M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; less than two accesses available; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with no noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
6B	Remove Brennan Avenue and The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight sections of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave. and The Boulevard and new transportation linkage (between Brennan Ave. and The Boulevard).		Upfront capital cost (initial investment) = $8.5M; 100-year life cycle costs (replacement costs) = $1.2M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; less than two accesses available; requires the acquisition of 7 Brennan Ave and a portion of 199 The Boulevard; and two years of construction with noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		
6C	Remove Brennan Avenue and The Boulevard at Whiskey Creek and Connect Brennan Avenue and The Boulevard and New Connection to Hurst Drive		1:50-Year design storm peak flow conveyance capacity reducing flooding during minor and major storms, daylight sections of watercourse and improved bankfull channel width with reduced erosion; removal of Brennan Ave. and The Boulevard and new transportation linkages.		Upfront capital cost (initial investment) = $10.2M; 100-year life cycle costs (replacement costs) = $1.4M; long term impacts to local businesses.		Elevated potential for archaeological artifacts in work area; two accesses available; requires the acquisition of 7 Brennan Ave, 205 Shoreview Road, 207 Shoreview Road and a portion of 199 The Boulevard; and multiple years of construction with noise impacts.		Construction of proper bankfull channel width using natural channel designs to improve fish habitat; opportunity for minor terrestrial habitat improvements.		

Negative	Neutral Impact	Positive
Greatest … Least		Greatest … Least

8 Public Consultation

For the Whiskey Creek Drainage at Minet's Point Municipal Class EA update, Public consultation was completed in accordance with the Schedule 'B' Municipal Class Environmental Assessment process outlined in the Municipal Engineers Association (MEA) Municipal Class Environmental Assessment Document (October 2000, as amended in 2007, 2011 and 2015). The public consultation undertaken for this study is outlined in the following sections.

8.1 NOTICE OF STUDY COMMENCEMENT AND PUBLIC INFORMATION CENTRE

Prior to the PIC, a Draft Environmental Assessment document was prepared for agency circulation and was made accessible via the City's webpage. A Notice of Study Commencement was published September 10 and 17, 2020 presenting the EA process and scope of the study. Further letters were sent to stakeholders to notify them of the PIC. This notification included a copy of the PIC comment sheet to provide everyone with an opportunity to ask questions and provide input/comments regarding the study. The Notice of Study Commencement and PIC notification letter are enclosed in Appendix J for reference.

Due to provincial COVID-19 gathering restrictions, the Public Information Centre was held virtually. A presentation describing the alternative solutions, in addition to the Draft Class EA Report, were made available on the project website. Local residents, business owners and interested stakeholders were notified of the materials and two virtual Q&A sessions were held on February 9th, 2021 and February 16th, 2021 for stakeholders to join via Microsoft Teams or by phone to ask questions and provide input/feedback regarding the study. Additional contact with interested stakeholders was made via phone and virtual meetings as requested. Comment sheets were provided, and attendees were encouraged to identify their preferences regarding the alternative design solutions. The PIC materials are enclosed in Appendix J for reference.

8.2 RESULTS OF PUBLIC CONSULTATION

The Virtual Q&A sessions were attended by fifteen (15) interested stakeholders, while written comments were provided by sixteen (16). Overall, twenty-one (21) interested stakeholders provided verbal/and or written comments. In addition to the interested stakeholders who attended the PIC, written comments were received from the following parties/agencies:

- Curve Lake First Nations; and
- Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI).

A copy of the Q&A sessions attendance sheet, as well as the comments received, are available in Appendix J for reference. A summary of the comments received is provided in Table 11.

8.3 PUBLIC PREFERENCE

Of the 21 stakeholders that either attended the Q&A sessions or returned a completed comment sheet, 15 felt that improvements are required to reduce the flooding in the study area while 6 preferred the "Do Nothing" alternative.

With regards to the proposed alternatives, the majority of stakeholders did not approve of the park entrance being relocated as part of the creek improvements. Similarly, changes to the transportation systems under Alternative Solutions 4 through 6 were not supported by the public. Through a review of these comments, it has been determined that the alternative solution preferred by the public is Alternative Solution 3 to reduce the frequency of flooding while minimizing the impact to the park and infrastructure in the area.

Comments not directly related to the alternative evaluation included concerns related to preserving the natural environment of the creek, removing sediment buildup, widening White Oaks Road and maintaining privacy for the properties west of the creek. These comments have been documented and will be considered during the detailed design phase of this project.

Table 11: Summary of Comments Received from Interested Stakeholders

Respondent ID	Response to Questions 1 (Y/N)	2 (A/B/C)	3 (Y/N)	4 (Y/N)	Preferred Solution (ALT)	Requests/Comments
1	Yes	B	No	No	3	Prefers Park entrance is not relocated
2	Yes	B	No	No	3	a) Privacy fencing/landscaping along Whiskey Creek
						b) Preservation/improvement of habitat along creek
						c) Prefers no changes to road network or park entrance
						d) Against Alternative 7
3	Yes	B	No	No	3	Urgent culvert repair required on Whitty Lane
4	Yes	C	No	No	3	a) Prefers Park entrance is not relocated
						b) Prefers a reasonable remediation of creek
						c) No impact on surrounding environment/neighbourhood
5	Yes	B	Yes	No	3	a) Privacy concerns of kayaks going up the creek
						b) Prefers removal of sediment at mouth of creek
6	No	C	No	No	1	a) Against Alternatives 4-6
						b) Against transportation system modifications
						c) Prefers improvements that have minimal impacts
7	No	C	No	No	1	a) If work is being done, prefers highest level of service
						b) Does not support changes to park entrance and roads
8	Yes	B	No	No	3	a) Prefers Park entrance is not relocated
						b) Preservation of trees and shrubs along creek
						c) Supports new culverts and widening creek
9	No	A	Yes	-	3	Against Alternative 7
10	Yes	C	No	No	3	a) Prefers Park entrance is not relocated
						b) Supports new culverts and widening creek
11	Yes	B	Yes	Yes	3	a) Against Alternative 7
						b) Supports Alternative 3
12	No	C	No	No	3	a) Prefers no changes to road network or park entrance
						b) Preservation/improvement of habitat along creek
						c) Supports only minor improvements to creek
13	Yes	A	No	No	3	a) Supports Alternative 3
						b) Does not support closing Brennan Ave
14	Yes	B	No	No	3	a) Prefers no changes to road network or park entrance
						b) Minimizing impact to residents top priority
15	Yes	A	No	No	3	a) Prefer no changes to road network or park entrance
						b) Supports Alternative 3
16	Yes	B	-	Yes	6A	a) Preservation/improvement of habitat along creek
						b) Support pedestrian safety improvements along WOR
17	-	-	-	-	3	a) Supports new culverts and widening creek
						b) Prefers the removal of sediment at mouth of creek
18	-	-	-	-	3	a) Preservation/improvement of habitat along creek
						b) Support widening White Oaks Rd for pedestrians
19	-	-	-	-	1	Does not support improvements to creek
20	-	-	-	-	1	Prefers no changes to road network or park entrance
21	-	-	-	-	3	a) Prefers no changes to road network or park entrance
						b) Supports Alternative 3

9 Preferred Solution

Following a comprehensive review of the alternatives, receipt of all comments from the interested stakeholders and agencies, the preferred solution is Alternative 3 - Improve Culvert/Watercourse to Convey Less Than 1:100-Year Design Storm. Alternative 3 was identified as the most beneficial option during the alternative solutions evaluation and has the support of most of the interested stakeholders. Based on the results of the alternative solutions evaluation, designing the hydraulic improvements to convey the peak flow generated by the 1:50-year design storm produces the greatest overall positive improvement.

It is noted, the *City's Storm Drainage and Stormwater Management Policies and Design Guidelines* specify that urban local road culvert crossings, such as those on Brennan Avenue and The Boulevard, satisfy the 1:50-year design flood frequency criteria. Also, the recommendations of the DMP include drainage infrastructure improvements upstream of The Boulevard. These improvements are to satisfy, at a minimum, the 1:50-year design flood frequency. As such, designing the preferred solution to convey the 1:50-year design flood frequency criteria satisfies the City's design flood frequency criteria and is consistent with the recommendations of the DMP.

To implement the preferred solution, the existing washroom/generator building must be relocated. Relocating the washroom/generator building is recommended to remove it from the erosion hazard associated with Whiskey Creek and to reduce the frequency the building floods. Based on the results of the Condition Assessment, the washroom/generator building structural components were identified for replacement in the long-term (11-25 years). As replacement of the washroom/generator building is planned in the long-term, implementation of the preferred solution in phases is recommended. Specifically, a portion of the works should be completed ahead of the replacement of the washroom/generator building to reduce flooding through the study while and the remainder of the works are to be completed once the washroom/generator building is relocated. Otherwise, any improvements in the study area would have to occur in the long-term, with flooding and public safety concerns persisting throughout the study area.

The limiting capacity of the watercourse through the study area is The Boulevard culvert crossing and it should be replaced as part of the first phase of construction. The Brennan Avenue culvert crossing has been identified as requiring replacement in the short-term (1-5 years) and should also be included in the first phase of construction. As such, the proposed improvements from Brennan Avenue, including the Brennan Avenue culvert crossing, upstream to the upstream limit of the study area should be completed as part of the first phase of construction. The remaining works downstream of Brennan Avenue would be completed as part of the second phase of construction after the

washroom/generator building has been replaced outside limits of the proposed works and erosion hazard associated with Whiskey Creek as recommended.

In the interim, until the washroom/generator building is relocated, the building should be floodproofed. The washroom/generator building should be floodproof to an elevation 0.3 m above the Regional Storm water level or 220.75 m. The City should also consider floodproofing the Minet's Point Sewage Pumping Station to prevent inflows into the sanitary system that may overwhelm the sewage pumping station. Under existing conditions, flood levels are expected to inundate the sewage pumping station, at levels at or above the lid and vent, during major storm events.

It is understood that the implementation of the preferred solution is subject to available capital funding and may not occur for several years. At the time of detailed design, it is recommended that a condition assessment be completed to re-evaluate the washroom/generator building condition. If the results of the condition assessment determine the washroom/generator building needs to be replaced, it is recommended the reconstructed building be relocated away from Whiskey Creek and separate washroom and generator buildings be constructed. This would allow the preferred alternative solution to be constructed in its entirety, starting from downstream to upstream, in one phase of construction rather than two. However, due to the anticipated construction timeline to complete the works and the applicable fisheries timing window for this reach of Whiskey Creek, two years of construction is expected for the proposed works.

Replacement of the washroom/generator building in a new location without altering the sewage pumping station is a Schedule A+ project as defined in the Municipal Class Environmental Assessment document. As such, the replacement of the building is pre-approved subject to advising the public of the project prior to implementation.

The preferred solution is illustrated on the Conceptual Drawing (CP-2) enclosed. The preferred solution including the cost and property acquisition requirements are summarized in the following table.

Table 12: Preferred Alternative Summary

	1:50-YEAR
Brennan Ave. Culvert Crossing	13.4 m x 1.5 m Span Structure
The Boulevard Culvert Crossing	11.0 m x 1.9 m Span Structure
Design Capacity (m^3/s)	51.2 (during the Regional Storm)
Property Acquisition	7 Brennan (all of) 199 The Boulevard (portion of)
Property Acquisition Cost	$1.1M
Construction Cost	$8.9M
Total Project Cost	$10.0M

10 Detailed Design and Construction

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

- Development, Interference with Wetlands & Alteration to Shorelines & Watercourses Permit – LSRCA; and
- Permit to Take Water – MECP.

During the detailed design of the Preferred Alternative Solution, the owners of the existing utilities in the study area should be notified of the proposed works, of any impacts the proposed works will have on the existing utilities, and of any conflicts or relocates required to complete the infrastructure improvements. Coordination with existing utilities will be required throughout detailed design and construction.

A Stage 2 Archaeological Assessments must be completed prior to the implementation of the preferred alternative solution, as early as possible during detailed design prior to any ground disturbance, including the required geotechnical/hydrogeological investigation. No construction activities shall take place within the study area prior to the Ministry of Heritage, Sport, Tourism and Culture Industries (Archaeology Program Unit) confirming in writing that all archaeological licensing and technical review requirements have been satisfied. Also, Curve Lake First Nation Cultural Heritage Liaisons are to be present during the Stage 2 AA.

Detailed design also needs to be completed in accordance with the recommendations of the Whiskey Creek at Minet's Point Fluvial Geomorphological Assessment and Design Alternative Review (Water's Edge Environmental Solutions Team, 2020) and the Whiskey Creek Drainage Improvements Natural Heritage Resources Technical Memorandum (Riverstone, 2020) enclosed.

A detailed geotechnical/hydrogeological investigation is required to verify the soil and groundwater conditions within the limits of construction. The geotechnical investigation is required in support of the culvert foundation design and to provide geotechnical recommendations regarding stable slopes, erosion protection measures, bedding and backfill, etc. A hydrogeological investigation is required to design the dewatering system and confirm the PTTW requirements for the project.

As part of this EA, alternative culvert foundation designs were considered, including helical piles, drilled piles and concrete footings. Drilled piles were determined to be the most cost-effective culvert foundation at Brennan Avenue and The Boulevard based on the available soils information. However, as part of final design, the culvert foundations will have to be re-evaluated based on the results and recommendations of the geotechnical investigation completed for the project.

As part of detailed design, the following should also be considered:

- Protection of the washroom/generator building as part of the first phase of construction – In the interim condition (Phase 1 construction) prior to the relocation of the washroom/generator building, the channel improvements will widen Whiskey Creek upstream of the washroom/generator building. The existing channel will remain adjacent to the washroom/generator building and the watercourse will transition from its ultimate cross-section back to existing between Brennan Avenue and the washroom/generating building. The transition will be susceptible to erosion and needs to be protected or armoured to prevent erosion of the channel next to the washroom/generator building.
- Revising the centerline road profile of The Boulevard above the culvert crossing - The existing low point in the centerline profile of The Boulevard is at its intersection with White Oaks Road. When flow in Whiskey Creek overtops The Boulevard it is directed to White Oaks Road and flows down White Oaks Road rather than reentering the watercourse. As part of the detailed design of The Boulevard culvert crossing, relocating the low point in the centerline road profile of The Boulevard directly over top of the culvert should be explored in an attempt to reintroduce flow back into Whiskey Creek on the downstream side of The Boulevard rather than it flowing down White Oaks Road.
- Pedestrian access/connectivity – concerns were expressed by local residents regarding the lack of sidewalks on and connectivity to Minet's Point Park from The Boulevard, White Oaks Road (north of The Boulevard), Brenna Avenue and Lismer Boulevard. As part of the detailed design of the preferred solution, opportunities to construct sidewalks, add trails and improve pedestrian access to the park through the study area should be explored.

11 Conclusion

The recommendations contained herein were submitted for Council review and endorsement of the preferred solution was received May 31, 2021. Council ratified the Whiskey Creek Drainage improvements at Minet's Point EA, approving the preferred solution. Those individuals and parties that requested to be kept informed of the Municipal Class EA process were notified of the selection of a Preferred Alternative Solution and the steps of the process moving forward. A Notice of Study Completion will be published June 17 and 24, 2021 (see Appendix L) initiating the 30-day review period.

If concerns are raised during the review period which cannot be resolved in discussion with the City of Barrie, the Minister of the Environment and Climate Change may be requested to make an Order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order), which addresses individual Environmental Assessments. Requests must be received by the Minister at the address below within thirty (30) days of the publication of the Notice of Completion for the project. A copy of the request must also be sent to the City of Barrie Corporate Asset Management Branch.

The Honourable Jeff Yurek
Minister of the Environment, Conservation and Parks
College Parks 5th Floor
777 Bay Street
Toronto, ON M7A 2J3

Nathanael Couperus, MASc., P.Eng.
Corporate Asset Management Branch
The Corporation of the City of Barrie
70 Collier Street
Barrie, ON L4M 4T5

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